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Wireless Telegraph and Signal Company—Mtg., 142; Stat., 371
Yorkshire House-to-House Electricity Company—Rpt., 436; Mtg., 501; Stat., 676
York Tramways Company—611

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THE ELECTRICIAN:

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ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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NOTES.

WE tender our sincere and most hearty congratulations to Prof. D. E. HUGHES, upon the latest mark of public appreciation of his benefactions to mankind. The KING OF THE BELGIANS has just conferred upon the genial Professor the decoration of Officier de l'Ordre Leopold. For over twenty-seven years Prof. HUGHES's type-printing telegraph has been largely used on the Belgian Government telegraph lines; and the honour recently conferred upon him has been, no doubt, chiefly prompted as a recognition of his services in this direction. But Belgium in common with every other country cannot afford to forget that it was Prof. HUGHES who freely gave to the world the invention that made telephony a practical and commercial possibility. At a time when other nations are beginning to estimate aright the importance of his services, and are tendering to him their public recognition and thanks, it surely behoves Great Britain no longer to delay her full measure of national appreciation of DAVID HUGHES's labours.

THE POSTMASTER-GENERAL'S Report for the financial year 1896-7, just issued, is as cheery as ever, the gigantic earnings of the Post Office in the previous year being even exceeded during the year now completed; and the only note of regret seems to be provoked by the fact that a profit which would have been £3,893,823 has been curtailed to £3,753,109, owing to a loss on the Telegraph Service amounting to £140,714. Not that the telegraph has been relatively unprosperous—its increase both in traffic and earnings being very substantial: but the expenditure on extensions has been unusually heavy, the cost of which has practically swallowed up the additional revenue. As, however, this expenditure is incurred at the instance of the Post Office, any commiseration we might be disposed to feel for it on account of the financial shortcomings of its adopted child would be misplaced. Indeed, when we look into the figures rather closely, it would seem that the Telegraph Service and not the Post Office is the real sufferer. Under the headings of "Sites and Buildings" and "Telegraph Extensions," the sums expended exceed by more than £100,000 those under the corresponding heads of capital expenditure in the postal account. No wonder that the "Percentage of Total Expenditure to Total Revenue" is so widely different in the two services—67·94 in the case of the Post Office, whilst for the Telegraphs it amounts to 104·74.

NOT that anybody finds fault with the expenditure itself; it is money well laid out, for which the country gets a fully adequate return; but it would not be spent if the Telegraph Service were conducted on those business lines which are stringently adhered to in Post Office affairs. With an income of, roughly, twelve millions, the expenditure of the latter is eight millions and a-quarter only; whereas the income of the Telegraphs, which is barely three millions, is charged with expenditure to the tune of over three millions. We are glad to notice that some part of these millions is being spent on underground wires to the Midland counties, necessitated partly by the ever-recurring storms which play havoc with the overhead systems from the Bristol Channel to the Wash almost every year; but partly also to avoid disturbance to the newly-erected trunk telephone wires. No information is yet forthcoming as to the success of these trunk wires from a money-earning point of view. One other matter of interest telegraphically is the Appendix to the Report referring to the proposed official vocabulary of "code words." This is given in full on another page.

IN view of the general opinion expressed at a meeting of Section A, of the British Association, at Toronto, that the Clark cell would soon be displaced by the cadmium cell, as a standard of electromotive force, the specification of the cadmium cell used by the Physikalisch-Technische Reichsanstalt, which will be found in another column, should prove of great practical interest, the more so since at this moment the Clark cell is passing through the fires of severe criticism. Doubt was expressed at Toronto as to whether the cadmium cell could be set up as readily as the Clark cell, by a person

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unskilled in the operation; but this doubt should vanish after reading how easily the Reichsanstalt pattern may be put together. Even though the cadmium cell should not ultimately supplant the zinc standard cell, there is a decided advantage in "having two strings to one's bow," especially when the second string is such a remarkably good one.

During the past week we have had an opportunity to take part in some tests of an alternate-current enclosed arc lamp, the joint invention of Mr. W. J. Davy and Mr. G. Thomas Davies, which leave no doubt as to the practical difficulties having been at last surmounted in the construction of a commercially-successful lamp of that much-desired type. For some time past the continuous-current enclosed arc lamp, both in this country and in America, has grown increasingly in favour and has largely supplanted arcs of the open type. Whether it is the better diffusion of light or the higher economy of carbon that has chiefly brought about the change may be a matter of individual opinion, but there can be no dispute that in both respects a well-constructed enclosed lamp is far superior to any open type of arc on the market. Until quite recently, however, the advantages produced by enclosing the arc have been available only with continuous currents, and all efforts to make a really satisfactory alternating enclosed lamp have been baffled by the peculiar difficulties the use of periodic currents involves. From time to time, indeed, one heard that makers, both in England and America, had solved the problem; but the few patterns that actually emerged from the experimental stage and made their appearance on the market were imperfect and unsatisfactory in their action.

As we hope to be able shortly to give our readers a full description of the new type of enclosed alternating lamp which is being made by the Davy Electrical Construction Company, we need now only publish the details of the tests which we made last Tuesday. The lamp tested had two 18mm. cored carbons enclosed in an opal glass globe of cylindrical shape. It ran in series with a choking coil on a constant-pressure alternate-current circuit, with a frequency of 50 cycles per second, and the voltage on the lamp itself remained steadily at 77 volts, while there were 68 volts across the arc, which exceeded ½in. in length. The current through the arc was about 8½ amperes. Photometered in a horizontal plane passing through the arc the observed candle-power was 357, the simultaneous consumption of power being 540 watts. This corresponds to a consumption of about 1·51 watts per candle—a very satisfactory performance for so small a lamp. Photometered at 45deg. to the horizontal plane, the candle-power was 420, with an expenditure of 540 watts, as before—a result corresponding to 1·28 watts per candle. During the whole test, and indeed during all the time that this and other lamps of the same type were under our observation, the light was white and steady and was also well diffused. The consumption of carbon appears to be at the rate of about 3·62mm. per hour for the two carbons together, or 1·5mm. at the top and 2·12mm. at the bottom. We have only to add that the physics of the alternating enclosed arc appear to be of an exceedingly complex though highly interesting character, and we hope that Mrs. Ayrton will be tempted to extend her valuable researches into that domain.

Balancing to false zero is usually deemed an unavoidable inconvenience in tests on submarine cables, and although scale zero methods have been suggested from time to time they have not found general favour with cable men. Whether the methods suggested by Mr. C. W. Schaefer in another column are entirely new or not they deserve careful consideration and trial, and we trust that we may hear the results of their application and the comparative accuracy obtained with them and other methods.

In view of the importance of the localisation of faults it is to be regretted that more quantitative information has not been published. It is reasonable to suppose that several methods of localisation are employed on each occasion that a fault develops in an important submarine line, and full numerical descriptions of such tests with a note as to their agreement with the actual position of the fault—although perhaps not so suitable for presentation to the Institution of Electrical Engineers as descriptions of singular breakages and hypotheses concerning sub-oceanic disturbances—are highly appreciated by telegraph men and should find their way to the technical journals. The description of a new method is valuable, but, when this is supplemented by actual numerical data from cases in which it has been applied, its value is enormously increased.

Deputations to the Continent seem to be the order of the day with the Manchester Corporation. We reprint elsewhere an abstract of the report of a deputation which recently visited a large number of Continental cities to inspect electric lighting and traction plant. The deputation consisted of Alderman Higginbottom, Chairman of the Electricity Committee, Councillor Phythian and Mr. C. H. Wordingham, the city electrical engineer. There has also returned from the Continent a deputation charged with the mission of investigating the systems of technical education in operation there; and the report of this latter body has appeared almost simultaneously with that of the first-named deputation. Although these two deputations have dealt with matters apparently isolated from one another, there is, as we shall presently show, good reason for commenting upon them conjointly.

Perusal of the abstract of the report on electric lighting and traction given elsewhere in this issue serves to show quite as accurately as reading the full report that the deputation have returned immensely impressed in favour of the Continental way of doing things. It was almost inevitable that they should acquire a good opinion of the trolley system, and that they should recommend its use on Manchester tramways. But we were hardly prepared for the wholesale imitation of Continental practice which the report recommends. If the scheme proposed should ever be strictly carried out, and without modification, Manchester streets will present overhead a sorry spectacle of span wires, guy wires, frogs *et hoc genus omne*. We protest that span wires stretched across the street,

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with double lines of poles, are *not* essential to the overhead trolley system. What is considered good enough f r the streets of Milan or Rome may or may not be good enough for Manchester or London, but that is not the point. What must be decided is—In how far these "good-enough" things are essential; to what extent they may be dispensed with without sacrificing the advantages of the overhead system of electric traction.

We wonder whether the Manchester electric traction deputation have thought it worth while to look at examples of trolley construction nearer home. Have they been to Bristol, or to Leeds? Or, have they been careful to note that in the best and most recent overhead construction in the United States, it is not the ugly span-wire system, but the pole-and-bracket method—similar to what may be seen at Leeds and Bristol—that has been adopted? So thoroughly enamoured of span wires have the deputation become that they are not content to use them for the trolley wires, but would also use them for arc lamps in all streets through which there are no tramways. In certain back streets, where both roadway and sidewalks are too narrow to afford space for poles, it is conceivable that this method of supporting arc lamps might be superior to the use of brackets; but, considered as a general rule, it is clumsy and unsightly, and offers no advantage that is not afforded, with fewer disadvantages, by the use of centre or side poles, or, where necessary, wall brackets.

Thus imbued with the notion that in the Continental method of doing things is to be found the one and only solution of the electric traction problem, the deputation has ventured to lend colour to the report of the sister deputation on technical education, an abstract of which we gave last week on pp. 876 7. At a meeting of the Manchester City Council recently, when this second report was under discussion, one of the members of the traction deputation, speaking for himself and his colleagues, regretted that they were "forced to the conclusion that England was very much behind Continental nations in regard to electrical work." He referred to the common belief that England is the home of engineering, and affirmed that it was erroneous. On the Continent he had seen "triple expansion engines—which they thought they could build in Lancashire better than anybody else—and he was bound to say that he had never seen finer." And the cause of all this was—our neglect of technical education.

Were it not that the character of Great Britain as the leading engineering nation is quite able to take care of itself, it would be time indeed to cry for a champion. Apparently the Chairman of the Electricity Committee would not only adopt Continental methods, but he would also purchase Continental plant for his lighting and tramway systems. Shall the alleged invasion of this country by American tramway plant be accompanied by a similar invasion from the Continent? The spectacle of a combination on Lancashire ground of Continental steam engines and dynamos with American tramway equipment would indeed be ludicrous. Nor need the humour of the thing be marred by any alarm; for the mania for un-English methods and machinery will soon have had its brief day, and the British engineer, we feel sure, will have proved again that he is still capable of taking the lead.

Makers of dynamos may with propriety quake now that the new "electrical generator" has come. This noteworthy apparatus is described in last week's *Chemical News* in words whose full beauty can only be appreciated by quotation. "Experiments of a lengthy nature which have also been engaged in at the above laboratory have at last terminated in the successful introduction of an electrical generator, which, even at the present time, although only in its infancy, is more than promising as a liberal source of electricity, not only on account of the extremely low rate of the chemicals employed, but also at the same time ranking next to perpetual motion on account of its perfect resuscitation, whereas the simplicity of its construction enables anyone, without any special knowledge, to obtain at a trifling expense an electrical current of almost any required pressure." After this alluring announcement, superior as it is to sense and syntax, it is depressing to find that the "generator" consists of a zinc rod in a porous pot (apparently destitute of electrolyte) acting as "a negative element" (which is unusual in a primary cell), and opposed to platinised carbon in a solution of ferric sulphate. The ferric sulphate is intended to serve as a depolariser, and is regenerated by the oxidising effect of air absorbed under the influence of the platinised carbon. "With four ounces of ferric salt, contained in a generator 7in. by 5in., an electric current may be maintained with very slight fall at 2 volts 8 amperes for 24 hours." Information as to the consumption of zinc is evidently unessential; perhaps that, as well as the ferric sulphate, is regenerated by, let us say, the ions of hydrogen from dissociated water vapour present in the atmosphere of the favoured spot chosen for the demonstration of the powers of "resuscitation" of the "generator." Verily it is a phœnix, and we commend it to the attention of ingenious gentlemen who construct and exploit primary batteries for purely company-promoting purposes.

[Owing to pressure on our space this week we are compelled to hold over some of our correspondence.]

Lectures on Patent Law.—It is announced that a course of six lectures on "Patent Law" will be delivered by Mr. J. Fletcher-Moulton, Q.C., in Middle Temple Hall on Tuesday, November 22nd, and following Tuesdays, at 7.45 p.m.

Postal Electric Motor-Van.—An electric motor-van is now being tried by the Post Office, for the conveyance of mails between St. Martin's-le-Grand and the S.W. district office in Victoria-street. During the past few days the van has been making five journeys a day.

The Siemens Engineering Society.—The inaugural meeting of this Society, which has been formed among the employés of Messrs. Siemens Bros. and Co., was held at the Charlton Assembly Rooms, on the 19th inst., when the President, Mr. Alexander Siemens, delivered an address.

Cable Interruptions.—

	Date of Interruption.
Obidos—Parintins	Dec. 7, 1896
Hong Kong—Macao	Sept. 28, 1897
Cayenne—Pinheiro	Sept. 29, 1897
Otranto—Vallona	Oct. 11. 1897
Alemquer—Santarem	Oct. 21, 1897
Paramaribo—Cayenne	Oct. 25, 1897
Cadiz—Teneriffe	Oct. 26, 1897

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Galileo Ferraris Memorial.—The Council of the Institution of Electrical Engineers desire it to be known that they will be happy to take charge of and remit to Milan the subscriptions of members of the Institution towards the fund being raised for the purpose of erecting a monument to the memory of the late Professor Galileo Ferraris. Such subscriptions should be made payable to and addressed to the Secretary of the Institution of Electrical Engineers.

Another Underground Electric Railway.—According to the Central News, surveys are being got ready for a deep-level electric railway, connecting the London, Brighton and South Coast main lines on the south of London with Euston, St. Pancras, and King's Cross terminal stations on the North-Western, Midland and Great Northern railways. The proposed line will pass through the heart of the West End, and have a station in the Strand.

Electric Traction in Dublin.—The second section of the Dublin tramways system, which has been electrically equipped by the British Thomson-Houston Company, is now completed, and the formal opening will shortly take place. The first section, viz., that from Ballsbridge to Dalkey has been running successfully during the past 18 months, and additional plant is now being erected in the Ballsbridge power station. An inclusive contract has just been made with the British Thomson-Houston Company to equip electrically the remainder of the tramways system now being worked by horses. When the entire conversion has been completed there will be in Dublin no less than 110 miles of track, operated by about 200 motor cars. A large central power station is being designed, the machinery of which will operate this entire system.

The Institution of Junior Engineers.—The annual general meeting of this Institution was held at the Westminster Palace Hotel on Friday, October 22, Mr. H. B. Vorley, Chairman of Council, presiding. The report of the Council contained a very satisfactory record of the proceedings of the society during the past year. Sixty-eight new members had been elected, and after making allowance for removal from the register, the total membership at the present time was shown to be 480. Seven meetings for the reading and discussion of Papers had been held, eleven visits to engineering works in the London district had been made, and numerous other works had been seen during the summer meeting in the North of Ireland. The Institution premium had been awarded to Mr. W. R. Beckton for his Paper on "The Protection of Buildings from Fire." The names of the members elected to the Council for the coming session were read, and it was announced that Sir A. R. Binnie, the retiring President, would be succeeded by Mr. John A. F. Aspinall, chief mechanical engineer of the Lancashire and Yorkshire Railway.

Water Power Utilisation on the Hudson River.—On the upper reaches of the Hudson River, says the *Electrical World* of New York, near the town of Mechanicville, the Hudson River Electric Power Transmission Company is erecting hydraulic works for electric power development of great magnitude. The concrete dam is rapidly approaching completion, and work in all branches is being steadily pushed forward. At the point selected for the hydraulic development a small island about midway of the stream divides the flow of water into two parts. Across the two channels thus formed concrete dams, having an aggregate length of about 1,000ft., are being erected. The concrete of which these are composed is made of broken rock brought from the neighbourhood of Schenectady, the shale of the river bottom at that point not proving to be available for this purpose. The dam was constructed with an almost vertical back, and a curved apron deflecting the overflow water into a practically horizontal flow to eliminate all danger of washing away the sub-structure. At the ends of the dam massive piers of concrete of circular plan are anchored solidly into the rock of the shore. The power house is to be built integrally with the western portion of the dam, and, as in certain other modern constructions of this character, horizontal turbines below the water level will be used, the dynamos being direct-connected to the shafts of these. The plan includes the installation of seven dynamos of 750 kilowatts each, though only five of these will be installed at present. These generators will be of the General Electric three-phase type. The turbines are each 42in. in diameter, four of these being mounted on each shaft for the operation of a single dynamo. These wheels will work under a head of 18ft., nearly all of which is comprised in the draught tubes, which extend from large iron casings between the two wheels of each pair, two pairs forming a set. Under the conditions of operation these wheels are expected to develop 250 H.P. each, or 1,000 H.P. for a set of four. In addition to the main turbines two smaller wheels are being installed for the operation of exciters. It is stated that the larger part of the power will be transmitted to Schenectady, 24 miles distant, for use at the works of the General Electric Company, although it is also intended to distribute a portion of this power in Albany, Troy and other towns and cities in the immediate neighbourhood of Mechanicville.

Laval Steam Turbine Working at 200 Atmospheres Pressure.—Under the above heading *l'Industrie Electrique* states that at the Stockholm Exhibition experiments have been made with turbines at pressures varying from 50 to 220 atmospheres, but the numerical results of such tests are not given. It is pointed out that the fundamental principle of the Laval steam turbine is that the steam is completely expanded before reaching the vanes on which it works, not by pressure, but only by virtue of its velocity, in a similar way as water in a hydraulic impulse turbine. The shape of the vanes is, moreover, such that the steam at the moment of leaving them is rejected by its own reaction at a speed nearly equal, but in a contrary direction, to that of the corresponding vane—that is to say, with a relatively small absolute velocity. One advantage claimed for thus previously expanding the steam is that the pressure is nearly the same on the two surfaces of the vanes, and if this is the case there is no need for a steam-tight fitting or for lubrication, both of which would be well-nigh impossible at such high temperatures; in the Laval turbine 2mm. to 2·5mm. clearance is allowed between the wheel and its envelope. Another result claimed, but which we cannot concede, is that the moving wheel is never in contact with steam at a high temperature, and, although the initial pressure may be much higher, the variations in temperature of the wheel itself are infinitely less than in the analogous case of the cylinders of a steam engine, and the losses by condensation are therefore less also. It is forgotten that the previous expansion of the steam, although it reduces the pressure, does not reduce appreciably the temperature, as the steam becomes superheated. Since 1894 M. de Laval has been experimenting in the direction of using higher pressures. The boiler resembles somewhat the Serpollet type in its construction. It consists of an iron tube of small diameter, but with thick walls, wound in concentric spirals, between which the furnace gases are led. Water is pumped in continuously at one end of the tube, and flows through it at a considerable speed, escaping as steam at the other end. From there it is led immediately to the turbine vanes, expanding on the way, but without reaching any steam chest or intermediate cylinder before its expansion, which might be a cause of danger. The rapidity of circulation and the great pressure are thus employed profitably to enormously reduce the size of the boiler and thus diminish the danger of explosion. With such a small reserve of water and steam special precautions have, of course, to be taken in regulating the supply of water and rate of combustion with the load on the engine. One method of doing this is by means of a special regulator fixed to the generator, and adjusting the rate of admission of the feed water. Another method consists in working with a forced draught produced by a fan connected directly to the turbine shaft. By varying the amount of air forced by this fan the rate of combustion is varied. Automatic stoking is also used. The article in our contemporary ends with a statement of the extreme compactness which can be given to a generating station on this system. A station for generating 100 H.P., comprising boiler, feed-pump, condenser, turbine and dynamo occupies a rectangle 18ft. 4in. by 12ft. 2in., and requires a chimney of very modest dimensions, as forced draught is a *sine quâ non*.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Concentration and Electrolysis.—F. Kohlrausch deals fully with a variety of problems concerning the effect of electrolysis upon various single and mixed solutions, from a theoretical point of view. He succeeds in working out some main conclusions, which may serve as a framework for the future complete theory. One of the leading principles is that a liquid cannot be altered by ionic migration only, apart from the events at the electrodes, provided the solution or mixture of solutions is uniform throughout. If it is not, certain local changes of concentration may be produced by a current, even in a single electrolyte, if the migration ratio of the two ions depends upon the concentration. This dependence is not yet fully known, and it is therefore impossible to frame a complete theory of the phenomena. But such a theory is of extreme practical interest, and a beginning can be made for the case of dilute solutions. In galvanic cells, in accumulators and in electro-plating baths dilute solutions often occur. Again, in the earth's crust dilute solutions occur frequently, and currents have most probably played an important part in the deposition of minerals. Kohlrausch works out two differential equations governing the connection between potential or current density, and concentration and ionic velocity. He proves that these are not invalidated by free ions, which are infinitesimal in quantity, and are as $1 : 4 \times 10^8$ to the ordinary ions. In one *cc* there would, for instance, be only 10^{-15} gr. of chlorine in the form of free ions. Free ions cannot be formed at the dividing surface of two solutions of unequal concentration, but only at metallically-conducting electrodes. In regions unaffected by diffusion the concentration cannot be changed by currents even if the electrolyte is not uniformly distributed, provided it be sufficiently dilute. As regards two electrolytes with a sharp dividing surface, such as those studied by Lodge and Whetham, the condition that one of two solutions with a common ion shall be displaced by the other is that a certain important function, termed by Kohlrausch the "persistent function," shall be the same on both sides of the surface. This persistent function is $\frac{a}{a}+\frac{\beta}{b}+ \ldots . \frac{\rho}{r}+ \ldots$, where $a, b \ldots$ are the "electrolytic mobilities," and $\alpha, \beta \ldots$ the concentrations of the ions. Whenever the slope of concentration is continuous all the electrolytic changes may be reversed by reversing the current.

[Kohlrausch, *Wied. Ann.*, No. 10, 1897.]

Induction Coils.—The theory of the induction coil is as yet in an imperfect state as far as the mechanism of the interrupter and the constitution of the primary circuit are concerned. B. Walter has made some determinations which clear up a number of obscure points. He worked with a peculiarly efficient coil, provided with a condenser and a silver-and-mercury interrupter working under a layer of petroleum. He introduced condensers of various capacities, and determined their effect upon the length of spark obtained in the secondary circuit. He found that the length greatly increases with the capacity up to a certain limit, which was 0·2 microfarads in his coil, and then gradually diminishes. Why that is so may be elegantly shown by the method devised by Braun. This, it will be remembered, consists in making the magnetic field deflect a narrow beam of cathode rays impinging upon a fluorescent screen, and drawing out the vibrating spot into a curve by means of a revolving mirror. The "make" current is thus seen to describe a regular logarithmic curve, as required by the theory. The "break" current, on the other hand, falls evenly to zero. The fall is made more rapid by the introduction of a small capacity, thus giving a higher spark potential in the secondary circuit. The condenser, which serves to absorb the current, may, if large, actually retard the extinction of the current. At 0·22 microfarad distinct vibrations set in, which at first go to increase the rapidity and extent of the fall, but at 0·9 microfarad the wave-length of the vibrations is sufficient to flatten out the curve and reduce the E.M.F. in the secondary circuit. It should be mentioned that this method of observation is only available when the secondary circuit is open, since otherwise the magnetic effect of the primary is cancelled. But that the vibrations actually exist under all circumstances is shown by the intermittent appearance of the secondary spark. Generally speaking, it may be assumed that the maximum value of the secondary E.M.F. is directly proportional to the maximum intensity attained by the primary current and to the square root of the inductance of the secondary coil, and inversely proportional to the square root of the capacity of the primary condenser. A crucial experiment showed that the spark-length is strictly proportional to the maximum value of the primary current. If this is generally true, then the voltage corresponding to a spark 1m. long would be 650.000, and to a lightning flash 200m. long a voltage of 130 millions.

[Walter, *Wied. Ann.*, No. 10, 1897.]

Electric Refraction in Wood.—Domenico Mazzotto has carried on the valuable work of Mack and Righi, on electric refractive indices of wood, and obtained some interesting results. His method was very simple and sure. Blocks of wood were mounted in the line of a system of Lecher wires, and the wave lengths in them were directly compared with waves in air. He found that the index of electrical refraction varies notably from one kind of wood to another, and increases with the density, the lowest being being 1·540 (deal of density 0·458, and the highest 2·244 (holmoak, density 1·238). In the same kind of wood, the electric vibration normal to the fibre is propagated more rapidly than parallel to it, and hence the index of refraction is greater in the second case. Each specimen of wood was mounted in three different ways. In the first the fibres were parallel to the wires; in the second, they were normal to them, but parallel to the electric vibration; in the third the fibres were normal to both. The three indices were for deal 1·596, 1·730, and 1·67, and for holmoak 2·244, 2·236, and 2·252 respectively. It will be noticed that at the greater density the differences are slighter. The results agree well with those previously obtained.

[Mazzotto, *Rend. dei Lincei*, No. 6, 2, 5, p. 73, 1897.]

Maxwell's Relation for Wood.—The same author has examined the validity of Maxwell's relation $n = \sqrt{k}$ for the wood investigated. He determined k by introducing slabs of wood cut in different directions in the terminal condenser of his Lecher wire system, and noting the wave systems created. To make the range of observation wider, he used the wood first in its natural state, and then desiccated it until it had lost 13 per cent. of its weight. For the two cases of the electric force being normal and parallel to the fibre, $\sqrt{k}$ turned out to be 1·64 and 1·95 for ordinary, and 1·21 and 1·37 for dried wood. The corresponding values of n are 1·57, 1·83, 1·14 and 1·31. This may be taken as substantially a confirmation of Maxwell's law.

[Mazzotto, *Rend. dei Lincei, ibid.*, p. 96.]

Conductivity of Deal.—A third question of interest in connection with the electric properties of deal is its conductivity. This was also studied by Mazzotto by a potentiometer method and a quadrant electrometer. He found the specific conductivity of deal along the fibres to be 280×10^{-19} C.G.S. units when dried in the air, and $0{\cdot}5 \times 10^{-19}$ when dried in an oven at 100deg. The conductivity is lower across the fibres, and, in addition, it diminishes 20 times more rapidly when dried at 100deg. Even so the diminutions of conductivity are not sufficient theoretically to explain the difference produced upon electric refraction and dielectric constants by the process of drying.

[Mazzotto, *Rend. dei Lincei*, 6, 2, 5, p. 134, 1897.]

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ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.*

BY J. ELTON YOUNG.

(*Continued from page 785, Vol. XXXIX.*)

Localisation of Earths and Contacts.

Earths on Overhead Lines.—Apart from the general leakage along an aërial line, due to the state of the weather and of the surfaces of the insulators, *earth faults* may arise from any cause whereby connection is made between the line and earth at some definite point. Thus breakage of an insulator may bring the wire into contact with a pole, wire, or stay, foliage, &c.; or an insulator that is merely cracked may be the source of the leak. In India floods sometimes rise so high as to submerge wires spanning them, or at any rate those lowest on the poles, causing dead earth.

Dead earth without discontinuity can be distinguished from total breakage with dead earth, when doubt exists, by the indications given under the head of "Total Breaks."

With intermediate stations on the line, the section in which the fault lies may be discovered by putting a current on through an indicator, and having the wire disconnected at successive stations; for when freed between the indicator and the fault the leakage will disappear or diminish. When, however, the proper localisation tests are applied with care, the position of the fault can frequently be found by them within a mile of the truth.

The *loop test* should as a rule be adopted for the localisation of an earth fault, being superior to all others, though when the leakage along the lines is great it may be seriously vitiated thereby, in common with other methods. The next best method to the loop is the "*earth overlap*," effected by observations of the apparent C.R. from each end of the wire when the other end earths. This test is more suitable than Blavier's for a fault which has varying resistance or much polarisation. Since, however, it requires both stations to test, it is not always applicable. The best alternative method, when no good second wire is at hand for the loop, is *Blavier's*, effected by taking free and earth readings from one end only. This has the advantage of not involving observations at both ends, whilst it is less vitiated by leakage than the "earth overlap" when the fault is near the testing station—an important merit. When, however, the resistance of the fault changes between the free and earth readings, Blavier's test is liable to serious error, which becomes greatest with the fault near the testing station. When the true C.R. of the line is not sufficiently well known, Schwendler's modification of the Blavier may be tried.

On aërial lines the position and resistance of the "resultant fault" are so variable that corrections of localisations of earth faults for leakage must frequently be a matter of uncertainty. They should, however, be applied whenever the fault's resistance is not very small relatively to the insulation resistance of the line or loop. The mode of doing so will be considered in the next chapter.

Earth Faults in Submarine Cables.—Under the heading of earth faults are here denoted all defects in the dielectric of a cable, by which its insulation is impaired or destroyed; ranging from those of such minute dimensions as to be almost invisible, to those which freely expose the conductor. It is assumed that in all cases the core or cable is immersed in water. Defining them by their resistance to leakage, submarine faults may be conveniently divided into two classes, namely, *high* and *low* resistance faults, corresponding as a rule to small and large dimensions; the intermediate state, between high and low resistance, being, roughly speaking, a transient one in practice. The one class have a resistance permanently high, which can be temporarily reduced to the intermediate state, whilst the other have a normally low resistance, sometimes capable of a temporary increase. The first are generally difficult to "break down"; the second difficult to "seal up."

As recommended in the study of total breaks, so with that of earth faults, a few practical experiments with a piece of core in a glass of salt water will impress their behaviour on the memory better than any description of the phenomena. The contact of the copper with the water, however slight, gives rise to the same set of actions and reactions as were described in the previous chapter. If sufficient surface of copper be exposed the fault will behave like a total break of equal area of exposure, its resistance approaching much the same values as the highest of those in the table given on p. 785, Vol. XXXIX. The discharge of the hydrogen under the negative testing current will be fairly free, the resistance of the fault will be readily reducible to its minimum by Lumsden treatment, and will approximately follow Kennelly's law. In fact, such a fault may sometimes be localised by the break methods, making an estimate of its resistance from the observation of its behaviour, and using this as a check on the results of the Kennelly tests, which latter will usually be found to put the distance of the fault at less than its true value.

As the aperture in the insulator exposing the copper is diminished in size, the fault departs from this regular behaviour, and exhibits under the negative current irregular, rapid, and often violent variations of resistance, very bewildering to an observer who has not studied a few experimental faults. They arise from the rapid partial sealing of the aperture by each bubble of gas as it forms, causing considerable rises of resistance, whilst every escape of a bubble produces a sudden fall. When the fault is of still smaller dimensions, it will often become permanently sealed for long periods by a single bubble, especially if the puncture happens to be situated directly underneath the core as it lies in the water. Owing to this imprisonment of the hydrogen, such faults will frequently display a higher resistance under the negative than under the positive current, contrary to the commoner rule, according to which the chloride film seals most.

"Breaking Down" a Submarine Fault.—The process called "*breaking down*" a submarine fault consists in the bursting of the sealing film, whether of chloride or of gas bubbles. The results of this are, firstly, increased leakage of signalling currents; this leakage, when not excessive, tends to improve rather than impair the clearness of signals, if it remain fairly constant. The second result, however, is increased unsteadiness of resistance under the variable polarising action of the leakage currents; this tends to derange signals. The third consequence is increased corrosion of copper at the fault by positive signalling currents; this tends to make matters worse by gradually eating into the strands. Testing currents of common strengths, say, 1 to 50 milliamperes, do not affect the gutta-percha itself; but if augmented to a few hundreds of milliamperes begin to enlarge the fault by "burning out" the insulation—notwithstanding the presence of water. This is an extreme measure rarely to be resorted to, since it may develop other defects. It should be remarked, however, that unless the fault have at first a low resistance it will be impossible to force such strong currents through it from a testing battery.

There is a certain amount of risk, when a strong current is applied to a fault, that it may break down some other defective spot in the core, thus appearing to create a new fault, though the latter must have been latent beforehand. Hence the breaking down of a fault is a thing to be avoided until the time comes for the ship to remove it, when localisation is greatly facilitated thereby.

The process of slow permanent *enlargement* of an earth fault, by rapid reversals with high-battery power, is different from its temporary breaking down by the brief application of a powerful negative testing current, after which it may generally be sealed again. With prolonged reversals the positive currents decompose minute quantities of copper, whilst the negative throw off the chloride so produced, thus gradually tending to form a cavity in the conductor, offering more surface and less resistance than the original exposure. Thus prolonged signalling with powerful currents through an open fault ultimately ends in entirely severing the conductor.

Blavier Test.—The tests about to be described in the following paragraphs are applicable to both high and low

* Extracted from a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights reserved.

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resistance faults, but with the former class their results require corrections for leakage; these will be dealt with in the next chapter. With faults of low resistance the only serious obstacle to accurate localisation lies in inconstancy of the fault's resistance during the tests.

Theoretically the best method of localisation is that which is least affected by the variations of the fault's resistance, whilst at the same time sufficiently fulfilling two other important requirements which apply to all testing—firstly, sensitiveness of appreciation, and secondly, the condition that errors made in observation shall have little effect on the result, this depending on the form of the algebraic expression from which the result is calculated.

The *Blavier*, with its extension by Schwendler, is the sole method of localisation by tests made from one end only, when no second line is available for a loop test. It consists in measuring the resistance with the distant end of the line first insulated and then earthed. Then if A (Fig. 26) be the testing station, and R_i R_e the readings so obtained, we have

$$R_i = x + z,$$

$$R_e = x + \frac{yz}{y+z},$$

and also $$l = x + y,$$

where l is the *true* C.R. of the line known from records. From these equations, the distance of the fault from A is

$$x = R_e - \sqrt{(R_i - R_e)(l - R_e)}. \quad . \quad . \quad . \quad (7)$$

The accuracy of the result entirely depends on the fault's resistance z, remaining the same during both of the observations. Errors arising from its variation will be greater the nearer the

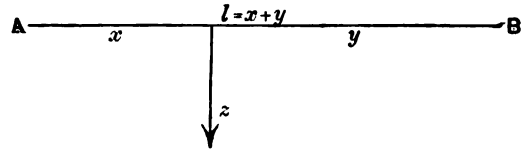

Fig. 26.

$x = 1{,}000$ ohms. $y = 2{,}950$ ohms. $l = 3{,}950$ ohms.

fault lies to the testing station, so that the result most to be relied upon will be that arrived at by the station furthest from the fault.

On the other hand, it will be shown subsequently, that when *two* faults exist the best condition is to test from the end nearest the one to be localised.

To ensure as much constancy as possible in the resistance of the fault, which is usually variable, the *lowest* of all the readings observed in a series taken with line free, and the lowest of those with line earthed, may be selected as the best values for $R_i R_e$; or if very unsteady the means of each series may be used. The Lumsden treatment may also be resorted to for securing a pair of readings that shall be comparative. It is applicable to landline faults which polarise, as well as to those in cables, their electrolytic action following the same law, viz., the minimum resistance is obtained with the negative current after the positive has first been kept on long enough to form a film of oxide at the surface of contact of the wire with earth—that is to say, till the resistance ceases to rise. Or, on a landline, polarisation of the fault may be minimised by making only momentary contacts with the testing battery key.

With submarine faults its is needful, in addition to these precautions, to maintain the same strength of current through the exposure during the measurement with the end earthed, as that which traverses it when the end is free, on account of the changes of fault resistance with current strength—whether by the formation of gas and chloride films or by virtue of Kennelly's law. This can be done by inserting between battery and bridge during the measurement of R_i a resistance

$$k = \frac{z(a + x + 2\rho)}{2y},$$

where a is the value of one of the bridge ratio arms, assumed to be even. To compute k, x must first be roughly ascertained by simple Blavier test, and from it $y = l - x$ and $z = R_i - x$ are found. Another test is then taken with k applied, whence a closer approximation is made to x, which is in turn used to find a second approximation to k, and so on. This is practically equivalent to the method of Mr. Kingsford (described in the *Journal* of the Institution of Electrical Engineers, Vol. XIV., p. 584). Or, as pointed out by Mr. W. J. Murphy, the current through the fault may be kept constant by making the current *to line* for the free reading

$$c_i = c_e \frac{R_e - x}{R_i - x}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

which is the simplest possible plan when a milliammeter or shunted galvanometer is inserted in the line to register the current passing.

For example, on a faulty cable (*see* Figs. 26, 27) a preliminary Blavier test gave $R_i = 3{,}200$ ohms and $R_e = 2{,}150$ ohms, with Z to line permanently for both balances. From these readings

$$x = 2{,}150 - \sqrt{(3{,}200 - 2{,}150)(3{,}950 - 2{,}150)} = 775 \text{ ohms.}$$

Hence $$c_i = c_e \frac{2{,}150 - 775}{3{,}200 - 775} = c_e \frac{5}{9}, \text{ nearly.}$$

The test was then made with a galvanometer (G_2) in the line, so shunted as to be of negligible resistance, and an adjustable resistance box (k) between the battery and bridge. R_e was first observed with nothing in this box, and its lowest value, using the Lumsden treatment, found to be 1,830 ohms. At the same time c_e was observed on G_2, and seen to be roughly 200 divisions at the moment of balance. R_i was now

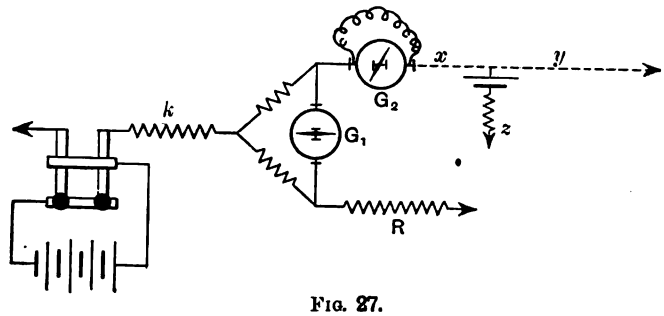

Fig. 27.

measured, and resistance unplugged in k, so that at the moment of balance c_i, observed on G_2, was roughly 110 divisions $\left(\frac{200 \times 5}{9}\right)$. The lowest reading for R_i by Lumsden balance being 2,170 ohms,

$$x_1 = 1{,}830 - \sqrt{(2{,}170 - 1{,}830)(3{,}950 - 1{,}830)} = 981 \text{ ohms.}$$

Hence, as a second approximation,

$$c_i = c_e \frac{1{,}830 - 981}{2{,}170 - 981} = c_e \frac{5}{7}, \text{ nearly.}$$

In the next test accordingly c_i was made $\frac{5}{7}$ths of c_e by increasing k. The lowest obtainable readings now were found to be $R_i = 2{,}670$ ohms, $R_e = 2{,}080$ ohms (the fault's resistance having run up); whence

$$x_2 = 2{,}080 - \sqrt{(2{,}670 - 2{,}080)(3{,}950 - 2{,}080)} = 1{,}080 \text{ ohms.}$$

A mean of the above two results was very closely correct, the actual distance to the fault being 1,000 ohms.

Schwendler's Method.—This method is designed for the localisation of earth on a landline when no loop is available, and when the value of the true C.R. of the line (l) is not known with sufficient exactness to apply Blavier's formula. Besides the free and earth readings, a third measurement is made when the distant end is earthed through a known resistance g (usually the resistance of the relay). Then

$$x = R_i - \sqrt{\frac{(R_i - W)(R_i - R_e)g}{W - R_e}}, \quad . \quad . \quad . \quad (9)$$

where W is the third measurement. It should be remarked that the term under the root is equal to the resistance of the fault (z).

This formula is open to all the objections of Blavier's, besides requiring a third bridge reading, which increases the chances of error when the fault's resistance does not remain constant. To minimise the variation of fault resistance the current strength may be adjusted so that the amount travers-

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ing the fault is equal in all three measurements. Schwendler gives the following ratios for the three E.M.F.s of the testing battery required for this purpose :—

$$E_1 : E_2 : E_3 :: \left(x+z+\frac{xz}{l-x}\right) : \left(x+z+\frac{xz}{l-x+g}\right) : (x+z),$$

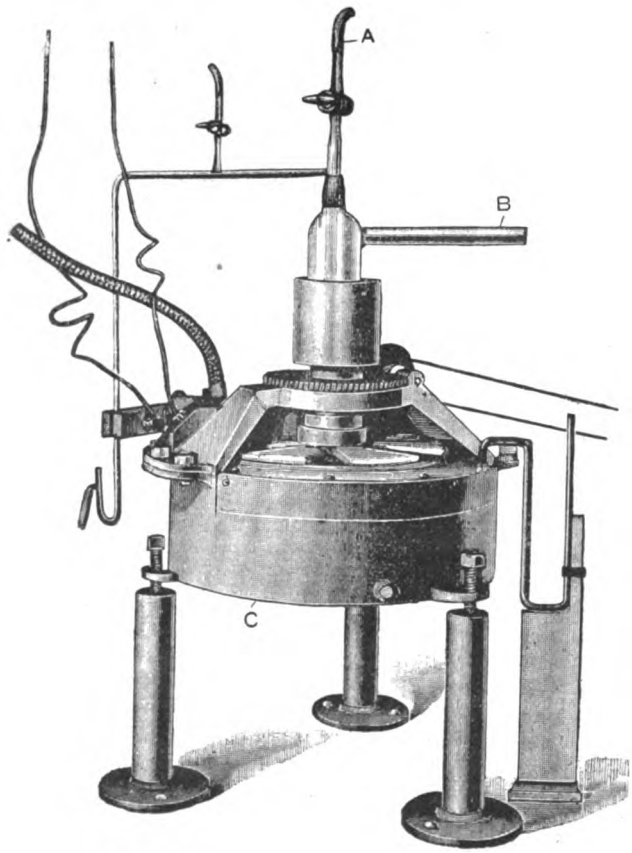
l being here assumed approximately known, as well as x and z.

The method is not used in cables—though with the above adjustment of E.M.F.s it might be tried—but has been employed with satisfactory results on overland lines in India.

(To be continued.)

THE RHODIN ELECTROLYTIC PROCESS.

The Rhodin electrolytic process for the manufacture of alkali and bleach, the invention of Mr. J. G. A. Rhodin, of Manchester, was recently demonstrated on a small scale in London by means of a model, an illustration of which is shown in the accompanying figure. We understand that works are in



Working Model of the Rhodin Electrolytic Apparatus.

process of erection for the commercial manufacture of caustic soda and bleaching powder from brine by this process. Referring to the illustration, which represents in all essential points the commercial form of the apparatus, the electrolysis of brine is carried on in the cast-iron cylindrical vessel C, the bottom of which inside is lined with wrought iron. A layer of mercury on the bottom forms the negative electrode, while the carbon electrode consists in a large number of short, vertical carbon rods projecting downwards from a rotating disc-shaped holder or cover, this cover being of vitrified earthenware. The brine is fed through the pipe A, and the spent liquor passes away through a pipe not shown in the figure. The layer of brine circulates between the upper surface of the mercury and the carbon rods, and as the earthenware cover rotates the mercury is stirred so as to renew the surface exposed to the deposition of sodium.

The action of the cell is as follows : The layer of mercury forms a lute or seal with the downward projecting edges of the inner earthenware vessel, so that when the inner vessel is filled with brine, and the outer annular space is filled with pure water, no connection between the liquid contents of these two portions of the cell can possibly take place. When the electric current passes through the cell the current passes from the lower end of the carbon cylinders to the surface of the mercury. The chlorine is given off at the surface of the carbon poles, and is carried away through the central tube B to the bleaching powder chambers. The sodium amalgam forms on the surface of the mercury in the inner portion of the vessel at the bottom surface of the brine, and passes partly by diffusion and partly by the mechanical agitation of the mercury, occasioned by the revolution of the inner vessel, to the outer annular space, where the layer of water extracts the sodium in the form of caustic soda. The mechanical agitation is assisted by placing radiating vanes in the bottom of the containing vessel, and these conduct the mercury to the outer edge of the vessel.

In actual working the iron vessel is heated externally to such a temperature that the liquid contents of the cell are raised to a little short of boiling point, and this not only prevents the absorption of a large amount of chlorine in the brine, but also very much increases the efficiency of the water in taking out the caustic from the amalgam, as well as reducing the electrical resistance of the liquid film between the lower surface of the carbon cylinders and the surface of mercury. In consequence of the low resistance in the cell the voltage of the electric current which is required to drive the current through the cell is very small, and is stated to be not higher than 3·3 volts per cell.

The following are among the advantages claimed for Mr. Rhodin's electrolytic apparatus and process :—

1. The process is a continuous one with a single anode chamber, costs less to construct, and gives results which far exceed any existing process.
2. The construction of the apparatus is such that it lends itself perfectly to the application of heat, a most important point, because the quantity of work which can be accomplished by the current when the electrolyte is hot is very much greater than when used on cold solutions.
3. The total absence of any rocking motion, no pumps, or circulation of mercury.
4. *There is practically no loss of mercury.*
5. The high efficiency obtained.
6. The low potential necessary to effect decomposition.
7. The ease of renewal of anodes, and the minimum destruction of same.
8. The apparatus, in addition to its use for the extraction of metals, soda, potash, and other alkaline salts, can also be successfully used for the electrolytic production of a large number of other chemicals, such as nitric acid, chloroform, naphthaline, nitro-benzol, aceto-acetic ether, &c.

THE REICHSANSTALT TYPE OF CADMIUM STANDARD CELL.*

BY PROF. W. JAEGER.

The advantages of the cadmium standard cell represented by the formula $Cd - CdSO_4 - Hg_2SO_4 - Hg$ were pointed out by Mr. Weston, of Newark.† Its particular feature is its very small temperature coefficient (about 0·004 per cent. per deg. C. at 20deg.), enabling it to be used in most cases even for accurate measurements without account of its temperature being taken. Since the beginning of 1894 the Reichsanstalt has had experience with cells of this kind, made up in various ways in the Anstalt itself, and has found that with regard to

* A communication from the Physikalisch-Technische Reichsansta translated from the *Elektrotechnische Zeitschrift* of Oct. 21, 1897.

† Herr Czapski had, already in 1884, made cells with cadmium electrodes and noticed their low temperature coefficients (*Wied. Ann.*, XXIV., 235, 1884), but this property of the cells was again forgotten.

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constancy and reproduction it is not second to the Clark cell.* It should be desirable for scientific institutions to possess tried regulations according to which they can construct cells for their own use. Those following are analogous to the rules issued by Dr. Kahle some time ago for Clark cells.†

General Arrangement.

If a particularly low internal resistance is not required the glass vessel can have the H form used by Lord Rayleigh or Kahle's modification of it. The two legs of the vessel are provided with platinum leading-in wires melted into the glass at the lower ends (*see* Fig. 1). Two types will be described, one not being suitable for transporting without special care, the other intended to be transportable.

In the former type (Fig. 1) the negative pole consists of a cadmium amalgam—one part of cadmium to six parts of mercury is the mixture used at the Reichsanstalt. Over this is a layer of pulverised crystals of cadmium sulphate, to ensure this pole always being in contact with a concentrated solution. This layer of crystals also prevents the mercurous sulphate from coming into contact with the amalgam. The positive pole is formed of metallic mercury, over which is a layer of paste formed by the trituration of mercurous sulphate with metallic mercury and a concentrated solution of cadmium sulphate in which are some crystals of this salt. The paste must not be too thin but must form a stiff pulp. The remainder of the cell is filled with a concentrated solution of cadmium sulphate. The tube is closed first by a layer of paraffin which is poured in, and with a thin washer of cork upon the paraffin.

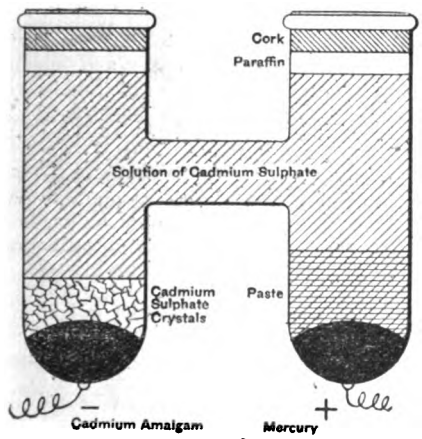

Fig. 1.

Finally, the cell is sealed with good sealing-wax, which is not acted on by petroleum. Of course, the tops of each of the glass legs may be fused up in the blow-pipe instead.

In the portable type the negative pole is formed in the same way as above described, but the positive pole is of amalgamated platinum. In order to give this electrode a greater surface the platinum wire is either rolled in a spiral, or connected to a piece of platinum foil. The space taken up by the liquid in the first type is in this one filled entirely with the paste.‡

Special Instructions.

Amalgamation of the Platinum.—The amalgamation of the platinum is done electrolytically. The metal is first warmed with aqua regia in a sand-bath until bubbles rise; then the cell is filled with a solution of mercury in nitric acid and the platinum is connected to the negative pole of a battery; another piece of platinum foil is used as anode. The current is allowed to flow until the platinum is covered regularly with mercury. The mercury must adhere well to the platinum.

Cadmium Amalgam.—The E.M.F. of the cadmium cell is independent of the composition of the amalgam between the limits of 6 and 13 parts of mercury to one part of cadmium, and its value is that given at the end of the article. Cadmium dissolves easily in mercury when heated, forming a liquid amalgam which, if of the composition usually given it, viz., one part of cadmium to six of mercury, is solid at ordinary temperatures. To fill the one leg of the cell with the amalgam the simplest way is to place in it a small piece of the solid amalgam and heat it in the sand bath until it melts. The mercury used for making this amalgam must of course be pure. Commercial cadmium obtained from good factories is usually pure enough, and occasional small impurities have no effect on the cell.

Cadmium Sulphate.

The cadmium sulphate of commerce is also usually sufficiently pure, but it is not always thoroughly neutral. As free acid affects the E.M.F. of the cell, it must be neutralised. The acidity can be recognised by testing with litmus. Occasionally it is only the mother liquor surrounding the crystals that is acid, in which case it suffices to wash the salt with distilled water. Otherwise one must neutralise the acid by digesting a solution of the salt in cadmium hydroxide.* As the solution usually becomes somewhat basic by this means, and then on bringing it in contact with the mercurous sulphate the latter is precipitated, one digests it for some time with this salt before using it until no more precipitation of the latter occurs. The cadmium sulphate solution must not be warmed over 70deg., for otherwise another hydrate is formed ($CdSO_4 + H_2O$, while under 70deg. the composition is $3CdSO_4 + 8H_2O$). The solubility of the cadmium sulphate changes very little with temperature,† so that raising the temperature is of no use in producing a concentrated solution, and the finely-powdered salt must be shaken up with the solution so long as any of it is dissolved. If the solution is not concentrated the E.M.F. is too high. At ordinary temperatures 100 parts of water dissolve about 115 parts of the hydrate.

Mercury.—The mercury for the positive pole can easily be obtained sufficiently pure by the usual methods; it must be free from any trace of a more positive metal.

Mercurous Sulphate (Hg_2SO_4).—This salt may be impure owing to oxides, basic salts or free acid. Oxides are reduced by the rubbing of the paste with metallic mercury, Basic salts indicate their presence by a yellow coloration, and being insoluble are harmless. They can be transformed into neutral salts by treating the salt with very dilute sulphuric acid, and subsequently washing it with distilled water, only the washing must not be continued so long that they are again decomposed into basic salts. The last trace of acid in the paste is removed with finely divided metallic mercury. The treatment of a strongly acid salt follows from the foregoing. If the salt has a pale yellow colour, or if it shows a pale yellow coloration when put into water, it can be used without further treatment. If the salt has been washed in water it must be dried as well as possible (without heat), and, in making the paste, so much solid cadmium sulphate must be added that a saturated solution of the latter salt is also formed.

The E.M.F. of the cadmium cell is (for cadmium amalgams containing some 7 to 14 per cent. of cadmium)

1·019 international volts at 20°C.,

if 1·433 international volts be taken as the E.M F. of the Clark cell at 15°C. The effect of temperature is given in the formula :—

$$E_t = E_{20} - 3{\cdot}8 \times 10^{-5}(t-20) - 0{\cdot}065 \times 10^{-5}(t-20)^2.$$

From experience with this cell since April, 1894, it has been found that it, as well as the Clark cell, is constant and reproducible within a ten-thousandth.

* *See* articles by W. Jaeger and R. Wachsmuth, in the *Elektrotechnische Zeitschrift*, 1894, p. 507, and in *Wied. Ann.*, LIX., 575, 1896. The data in these articles refer only to cells made at the Reichsanstalt.

† *Zeitschr. f. Intrk.*, XIII., 191, 1893; and *Wied. Ann.*, LI., 203, 1894.

‡ Cells of this type have also been constructed without clay cells and of low resistance (about 50 ohms). These will give a continuous current of 0·0001 amperes for a considerable time without polarisation.

* Cadmium hydroxide may be precipitated by treating a solution of cadmium sulphate with a solution of caustic soda. The precipitate must be well washed.

† F. Mylius and R. Funk, *Berichte der Chemischen Gesellschaft*, XXX., 824, 1897.

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THE OFFICIAL VOCABULARY FOR CODE TELEGRAMS.*

There has always been a tendency on the part of code-makers (owing to the desire (1) to obtain as many code expressions as possible, and (2) to adapt codes to a definite system) to make use of manufactured expressions instead of real words; and, if unchecked, this tendency would end in a large use of mere arbitrary combinations of letters (*i.e.*, letter-cypher)—a result which is most undesirable in view of the fact that such combinations are difficult to transmit.

The administrations have thus been obliged to adopt restrictive regulations. At one time words in a large number of languages were admitted, and code-makers who had coined words having the appearance of, say, Italian or German, would threaten, when their attention was called to the regulations, to use Illyrian, Croatian, or Turkish. Proper names were also admitted as code words, and these were still more difficult to check. A certain firm tendered to one of the cable companies a code which, they said, consisted entirely of names of Polish villages not to be found in any gazetteer, and they challenged the Company to disprove their assertion. This state of things could not possibly be maintained; and in 1879 the languages for code words were, by common consent, reduced to eight, viz., English, French, German, Italian, Spanish, Portuguese, Dutch and Latin. At the same time the use of proper names as code words was prohibited. These measures palliated but did not remove the evil. Elaborate codes were prepared purporting to be in Latin, which in reality consisted of Latin roots with terminations unknown to any Latin grammar, and often in reality taken from Italian or Spanish. The difficulty of applying an effective check in eight languages even led to the manufacture of codes consisting of groups of consonants arranged in a preconcerted order and connected by vowels so as to have the appearance of actual words. The prevalence of such abuses led to disputes resulting in delay and trouble both to the administrations and to the public.

These circumstances gave rise to the proposal to compile an official vocabulary, to contain a standard list from which there need be no appeal. The idea of an official vocabulary commended itself to many of the Continental Administrations. The cable companies also were strongly in favour of the idea, and it was welcomed by many representatives of commerce, including some of the principal Chambers of the United Kingdom. This feeling found expression in a proposal at the International Telegraph Conference at Berlin in 1885. The proposal was not adopted. But in the interval before the Conference of Paris in 1890 the difficulties arising from the absence of a recognised standard became increasingly manifest, and it was decided that an official vocabulary should be compiled by the International Telegraph Bureau. From the point of view of the Administrations the vocabulary would obviously be most advantageous. But it was felt that the restriction of code to a limited selection of words might encounter opposition on the part of the public. It was accordingly resolved to proceed tentatively. The vocabulary was in the first instance only to become obligatory in the "European" system, in which little code is used. Moreover, it was only to become compulsory for that system after three years from the date of publication. The date for compulsory use being thus postponed till January 1, 1898, there was an opportunity of reconsidering the question at the Conference of Budapest in 1896.

The publication of the vocabulary in October, 1894, aroused, especially in this country, considerable criticism, which, if somewhat exaggerated, was by no means groundless. The vocabulary professed not merely to form a standard list of code words, but to maintain a sufficient degree of dissimilarity to admit of any word in the collection being used without any risk of confusion with any other word. Unfortunately, the requisite dissimilarity was not observed. Many of the words were dangerously alike, so that while the vocabulary greatly restricted the former freedom of selection, it offered no guarantee of accuracy. It was incomplete without being correct.

The British delegates urged these views at the Conference of Budapest, and ultimately, after great difficulty, an arrangement was arrived at on the following basis:—

1. The decision of the Paris Conference, under which the vocabulary would have become compulsory for European telegrams from January 1, 1898, to be rescinded.

2. An enlarged vocabulary to be prepared by the International Bureau.

3. The new vocabulary to become compulsory, for Extra-European as well as for European telegrams, but not until a date to be fixed by a future conference. The next conference will not take place before 1901. The new vocabulary will be entirely different from the existing one. It will not profess to have any regard to dissimilarity between the words. The selection, for the code-using public, of words sufficiently dissimilar will now be left to professional experts. The new official vocabulary will only serve the primary purpose of a standard collection or dictionary of legitimate code words. With the view of making the collection as complete as possible, the International Bureau has offered to include in it all legitimate words in existing codes which are submitted for insertion. By this means the public are enabled to provide against the necessity for any alteration of their codes, so far as they contain legitimate words in the event of a future conference confirming the decision to make the use of the new vocabulary compulsory.

* Being Appendix II. of the 43rd Report of the Postmaster-General on the Post Office.

ELECTRICAL PROGRESS IN MANCHESTER.*

The object of the inspection was to ascertain the latest Continental practice in electric lighting, and to learn the extent to which electric traction was used, and the various methods by which it was applied, and especially if possible to ascertain how the problem of how the current for both lighting and traction was dealt with.

The first point which stood ont prominently was the employment of slow-speed dynamos, coupled directly to slow-speed engines. This practice is almost universal on the Continent, there being very few instances of belt or rope driving. Secondly it was clear that the tendency was to have few machines of very large power rather than a number of small machines. As regards boilers. Tubular boilers were almost universally employed, but on the other hand, it was in nearly all cases stated that the reason for this was economy of space, and that boilers of Lancashire type would be preferred on other grounds.

One result of the investigation is to show that electric traction is fast superseding all other means of hauling trams. Wherever electric traction has been introduced on a small scale, the system is being largely extended, and the use of horses is being entirely abandoned. Electric traction is not only preferred to horse traction, but to all other forms of mechanical propulsion, even the Serpollet steam system in use in Paris, and which appeared so promising, is being abandoned in favour of the electric system.

Comparing the advantages of the various electric systems there can be no question that the overhead trolley is by far the cheapest to construct, costs less for maintenance than any other system, is the simplest to operate, and the most easily repaired. It is much less liable to interruption than either the underground slot system or the closed conduit system. The accumulator system is extremely reliable, but the expense attendant on its introduction throughout the whole of the system of tramways is prohibitive, while if it be adopted for certain portions of the city the working expenses are largely augmented on account of the great weight of the batteries having to be hauled over the whole of lines whether the accumulators are furnishing current or not. The underground slot system, though as simple to work as the overhead trolley, is very much more expensive, and possesses the serious disadvantage that it entails an entire cessation of traffic, over the portion of line being converted for at least three weeks during its construction. The closed conduit system though very attractive in theory, is not at present sufficiently developed to admit of its adoption being recommended, as it is not capable of dealing with heavy traffic, is liable to fail, and may give rise to shocks fatal to animals, and unpleasant to human beings. Inquiry and observation show conclusively that on the Continent, wherever possible, the overhead system with either trolley or bow is employed. Other systems are only resorted to when the overhead is forbidden from æsthetic considerations. These considerations doubtless have weight when streets such as the principal streets of towns like Paris or Berlin are in question, but in the case of a great commercial city like Manchester, where cheap transit is a paramount consideration, and where an interruption of the heavy traffic would be fraught with disastrous consequences, there appears no necessity to insist upon the streets being kept absolutely free from overhead wires. Again, the overhead construction has been brought to such a state of perfection that the objection on æsthetic grounds is extremely small; indeed, there are probably not half a dozen streets in the finest cities, architecturally speaking, in the world, in which it could be held to be a disfigurement. Certainly, in our opinion, it would be none in the busy commercial streets of Manchester in which the trams at present run. A further advantage of the overhead system is that it lends itself very readily to the combination of street lighting and electric traction, since the same posts which carry the overhead wires may be used to support the lamps without appreciable extra expense.

Traction by means of accumulators has received very considerable development on the Continent, and there can be no doubt

* Abstract of a report of a Special Deputation of the Electricity Committee of the Manchester Corporation on the results of inspection of Continental stations. The deputation consisted of Alderman Higginbottom, Councillor Phythian, and Mr. C. H. Wordingham.

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that it has been proved to be commercially successful as well as practicable from an engineering point of view. At the same time, it is unquestionably more expensive than the trolley system, both as regards capital cost and cost of maintenance, the latter being very heavy indeed.

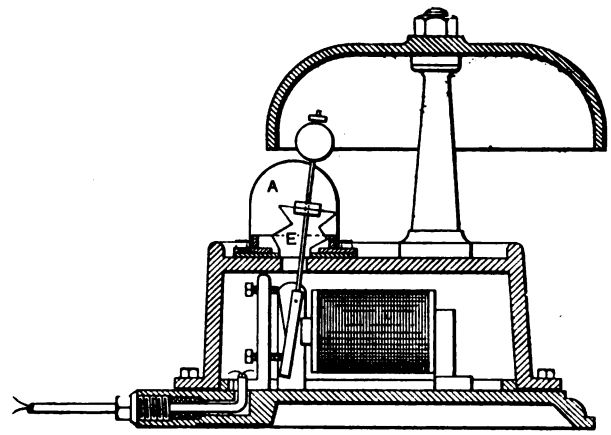
Passing on now to the question of the supply of current for both lighting and traction purposes, there can be no question as to the economy of combining the two. In the first place, the traction load is one extending over long hours, and the machinery used for the production of current for this purpose can be looked after by the same men, who must of necessity be in attendance ready to run the lighting plant if required. Further than this, by combining the two stations, there need not be so many machines held in reserve, since the reserve machines can be common to the two systems, it being extremely improbable that there would be a breakdown on the lighting and traction machines at the same time. The same remark applies also to the boilers, and another very large source of economy arises from the fact that the loss from radiation from the steam pipes can be very greatly reduced by supplying both sets of engines from the same steam range. This economy may not at first sight appear important, but as a matter of fact the loss from radiation from steam pipes is extremely large, and this alone would warrant the combination of the two stations. Other sources of economy are management and saving of land by the concentration of the plant. The plant already put down at the generating station in Manchester is exactly suited to the production of current for electric traction, and by far the greater proportion of the tram lines could be worked from the existing site. Some of the longer lines, however, could not be worked directly from the present station, but the provision of current for lighting purposes over so large an area as that of Manchester, together with those outlying districts which have already agreed to take a supply from the city, necessitates a high-pressure generating station, and this would enable the question of electric traction to be dealt with with perfect ease over the whole of the tramway system.

To sum up, it would appear that the overhead trolley system, with span wires attached to posts fixed along the sides of the streets, is the most suitable for Manchester, and these posts could be conveniently used to carry electric arc lamps for lighting the principal thoroughfares. The greater part of the current for working the tramways would be supplied from machinery erected on the land adjoining the existing station, and also from the present plant, while those lines which are situated at too great a distance from the generating station would be supplied from the new high-pressure generating station, which is necessary for the lighting of the whole city area.

The deputation were much impressed with the large amount of street lighting to be found in the Continental cities. The systems of arc lighting in the streets depend entirely on the width and character of the streets or squares to be lit, and no rule can be strictly laid down. It was evident, however, that where possible the various cities were adopting arc lamps in the centre of the streets, suspended by cross span wires fixed by rosettes to the buildings on each side, or from span wires fixed from vertical posts on each side. Where tramlines were laid the general rule was for posts to be fixed, with arc lamps fixed vertical on the posts, or overhanging from the curved head. In several of the cities visited these side posts have simply taken the place of the gaslamps which have been removed. In cities where rosettes are fixed to the buildings, and span wires and centre lamps, the footpaths are left free from any obstruction whatever. This was specially noticeable in Milan and Cologne. The deputation strongly recommend that street lighting by electric arc lamps be extended in Manchester for the winter of 1898-9; and that, in view of the introduction at an early date of electric traction for tramway purposes, the system of arc lighting should be as follows: Where the tramlines are laid steel posts should be erected on each side of the street, with arc lamps fixed on same. That the steel post should be prepared to receive cross span wires to carry the overhead trolley wires if the overhead system is adopted in Manchester. In the streets where there are no tramlines the arc lamps to be suspended in the centre of the streets and carried by span wires. These span wires to be fixed by rosettes to the sides of the buildings if permission can be obtained from the tenants and landlords, and if the permission cannot be obtained steel side posts be erected, and the span wires be carried from them.

WATERTIGHT ELECTRIC BELLS.

In many situations it is a great advantage to have bells absolutely watertight, and a new type recently put on the market by "Mercier's Patents (Limited)" seems to thoroughly fulfil this requirement. The entire instrument with the necessary exception of the gong and hammer is inclosed in a cast-iron case, the base being also of the same metal. There is a rubber joint between the cover and the base, and the wires from without are led through a screw gland. The aperture in the case for the spindle of the hammer is sealed by a flexible rubber cap E, which is protected from mechanical injury by a metal cap A, in which is a hole just large enough to allow for the motion of the hammer. The makers assert that they have had one of these bells working under water or over 18 months. The illustration shows a bell of the table pattern, and a hanging pattern is also made on the same lines. The Company also manufacture some well-constructed watertight pushes and ringing keys, chiefly intended for railway and mining work. We welcome any introduction of watertight fittings, and cannot but wish that their use were more extended in ordinary



domestic electric light wiring. Were all the switches in house-cellars impervious to moisture it would, we think, be less often necessary to turn on the current for an hour or so to dry them immediately before the advent of the man with the ohmmeter.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, October 29th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the rooms of the Chemical Society, Burlington House. Agenda: (1) Exhibition and Description of the Barr and Stroud Naval Range-Finder, by Prof. Stroud; (2) "A Telemetrical Focometer and Spherometer," by Prof. Stroud; (3) Mr. Ackermann will exhibit a Surface Tension Experiment.

SATURDAY, October 30th.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to the Queen's-road (Bayswater) Station of the Central London Railway Works.

MONDAY, November 1st.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF CHEMICAL INDUSTRY.

8 p.m. Meeting of the London Section in the Chemical Society's Rooms, Burlington House. Papers to be read: (1) "The Adulteration of Portland Cement" by W. H. Stanger and Bertram Blount. (2) "An Improved Adjustable Drip-Proof Bunsen," by W. P. Evans.

TUESDAY, November 2nd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Short Address by Sir John Wolfe Barry, K.C.B., LL.D., F.R.S., the President; and Presentation of Medals and Prizes awarded by the Council. Reception by the President in the Library after the Meeting.

WEDNESDAY, November 3rd.

INSTITUTION OF MECHANICAL ENGINEERS.

7.30 p.m. Ordinary General Meeting, at 25, Great George-street, S.W. Papers to be read: (1) "Experiments upon Propeller Ventilating Fans and upon the Electric Motor driving them," by W. G. Walker. Adjourned Discussion and Supplementary Paper; (2) "Diagram Accounts for Engineering Work," by John Jameson.

THURSDAY, November 4th.

INSTITUTION OF MECHANICAL ENGINEERS.

7.30 p.m. Ordinary General Meeting at 25, Great George-street, S.W. Paper to be read: "Mechanical Features of Electric Traction," by Philip Dawson.

FRIDAY, November 5th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Inaugural Meeting of the 17th Session at the Westminster Palace Hotel. Presidential address by John A. F. Aspinall.

RÖNTGEN SOCIETY.

9 p.m. Opening Meeting and Exhibition at St. Martin's Town Hall, Trafalgar-square, W.C. Presidential address by Prof. Silvanus P. Thompson, F.R.S.

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The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878)

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Last week's number of "The Electrician" completed Volume XXXIX. With this week's number is issued (Gratis) the Index to the Volume.

Complaints of non-receipt should be promptly made to the Publisher.

NOW READY.—Vol. XXXIX. of "THE ELECTRICIAN," bound in strong cloth. Price 17s. 6d., post free 18s. 6d. Also ready, Cases for binding. Price 2s., by post 2s. 3d.

ELECTRIC INSPECTORS.

By the Electric Lighting Act of 1882 the Board of Trade was given power to insert in any Licence, Provisional Order, or Special Act, for the supply of electricity, regulations and conditions with regard to, amongst other things:—"(*b*) the securing a regular and efficient supply of electricity"; "(*c*) the securing of the safety of the public from personal injury, or from fire or otherwise"; and "(*e*) the authorising inspection and inquiry from time to time by the Board of Trade and the Local Authority." In pursuance of these provisions of the Act the branch of industry which undertakes the supply of electricity finds itself regulated and controlled by two sets of regulations, viz., those embodied in the Licence, Provisional Order or Special Act; and the Board of Trade regulations, with sub-headings; (A) safety, and (B) supply. In the Provisional Orders we find clauses specifically calling for the appointment of "Electric Inspectors for the purpose of inspecting electric lines and works, and of certifying meters under this Act." A somewhat curious provision with regard to the appointment of Inspectors may here be noted. It would appear that where the local authority is not itself the undertaker, it *must* appoint one or more Inspectors. On the other hand, where the local authority is the undertaker, the Board of Trade *may* appoint one or more Inspectors, but the initiative must come from a person supplied with energy by the undertakers or from the local authority itself.

Notwithstanding these provisions in the Act, and in spite of the extraordinary growth which we have witnessed in the supply of electricity, not to speak of the equally steady growth in the number of Provisional Orders, it is somewhat surprising

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to find that the number of Electric Inspectors is very small indeed. For the most part, we believe that they have been appointed by local authorities who are not themselves undertakers. While it is not our purpose to discuss the capabilities or the opportunities of the gentlemen at present thus acting, it is well to have these in our minds when considering their position—or rather the functions of the office which they hold. We fear that the present holders of this office do not find their position a very definite one, perhaps we might even go farther and say not altogether a happy one. And is it to be wondered? The feeling must often be with them that they are as Mahomet's coffin—neither in the heaven of official sanction nor the happy earth of assured industrial position. One is continually hearing opinions expressed which seem to imply that an Inspector has only to do with meters. Possibly the non-existence until a comparatively recent date of *certified* meters, on which he could operate, may have hindered appointments, and if this be so, the idea of a supposed necessary connection between inspectors and meters is more wide-spread and more influential than one is at first prepared to credit. Be that as it may, however, while the opinion cited has a certain basis in fact, it is by no means all the truth. Note the words quoted at the beginning of this article and observe that the first-mentioned of an Inspector's duties is the "inspecting of electric lines and works."

Now, it may be urged that during the 15 years which have elapsed since the passing of the Act, the number of appointments to this office has been so phenomenally small as to justify the opinion that the office of Inspector is one of very small moment, and that any consideration of his functions is quite uncalled for. We believe, however, that this is essentially a shortsighted view both of present circumstances and of future possibilities. Think, for instance, of the enormous sums of money which now change hands on the records of meters which have never been through an Inspector's hands. Not that every electric supply company is necessarily dishonest, but it is not in accordance with recognised business principles to accept without suspicion or reasonable check an account the amount of which is entirely dependent on the goodwill and honest intention of the seller. Again, a large majority of the meters at present in use are ampere-hour meters, and the consumer's bill is made up on the assumption that the supply is always given at the declared pressure, or that the time average differs but little from such declared pressure. No one knows how near these conditions are fulfilled in actual practice, but most consumers have a suspicion that it is more a question of how low the pressure may be kept without raising complaint. For these and for other similar reasons, which need not be obtruded here, we believe that the true policy would be to elevate rather than to degrade the office of Electric Inspector. A body of Inspectors, having the capacity to arrive at accurate and reasonable conclusions in the diverse matters coming before them and endowed with the requisite official authority and responsibility to give their decisions due force, would have a very important influence on the electric supply industry, and it is not easy to see how that influence could be anything else but good.

In order, however, that this state of affairs may follow there is much that requires to be done. The scope of the duties required of an Inspector by the Act must be carefully examined in the light of present practice. His responsibility and official position must be defined more explicitly than is done in the Provisional Orders. We may recall here a few of the things an Electric Inspector may do, according to present usage. His instruments may be, and in most cases generally are, absolutely unverified by any standardising authority. He may test a meter, say, by any method he chooses. He may lay down any scale he likes as to the accuracy required in a certified meter. The scale of fees for testing is a matter for the local authority. The state of affairs is indeed simply chaos. An object-lesson showing what is likely to follow if this continues much longer may be found in a recent occurrence in the administration of the Weights and Measures Act. Some time ago a deputation waited upon the President of the Board of Trade to urge upon him a reform of the Weights and Measures Acts. The circumstances which gave rise to this movement are closely analagous to what is now taking shape in the electrical industry in respect of the functions of Inspectors, and a little consideration of the circumstances referred to may possibly help in pointing our way to wise conclusions. The Weights and Measures Act of 1878, and its amending Act of 1889, had together wrought a wise and beneficent change in the field of their operations. As time passed, however, those concerned with the administration for local purposes began to feel the burden of anomalies which had arisen out of various defects in the Acts. How grievously this burden pressed may be inferred from the fact that it brought about the unusual spectacle of inspector and inspected joining in a movement for reform. A conference of Inspectors and manufacturers of weighing and measuring instruments was held in Birmingham during April, 1895, at which a committee was appointed to examine and report upon the whole matter. This committee, consisting of six inspectors and six manufacturers, carried out an extensive examination of the subject, and their Report and suggestions are most valuable to those concerned. Their Report, we may observe, deals with such matters as: the form and capabilities of weighing machines; the forms and material of the various weights, &c.; the methods of testing and accuracy; the duties and status of inspectors; the tests as to knowledge and skill to which candidates for the office of inspector must conform. It can therefore be easily seen how close a parallel exists between inspectors of weights and measures and electric inspectors. Both have the duty of seeing that absolute justice in reckoning is observed between buyer and seller. But to the Electric Inspector is superadded other duties—*e.g.*, a certain oversight with regard to the safety of the public.

On this matter it is unnecessary to dilate further, but it may be instructive to quote these words from the Report: "The Committee considered that the two main objects of their deliberations were—(1) to secure uniformity in the administration of the Weights and Measures Acts; (2) to suggest such legislative alterations as may be necessary to secure such uniformity of administration."

These two "suggestions," with an obvious change in the first, would serve admirably as instructions for a thorough investigation of the whole matter.

REVIEWS.

Applied Mechanics. By Prof. JOHN PERRY, M.E., D.Sc., F.R.S. (London: Cassell and Co. 1897.)

The title-page of this work announces that it is "A treatise for the use of students who have time to work experimental, numerical and graphical exercises illustrating the subject." He would be no student of the subject who, through lack of time or from any cause, should neglect such exercises. Many years of personal experience in the teaching of applied mechanics and allied subjects has convinced us of the imperative necessity that the student should expend a large part of his time in actually working out numerical and graphical

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exercises, and in performing quantitative experiments with simple but effective apparatus. Merely to read through a treatise on a subject of this kind, however ably and authoritatively written it may be, would produce no more useful result than to peruse a book on swimming without taking exercise in the natatory art. It does not follow, however, that a text-book on "Applied Mechanics," especially one intended for use in class teaching, should consist partly in actual exercises, with the numerical answers appended to the them. A student is all the better instructed in working out a problem if he is given no clue to the order of magnitude of the answer; and, in our opinion, it is preferable that the class teacher shall himself set problems, which he may conveniently keep in manuscript in his own possession. Prof. Perry apparently thinks otherwise, for each section of his book is accompanied by a set of problems, with their answers.

A lifetime devoted to teaching technical science and engineering subjects has placed Prof. Perry in the position of an authority, whose opinions are neither to be disregarded nor lightly weighed. His long experience and sound scientific insight attach importance to his views as to *what* ought to be taught, in the teaching of applied mechanics, and as to the *way* in which it should be taught. He has now given the world a book that is designed to embody his opinions in both these respects—a text-book that is far more than any ordinary text-book; a guide for the student of what to learn and how to learn it, and for the teacher as much of how to teach as of what syllabus to arrange; and indeed more—a polemic. The keynote to Prof. Perry's method is to be found in the introductory chapter of the book. He gives us in the preface, it is true, an outline of the arrangement of studies which he considers most desirable, and tells us that the contents of his book are practically what has been for many years the course of instruction in applied mechanics at the Finsbury Technical College; but this is merely the husk and shell of the matter, for the spicy kernel we must search the book itself—and we get our first taste of the full flavour before we have read to the bottom of the first page. To begin with, Prof. Perry informs the reader what he expects of him, and spares him nothing:

> The student of applied mechanics is supposed to have some acquaintance already with the principles of mechanics; to be able to multiply and divide numbers and to use logarithms; to have done a little practical geometry; to know a little algebra and the definitions of sine, cosine and tangent of an angle; and to have used squared paper. He is supposed to be working many numerical and graphical exercises; to be spending four hours a week at least in a mechanical laboratory; to be learning about materials and tools in an iron and wood workshop; and to be getting acquainted with gearing and engineering appliances in a drawing office and elsewhere.

Then he turns upon the body of teachers and tells them as a class that they do not understand their business:—

> When we think of what goes on under the name of *teaching* we can almost forgive a man who uses a method of his own, however unscientific it may be. Nevertheless, it is not easy to forgive men who, because they have found a study interesting themselves, make their students waste a term upon it, when only a few exercises are wanted—on what is sometimes called the scientific study of arithmetic, for example, or of mensuration. In our own subject of Applied Mechanics there are teachers who spend most of their time on *graphical statics*, or the graphing of functions on squared paper, or the cursory examination of thousands of models of mechanical contrivances. One teacher seems to think that applied mechanics is simply the study of *kinematics* and mechanisms; another that it is simply exercise work on pure mechanics; another that it is the breaking of specimens on a large *testing machine*; another that it is the trying to do in a school or college what can only be done in real engineering works; another, that it is mere graphics; another, that it is all calculus and no graphics; another that it is all shading and colouring, and the production of pretty pictures without centre lines or dimensions. Probably the greatest mistake is that of wasting time in a school in giving the information that one cannot help picking up in one's ordinary practical work after leaving school.

Then comes the first article of faith:—

> We believe that the principles which an engineer really recollects and keeps ready for mental use are very few. By means of lectures, models, drawing office and laboratory, and numerical exercise work, we show a man how these simple principles enter, in curiously different-looking shapes, into his engineering practice. We give him the use of all the necessary methods of study, and we send him out into practical life prepared to study things for himself. We ought to recognise the fact that his real study of his profession is not at school or at college. We ought to teach him how to learn for himself. Any child can state Newton's second law of motion, and the other half-dozen all-important principles of mechanics, so as to get full marks in an examination paper; the engineer knows that the phenomena he deals with are exceedingly complex, and that only a long experience will enable him to utilise the so easily stated principles. Schools and colleges are the places in which men ought to learn the uses of all mental tools; they are sure to specialise afterwards, but in the meantime we ought to give them plenty of tools to choose from. The average student cannot take in more than the elementary principles; the best students need not take in more.

After such utterances it is natural to expect a sort of *anathema maranatha* upon the unbelieving and indifferent: we have not far to search for it, it is at the bottom of the same page:—"*The man who shirks the following exercises and laboratory work will lose a great deal more than he is aware of.*" With such a vaguely portentious declaration facing them, student and teacher alike have nothing for it but to work through the book with a will, or to abandon Prof. Perry and all his ways.

We have already said that these introductory remarks on the part of the author are the key-note to the tune he plays throughout the body of his work. Prof. Perry will not let us even for one moment forget that note, and he has a remarkable way of thumping it out in odd places, where it produces neither melody nor harmony, but only irritating discord. No doubt the note itself, in the first place, is a good one, and it rings out full and true; or, to forsake the metaphor, it cannot be gainsaid that the principles of study he lays down are perfectly sound. But a student, puzzling, it may be, over a knotty problem in statics, does not care to be distracted by a nudge in the ribs and a reminder that he is being taught ever so nicely. Yet that is virtually what Prof. Perry does, not once nor twice, but repeatedly throughout his book. We need cite no more than a couple of examples:—

> 53. *The Use of Squared Paper.*—And here we come *to a matter of the greatest importance* to the practical man. How do we practically compare two things whose values depend on one another? How do we find out the *law of their dependence?* It is a strange fact that there should be a class in the community who have a little difficulty in manipulating decimals in arithmetic, but it is almost a stranger evidence of *neglected education* that so many people should be ignorant of the great uses to which a sheet of squared paper may be put. A sheet of squared paper can be bought very cheaply. It has a great number of horizontal lines at equal distances apart.

The student of this part of the book had previously been called upon to cudgel his brains "to find out in what way friction modifies the law given in books"—another dig in the ribs, by the way; he stands face to face with the difficulty that a certain experiment does not quite agree with this law that "the books" give, and his soul cries out for an explanation. A helpful solution is dangled before him, but just as he is about to grasp it he is distracted by a homily comprising a slap at the anti-decimal party, another at our entire educational system for not including instruction in the use of a certain kind of paper, and a remark on the cheapness at which the paper can be purchased. Not till then may he know even what squared paper really is, still less how it is to help him out of his difficulty. For our second example we quote from p. 266, where the Professor is explaining a graphical problem in dynamics:—

> A student who works such an exercise as this carefully is getting all sorts of *valuable notions* (the emphasis is the author's), not merely of mechanics but of practical mathematics. Unfortunately, twenty academic exercises can be worked out without thought or trouble to teacher or student, and by the rules of the game this is sufficient for the passing of examinations. For the present, therefore, my advice will be followed by a few earnest students only—the men who want to know, the men who are not merely in search of examination tips, the men who find academic exercises difficult because they think about what they do. If such exercises as the above ever become obligatory on all examination candidates, of course their academic friends will discover ways of doing such exercises without the trouble of thinking about them.

Whether the reader takes this as a pat on the back or a slap in the face is "all according"; but whichever way he takes it he is plunged the next moment back into the continuation of the dynamical problem. There is something pathetic about "the men who find academic exercises difficult because they think about what they do." To think that up till now these fellows have all been ploughed owing to the mistaken notion that they were duffers. Verily, they have a grievance.

But the originality of thought, the incisiveness of expression and the influence of ripe experience, which combine to make Prof. Perry's "Applied Mechanics" a vigorous polemic, also serve to produce a quantity of highly instructive and interesting matter for the student. Perhaps the style is a trifle too chatty and off-hand to be elegant, though, for those who have sat in

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the Professor's lecture-room, the colloquial phrases may be pleasantly reminiscent. As regards the scope of the subject-matter treated, what need that much be said? It shall suffice for us to observe that the book claims to be a text-book for elementary and for advanced students, and is all that it claims to be. The distinction between the elementary and the advanced passages is clearly and conveniently marked by a difference in type in the letter-press. It is really immaterial how much of the book is devoted to Graphic Statics and how much to Dynamics, what proportion is occupied by Hydraulics and what by Pneumatics, or how fully the subject of Beams is treated. The author has set himself to teach *Principles*; and in language quoted from his book we may add: "The average student *cannot* take in more than the elementary principles: the best of students *need* not take in more."

Elements of Mechanics, including Kinematics, Kinetics and Statics. By Prof. T. Wallace Wright, M.A., Ph.D. (London: E. and F. N. Spon; New York: D. van Nostrand and Co., 1896.)

This is an interesting and in some respects a curious work. Prof. Greenhill, of Woolwich, who has written the preface, tells us that the author "is evidently an active disciple of Mach of Vienna, and of his 'Science of Mechanics'; and the present work is the first in the English language to preach and popularise these new doctrines." We learn something of Mach's philosophy on pages 47 and 125. On the first, in connection with the Newtonian definition of *mass*, we are told that "Of this definition Mach remarks (*Die Mechanik*, p. 181); 'It is to be observed that the formulation given by Newton which defines mass as the quantity of matter of a body measured by the product of its volume and density, is unfortunate. Since we can only define density as the mass of unit volume, the circle is manifest.'" Unfortunate indeed, even as all metaphysical limitations and paradoxes are unfortunate; but the misfortune, so far as physical science is concerned, is shared by every complete set of definitions that attempts to resolve ideas into their most fundamental and simple form—"the circle is manifest." But why bother students of mechanics about such things? Why addle their pates with the mystery of the quagmire that lies beneath the solid—if thin—crust of ground commonly called axioms? The chief defect in Prof. Wright's treatment of his subject is that he continually and, apparently, with great delight takes his reader to a thin place in the crust and pokes a hole in it. The author is too metaphysical, too fond of the archaic disquisitions and sophisms of the men who evolved their physical science entirely out of their inner consciousness. What other effect than a bad headache can result from trying to understand, for example, Mach's statement (on p. 125), that "the universe is not twice given, with an earth at rest and an earth in motion. It is accordingly not permitted us to say how things would be if the earth did not rotate." And where the reader is not taken to pry into modern metaphysics, he is frequently invited to ridicule the metaphysics of the ancients. Of what practical value, for instance, can it be to a student of mechanics to attempt to solve the following sophism, which is set as a problem on page 43:—

> Discuss the argument of Zeno of Elea (B.C. 500) against motion: "Since an arrow cannot move where it is not, and since it cannot move where it is, it therefore follows that it cannot move at all."

"B.C. 500," indeed! We should think so. If Prof. Wright will prune his work of all such musty, fusty lore he may make it less interesting to the curiosity seeker, but vastly more serviceable in the modern science class-room.

Elektrische Ströme. Zehn Vorträge über die physikalischen Grundlagen der Starkstrom-Technik. By Emil Cohn. (Leipsic: S. Hirzel. 1897.)

It is said that in certain dioceses newly-ordained curates are not allowed for a number of months or years to preach their own sermons, but are compelled to make use of the published works of recognised masters in the art. If a similar regulation were enforced in the case of our younger lecturers on scientific subjects, works like the one under review might well be accepted as furnishing suitable stock lectures. Dr. Cohn's ten lectures are intended for those having already an elementary scientific training. They were originally delivered in Heidelberg to an audience chiefly composed of engineers, architects, and the ever-present "Verwaltungsbeamten." Their object is to give a clear notion of the nature and laws of the electric current, without any detailed description of the appliances for generating, or of those for utilising it. The matter is well divided over the ten lectures, and, although written in fairly popular style, maintains throughout considerable scientific accuracy of expression. The phenomena of induction and of single and polyphase alternating currents are dealt with in a particularly clear manner. One word in the book is, however, to be considered as excluded from all our praise, viz., Cardew'sche Hitzdraht-Dynamometer. If Major Cardew held a similar position in Germany to the one he fills here, he would no doubt be able to enforce that such a hideous association of his name be "*verboten*."

"Deductive Physics." By F. J. Rogers, M.S. (Ithica, N.Y.: Andrus and Church, 1897.)

The two contrary mental processes by which mankind may arrive at a knowledge of science and of common things—the synthetic and the analytic processes—are severally embodied in what are generally known as the deductive and the inductive methods. By the deductive method is implied that synthetical or constructive process of thought by means of which a number of primary axioms, definitions, and postulates are made the sole basis for arriving at the ultimate conclusion. By the inductive or analytic method of thought, on the other hand, is implied the reverse process of reasoning from a number of particular cases to a general conclusion. In physical science the inductive process is generally referred to particular cases that are arrived at by specific experiment or observation. For a being possessed of a knowledge of all possible facts and of their inter-connection or logical relationship, either of these two methods of reasoning would be equally successful and easy. But for a human being, limited both as to the number of separate facts ascertained, and also in the mental power of perceiving the *nexus* between them, there are restrictions of thought that make the deductive method often more difficult, and sometimes impossible.

It will probably be admitted that the early stages of development, whether of an individual mental capacity or of a science, partake of an inductive rather than of a synthetic character. The human infant learns by a process of tearing to pieces, dignified in later years by the term analysis; the infant science, at any rate so far as it relates to concrete and not merely abstract ideas, is built up on a foundation the primary elements of which are a number of analytical considerations of detailed phenomena. Even abstract ideas, such as are embodied in pure mathematics, were probably first acquired by the human species by an analytical process of counting, in which case we may regard such abstract sciences as mathematics as having had their origin in inductive reasoning. The later developments of a science, as of the human specimen, tend towards the alternative mode of thought. Gradually the number of special facts, about which some degree of certainty may be felt, increases until it is possible, metaphorically speaking, to "put two and two together"—a purely synthetical process, whatever its sphere of action. Abstract sciences and some few physical sciences, either as a whole or in part, rapidly pass into the deductive stage. Thus arithmetic, "Euclid," trigonometry, as examples of purely abstract sciences, are wholly deductive; and what is known as theoretical mechanics is largely if not wholly so. These are all based upon certain propositions, of so fundamental a nature that their denial is itself an absurdity. Chemistry and physics afford examples of sciences which are only in part deductive, the other and greater part being a collection of isolated or but partially correlated facts that have still to be dealt with inductively when reasoning about them. And even in certain parts where these sciences appear to be deductive, it is often only the general assent to a hypothetical theory that has not been absolutely proved which makes them so. Indeed, such a science as physics or chemistry may be likened unto a great country, a small portion of which has been civilised and built into a connected system of roads; with a larger area of land already explored but as yet uncultivated, no roads connecting one place with another; a tract of unknown territory of unguessed

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extent lying beyond in every direction. Those whose ambition is expansion may turn either towards the *terra incognita*, to discover new lands, or towards the already explored parts that need development. Science to-day requires the men who can develop even more than those who will explore,

Deductive physics, at the present stage of development, is only a fraction of the science. However much the devout lover of the science may wish to regard it as a logically connected whole, the attempt to formulate that logical connection must break down before any great progress has been made. Isolated patches there are which may be knit together; but with "the vast array of facts, principles, and relations included under the head of modern physics," as Mr. Rogers expresses it, nothing satisfactory in this direction can be done. This consideration, however, has not occurred to Mr. Rogers, or it has not deterred him from attempting the impossible task announced in his preface:—"The object of this volume is to present in *compact* though logically complete form the principal facts, laws, definitions and formulas of the science of physics."

Let us examine in closer detail Mr. Rogers's book, to see in what degree it really constitutes a system of deductive physics. In the "Introduction" the law of inverse squares is explained, and we are told that "this law does not result from the nature of gravitation, electricity, &c., but it depends upon the *nature of space*. It is, therefore, a geometrical and not a physical law." Precisely! yet the entire chapter on "Central Forces, Fields of Force and Potential" is but an essay on the law of inverse squares, treated mathematically with reference to phenomena that do not in the least affect either the treatment or the conclusions. If only one could postulate a hitherto unknown central force emanating from, say, a herring, and acting between all the herrings in the universe, one might obtain from Mr. Rogers's chapter a theory of herring fields of force and herring-potential, without doing more than substitute "herring" for "mass" or "magnetic pole." This is not physics! The same criticism might be directed against the chapters on Optics, in which certain primary assumptions are made the basis of a number of purely geometrical exercises. A student can no more truly learn physical science by such a process than he can learn the grocery business by doing elementary arithmetical problems about so many pounds of tea at so much a pound.

To judge by appearances, Mr. Rogers found his syllogistic steed a very poor nag, and he seems to have been under the necessity frequently to spur it along. He is constantly being pulled up by obstacles that no known syllogism will get him over; so he must have recourse to the *ipse dixit* to circumvent the difficulty. This is Mr. Rogers' misfortune rather than his fault, for he is not to be blamed if all the fragments of Physics will not fit together like the pieces of a dissected puzzle. Such fragments as the magnetic properties of iron must have been especially trying to his patience; while the phenomena of terrestrial magnetism appear to have been hopeless, for they are coldly introduced with the formula "it has been found," and are given in a series of detached statements.

Lest we should be deemed unduly severe in our judgment of Mr. Rogers's book, we may add that, while we consider he has failed to produce a complete system of deductive physics, or any approach thereto, we have no hesitation in pronouncing the work to be a careful and generally accurate synopsis of physical laws and phenomena. Students may be disappointed with it in regard to its philosophical pretensions, but they will not be misled as to facts.

Steam Boilers. By GEORGE HALLIDAY, Wh.Sc. (London: Edward Arnold, 1897.)

Mr. Halliday's useful little book forms one of a series of practical science manuals, edited by Prof. Meldola, at whose suggestion it was written. It is intended for the use of students and workmen. Although not pretending to be a complete treatise on steam boilers, it will serve as a useful introduction to standard works on the subject. The introductory part acquaints the reader with the chief phenomena of steam generation. Subsequently the author describes the various types of boilers in common use, and discusses various questions as to design and construction. There is a short chapter on "Grates, Riveting and Flues," in which an attempt is made to indicate the proper basis for the design of these parts. But the space allotted is too small for adequate treatment, and the final result is a lot of empirical rules, many of which are open to criticism. We recommend the reader of Mr. Halliday's book to take this chapter merely as an outline or skeleton, the details of which are to be filled in from standard sources of more complete information. In the chapter describing methods of determining the dryness factor of steam, the salt test is given, without any warning that the test is utterly useless and misleading. The percentage of salt, ascertained by this test, can be no indication whatever of the amount of wetness arising from condensation in the pipes—often the chief cause of wetness—and can only be influenced by the amount of priming of the boiler. Most of the book is descriptive in character, but with useful practical remarks and references interspersed, the language being clear and simple, and well adapted to the readers for whom the book is written. Appended to descriptions of some of the boilers will be found tabulated data. Thus, for example, with reference to the Babcock-Wilcox boiler, the author gives the results of a test made on the boilers of the Chelsea Electricity Supply Company's station by Mr. King in 1893.

On the whole, Mr. Halliday's work is a very excellent little manual, and we can recommend it to beginners in the study of steam generation. The book is well illustrated with numerous figures in the text.

Experiments on Steam Boilers. By BRYAN DONKIN and Prof. A. B. W. KENNEDY, M.M.Inst.C.E., &c. (London: Offices of *Engineering*, 1897.)

The work before us embodies a reprint of a series of articles that appeared in *Engineering* recently, and it gives particulars of a number of efficiency trials of boilers undertaken by the authors at various times. The boilers that were subjected to trials were as follows: one Lancashire type, one railway locomotive type, two Cornish type (one of these being multitubular), two vertical type (one with a steam blast draught), and one locomotive agricultural type of boiler; besides of externally fired boilers, one elephant boiler and one water-tube boiler. A uniform programme was adopted for all the trials; and the coal used in all the trials (save only in the case of certain repeat trials) was of uniform quality, having been taken from a 100-ton lot of "Nixon's navigation" purchased for the series of trials and carefully mixed. So far as uniform conditions can make them so, therefore, the results of the trials are strictly comparable; and we do not doubt that engineers in search of reliable data as to the performance of boilers on trial will turn to this work, and find therein a mass of useful information concerning what they seek.

But, at the best, these results can be looked upon as no more than, as it were, a drop in a bucket. Not one merely, but a hundred such series of trials of various types of boilers, with various kinds of fuel, and under various conditions, are necessary. Prof. Kennedy and Mr. Donkin have set a good example which we hope many engineers who have the ability and the leisure will follow. They have depicted for us with painstaking accuracy the deatils of one position of the kaleidoscope. How much those details are the accident of the particular specimens experimented upon, and how much they are inherent in the types; how appreciably a small change in the conditions of working would have toppled the kaleidoscope picture into an altogether different pattern—these are matters about which every individual reader and boiler-maker will have his own opinions, but which will not be definitely settled until much more data are available than we possess at the present time. Meanwhile, the practical problem of what type of boiler to use in any particular case solves itself in a rough and-ready but eminently practical fashion whenever it crops up.

BOOKS RECEIVED.

"Wechselstrommessungen und Magnetische Messungen." By Dr. C. Heinke. (Leipzig: S. Hirzel.)

"Fortschritte der Elektrotechnik." By Dr. Karl Strecker. Year, 1895; 5th number (patents.) (Berlin: Julius Springer.)

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IMPROVEMENTS IN THE LOCALISATION OF FAULTS IN SUBMARINE CABLES BY NULL-METHOD BRIDGE MEASUREMENT.

BY C. W. SCHAEFER.*

In the localisation of a fault in a submarine cable when both ends are not accessible at the same time to one observer, various expedients have been suggested for approximately reproducing the conditions of the loop test, which is practically a simultaneous test from both ends of the cable, the resistance of the fault being effective only as modifying the possible appreciation by the bridge system by reason of the reduction of current it causes. No test, however, will eliminate the resistance of the fault from the calculation except when the condition of simultaneity is satisfied. The Kempe "loss of current test," and Ayrton and Perry's "duplex partial earth test" approach these requirements in a remarkable degree, but both are somewhat deficient in respect of certain conditions of appreciation and practicability. Matters are very much simplified in these methods if both stations are provided with absolutely calibrated mil-ammeters, especially if their resistance is negligible. The Weston instrument fulfils these requirements in an eminent degree, although it certainly would be more advantageous to use a suspended coil system instead of pivots for extreme delicacy. The Kempe formula may then be developed as follows:—When station S_1 (Fig. 1) applies the testing current

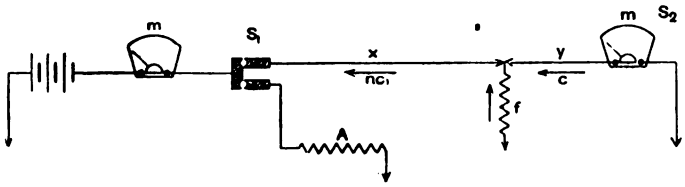

FIG. 1.

let nc represent the current observed at that end, and c the received current at the distant station S_2. Then, supposing that the resistances of the mil-ammeters (m) are negligible, we have

$$c = nc\left(\frac{f}{f+y}\right),$$

from which

$$\frac{1}{n} = \left(\frac{f}{f+y}\right). \quad \ldots\ldots\ (1)$$

Then let A represent the resistance in circuit with the same battery to reproduce the current nc.

$$A = x + \frac{fy}{f+y} \quad \ldots\ldots\ (2)$$

and

$$x + y = L \quad \ldots\ldots\ (3)$$

From these three equations we have

$$x = \left(\frac{An - L}{n-1}\right). \quad \ldots\ldots\ (4)$$

This is the most simple rendering of the Kempe formula.

It is extremely rare, however, to find a cable free from disturbances of potential for which correction must be made, and to overcome this obstacle Kempe recommends the old idea of annulling the "earth current" by means of a compensating arrangement of shunted Daniel cells. This, indeed, seems to be the only plan hitherto adopted in the correction of such measurements, but the objections to it are of such magnitude that the practical value of these otherwise excellent methods has been very much under-estimated, and their application has therefore been exceedingly limited, preference being given to other tests which are lacking in simultaneity, such, for instance, as overlaps.

Considering the "loss of current test" first, let us examine the principal sources of error and see what can be done to overcome them. Although theoretically it would appear that in the reproduction method of measuring a resistance, the accuracy merely depends upon the exactness with which we are able to adjust the resistance and observe the current readings, there is a decided want of sensitiveness in appreciation. Besides this, the behaviour of the testing battery must be studied to account for other errors that are inevitable in practice.

It appears that all batteries are affected by what may be regarded as two distinct disturbances, viz.: (1) the variation of their resistance as affected by their current; and (2) the variation of their effective potential, caused by polarisation. The first is an inverse function of the current, and therefore, in reproduction methods, does not introduce an error. Not so, however, with the polarisation effect, which is a direct function of both the current and period of application of the battery. It is principally, if not wholly due to this obscure change of condition that the reproduced resistance may differ very appreciably from the true value. It is possible to minimise the "variation of resistance effect" by selecting a battery having large plates, and consequently a low internal resistance; but the polarisation is less easily overcome, although with carefully selected depolarisers and large plates, or better still, with secondary batteries, a vast improvement may be expected.

In order that the ratios of currents observed by the terminals may be comparable, it is necessary to determine the absolute calibration of the instruments, and since this is a matter of such importance in the modern practice of cable work, a brief suggestion may be made as to the most simple and accurate means of attaining this end.

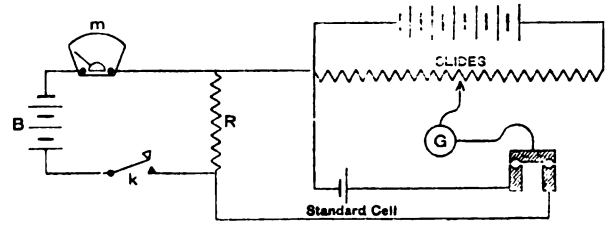

FIG. 2.

Place the mil-ammeter (m) (Fig. 2) horizontally, and join it up in simple circuit with a battery (B), key (k), and an adjustable resistance (R) which should be carefully corrected for temperature. At the extremities of this resistance, measure the potential (preferably by null-method with slides) at the same instant as the mil-ammeter reading is observed, checking the value of the slide reading after each observation. Care should be taken to calibrate as rapidly as possible so as to minimise the heating error to which R is liable by a too long application of the current. For obvious reasons, it is desirable to use batteries in which the polarisation is small. Leclanché's are suitable in circuit with the slides, but for the mil-ammeter circuit, if procurable, two or three *tray* cells are to be recommended. Then if V is the measured potential at the terminals of R, in millivolts, the current in milliamperes will be

$$c = \frac{V}{R}. \quad \ldots\ldots\ (5)$$

Readings should be taken at various points in the mil-ammeter scale, and by means of a curve sheet on which the calculated currents are plotted relatively to the observed values, the requisite correction for any part of the scale can be detected at a glance. Recalibration is advisable periodically.

To overcome the sluggishness of the pivoted system it will be found an improvement to attach a sufficiently weighted flat spring to the base of the instrument by means of which the necessary vibration may be imparted at the moment the readings are taken.

In order that the Kempe test may be made easy to put into practice, it is necessary to remove the disturbing elements already described, and further, to devise some better means of correcting for the earth current. I have found the following arrangement serviceable in eliminating these difficulties, and by its means the full sensitiveness of null-method bridge measurement is ensured, besides which, the same simple connections are applicable in numerous other tests. As will be seen from the diagram (Fig. 3), in the line circuit of a Wheatstone bridge is placed a high resistance (H.R.) of 0·1 megohm or more, which

* We are indebted to Mr. F. Alex. Taylor, of the Eastern Telegraph Company, for careful revision of Mr. Schaefer's proofs.

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may be cut out by means of the short-circuit piece (p). This high resistance may either be connected to the cable through a mil ammeter, or directly to the cell (S.C.) of known E.M.F. and reasonably low internal resistance, having its zinc terminal earthed. By this system of connections we are able to ascertain the value of the potential disturbing the test by simple deflection method, and to make the correction in the manner to be described. The *constant* is first obtained thus:—Make $a\mu = 0$, and with any convenient coil or sets of coils unplugged in μ obtain a reading with the cell (S.C.) through the high resistance, the fork of the bridge being meanwhile earthed through the battery key. The galvanometer shunt (sh) must be noted, or preferably entirely removed.

Let d_1 be the deflection, and E_1 the E.M.F. of the cell in millivolts,

then $\frac{d_1}{E_1} = D$, the number of divisions per millivolt. . (6)

Keeping all conditions the same, switch over to the cable (the distant end being earthed through a mil-ammeter), and observe the deflection (d_{II}) due to the difference of potentials,

then $\frac{d_{II}}{D} = e$, the number of millivolts affecting bridge measurement. . (7)

Having previously arranged with the distant station S_2 to watch for current, and note readings at intervals of, say, every fifteen seconds, the high resistance is short-circuited, and with any convenient ratio in the bridge arms, observe the resistance of the circuit, balancing to scale zero, and simultaneously with S_2 also note the current to line.

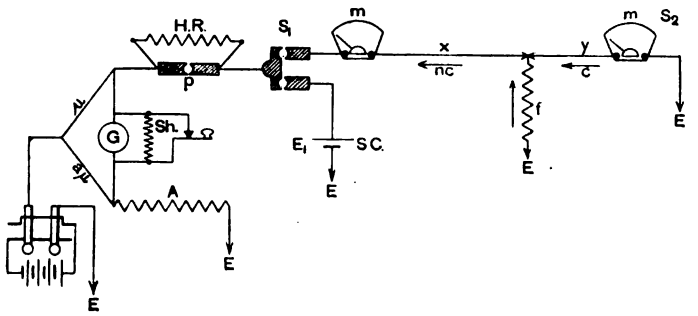

FIG. 3.

The scale zero reading thus obtained will be either less than, or in excess of, the true value by an amount $\left(\frac{e}{nc}\right)$ ohms, which represents the earth current effect.

This correction is additive if the direction of the earth current coincides with the testing current and *vice versâ*. Practically it will be convenient to always so arrange the galvanometer that for the direction of current applied, deflection to the *left* of the zero means *less* resistance required in (A) to balance; in which case if the preliminary cable potential deflection be to the *left*, the correction to the observed resistance well be additive and *vice versâ*.

Let A represent the observed resistance, the current being nc. Then $A \pm \frac{e}{nc} = A_1$, the *true* value of the resistance measured. Putting this corrected value of A in equation (4)

it becomes $$x = \frac{n\left(A \pm \frac{e}{nc}\right) - L}{n-1} = \frac{A_1 n - L}{n-1} \quad . \quad . \quad . \quad (8)$$

Let us now examine the Ayrton and Perry test, which with the assistance of absolutely calibrated mil-ammeters may be considered in its most simple aspect as follows:—

The terminals test with dissimilar currents, and under these circumstances let A and B (Fig. 4) respectively represent the resistances to reproduce (nc) and (c), thus

$$A = x + f - \frac{cf}{nc} = x + f\left(1 - \frac{1}{n}\right), \quad . \quad . \quad . \quad (9)$$

and $$B = y + f - \frac{nc \cdot f}{c} = y + f(1-n). \quad . \quad . \quad (10)$$

Therefore, $$\frac{A - x}{1 - \frac{1}{n}} = \frac{B - y}{1 - n};$$

and putting for y, its value as obtained from equation 3, we get $$x = \frac{An - (L - B)}{n-1} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

This test, therefore, is liable to the same errors as those previously commented upon, and although it has the advantage of being more sensitive under certain conditions of the faults resistance, discrepancies in reproduction readings are possible by both stations. And although independent of any E.M.F. or variation of the faults resistance, provided the observations are simultaneous, some correction has to be made for the difference of earth potentials at the terminals of the cable.

I propose the following improvement, which again is nothing more than a similar system of connections at both stations as before described. The routine would be somewhat as follows:—One minute after a given signal each station simultaneously observes the deflection due to the cable potential, noting the values every 15 seconds subsequently until the expiration of the second minute, when each immediately alters connections and applies opposite currents to line. Both then balance to scale zero as rapidly as possible, noting current and bridge readings synchronously at the 15sec. intervals, continuing this process for, say, five or more consecutive minutes, which will generally be more than ample for the test to be satisfactorily accomplished. The correction on each station's figures will have to be made as previously shown, and these corrected results are then exchanged for working out, selecting the last reading of e in preference to the others. By this device, the full appreciation of null-method measurement is ensured, and the requisite correction made for the difference of earth potentials between the two stations.

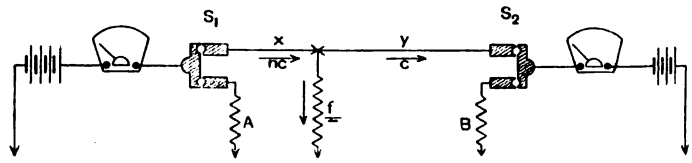

FIG. 4.

This may be shown thus:—

Station S_1's reading $= A = x + f - \frac{f}{n} \pm \frac{e}{nc}$,

$$\therefore \; A \mp \frac{e}{nc} = x + f\left(1 - \frac{1}{n}\right), \quad . \quad . \quad . \quad (12)$$

and station S_2's reading $= B = y + f - fn \pm \frac{e_1}{c}$,

$$\therefore \; B \mp \frac{e_1}{c} = y + f(1-n). \quad . \quad . \quad . \quad . \quad (13)$$

From these equations together with (3) we get

$$x = \frac{n\left(A \mp \frac{e}{nc}\right) - \left\{L - \left(B \mp \frac{e_1}{c}\right)\right\}}{n-1} \quad . \quad . \quad (14)$$

or $$x = \frac{nA_1 - \{L - B_1\}}{n-1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

where A_1 and B_1 are the *true* resistances measured.

The best conditions for the test depend upon the following considerations. It can be shown that the error in x depends greatly upon the ratio of the currents, or in other words, that it is desirable to make n as large as possible. But supposing each station's galvanometer to be equally sensitive, and other conditions being similar, the appreciation varies directly as the current, and for these reasons it is advisable to make n not less and not much greater than 2. If, however, instead of testing with dissimilar currents, both stations use currents

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in similar directions to line, the potential at the fault becomes greater, and in some cases this may prove more advantageous, especially if, as often happens, the fault's resistance tends to a minimum under these circumstances.

The equations then become:

$$A \mp \frac{e}{nc} = x + f\left(1 + \frac{1}{n}\right), \quad . \quad . \quad . \quad . \quad (16)$$

and

$$B \mp \frac{e_1}{c} = y + f(1+n); \quad . \quad . \quad . \quad . \quad (17)$$

from which

$$x = \frac{n\left(A \mp \frac{e}{nc}\right) + \left\{L - \left(B \mp \frac{e_1}{c}\right)\right\}}{n+1}, \quad . \quad . \quad (18)$$

or

$$x = \frac{nA_1 + (L - B_1)}{n+1}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

which is similar in form to equation 15.

In this instance, if both stations have similar appreciation, the best conditions would be when $n = 1$.

In these modifications of what might be called the "simultaneous scale zero test," we are able, by arranging intelligently, to use such currents through the fault as will minimise its resistance and best meet the exigencies of the case.

Turning now to other tests, and without going into superfluous details, it may be of interest to point out the further capabilities of this scale zero system of measurement. The ordinary "free" or "earth overlap" test demands certain conditions which cannot always be satisfied, and even to skilled observers using dead-beat galvanometers the selection of the zero is often a most difficult matter, owing to the rapid and yet long-lasting combined discharge effects due to polarisation and capacity. It generally resolves itself in such cases into the acceptation of a certain interval after cutting off the testing current, which as nearly as can be estimated is equalised by the observers.

As an expedient, which is freer from errors due to personal equation, the scale zero method could be adopted, the routine being somewhat as follows: Each observer during the *first* alternate period allotted to him merely observes the cable potential, whilst the remainder of his periods are occupied in scale zero readings. The corrected readings are then applied to the usual "Anderson and Kennelly" formulæ. Instead of adding a resistance to the shorter limb, we could so arrange the currents by approximation that the station on the longer limb tests with $\frac{x(f+y)}{y(f+x)}$ times the current used by the other station, where x and y are respectively the longer and shorter limbs, and f the resistance of the fault. These conditions being satisfied, the current traversing the fault would be equalised.

The ordinary "Bridge Potential" test as suggested by Mr. Kennelly (*The Electrician*, June 9, 1883) is also very much simplified by this method of "earth current correction" applied to the "scale zero" reading whilst the distant station balances to false zero; that is to say, measures the *change of potential* due to the testing current. Then if R is the corrected scale zero reading with a current c, and v the change of potential due to that current, the distance to the fault will be

$$x = \left(R - \frac{v}{c}\right).$$

In the "combined resistance and discharge" test as used in the localisation of high resistance breaks, such for instance as occur when the conductor is broken and partially surrounded by the gutta-percha, this plan will, no doubt, be found a very useful adjunct.

Although it is in no way suggested that the "scale zero" method will supersede, or even approach that of the "false zero" in accuracy of observation, so long as variations take place in the earth current, it is a fact that the former system has hitherto been limited to the more refined measurements of simple resistances and to laboratory work, and it has, so far as I am aware, not received the consideration it deserves.

THE FERROMAGNETIC PROPERTIES OF IRON AND STEEL.*

BY PROF. J. A. FLEMING, D.SC., F.R.S.

(*Continued from page 863, Vol. XXXIX.*)

First, as to the probable *number of molecules* of a gas in a cubic centimetre. Maxwell says† "a cube whose side is the one four-thousandth of a millimetre would contain from 60 to 100 million molecules of oxygen or nitrogen gas at ordinary temperature and pressure." This is equivalent to saying there are from 30×10^{20} to 60×10^{20} molecules per cubic centimetre. Lord Kelvin gives‡ as the probable number 10^{18} molecules of air per cubic centimetre. The work of O. E. Meyer and Van der Waals leads to an estimate that there are about 10^{20} molecules per cubic centimetre. Other writers give 10^{21}. All we can do in this case is to take as a probable value a mean of the various estimates which have been given, and we shall assume, as a starting-point, that the number of molecules of gaseous oxygen in a cubic centimetre of the gas at 0°C. and 760mm. is a number represented by 10^{19}, or ten million million million.

Next, as to size. Lord Kelvin‡ has four different lines of argument, which all lead him to the conclusion that the diameter of a molecule is represented by a number lying between $\frac{2}{10^7}$ and $\frac{1}{10^9}$ of a centimetre.

Suppose we select the mean of these somewhat different values, and take the average diameter of a molecule as $\frac{1}{10^7}$ of a centimetre. Then the mean radius of a molecule is $\frac{1}{2} \cdot \frac{1}{10^7}$ of a centimetre. To get some idea of what this means, imagine a cubical box, each side of which is 500 miles long. Fill this gigantic box with cricket balls. The number and diameter of these balls would be to the size of the box in the same relation as the number and size of the molecules in a cubic centimetre of water is to the cubic centimetre. Another line of argument as to the diameters of molcules is as follows:—The great incompressibility of liquids leads to the conclusion that in them the average distance between the centres of the molecules is the same as that between the centres of the molecules of gas molecules at the instant of a collision. We may call this condition one of molecular contact, and say that in a liquid the molecules are practically in contact with each other. Hence if the mean diameter of a molecule is anything like $\frac{1}{10^7}$ of a centimetre, there must be 10^{21} molecules of a liquid in a cubic centimetre.

It has been shown by Prof. Dewar that when gaseous oxygen is condensed into a liquid its density increases about 800 times. Hence, if there are 10^{19} molecules in a cubic centimetre of gaseous oxygen there will be 800 times as many or 8×10^{21} in the liquid oxygen. Hence, from the above, we should deduce that the diameter of the oxygen molecule is $\frac{1}{2} \cdot \frac{1}{10^7}$ centimetre, which is a number lying within the limits given by Lord Kelvin. Therefore its mean radius would be $\frac{1}{4} \cdot \frac{1}{10^7}$ of a centimetre. For the purposes of this discussion I will take the mean value given by Lord Kelvin, viz., $\frac{1}{2} \cdot \frac{1}{10^7}$, as the probable mean radius of a molecule.

Next, as to the absolute mass of a molecule. We know that 11,162 cubic centimetres of gaseous hydrogen at 0°C and 760mm. weigh one gramme. Hence, if there are 10^{19} molecules per cubic centimetre, the mass of a molecule of hydrogen is

* A lecture delivered October 18, 1897, to the Sheffield Society Engineers and Metallurgists. *Copyright.*

† "Encyclopædia Britannica," Article "Atom."

‡ Popular Lectures on the Constitution of Matter. "On the Size of Atoms."

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$\frac{1}{112 \times 10^{21}}$ of a gramme, and hence since there are two atoms of hydrogen in a molecule, the absolute mass of an *atom* of hydrogen is approximately $\frac{1}{2 \cdot 10^{23}}$ of a gramme.

For a gas such as oxygen or hydrogen, good authorities, therefore, have given us warrant for believing that the following figures are probably not grossly in error. The probable number of molecules of the gas in a cub. cm. is 10^{19}. The probable average diameter of a molecule is $\frac{1}{10^7}$ of a centimetre. The absolute mass of a molecule of hydrogen is $\frac{1}{10^{23}}$ of a gramme.

In the next place let us consider the case of the metal, iron, in the solid condition.

The absolute mass of an atom of iron is 56 times that of an atom of hydrogen, and it must therefore be $\frac{56}{2} \cdot \frac{1}{10^{23}}$ of a gramme, or, say, $\frac{3}{10^{22}}$ of a gramme.

From the above data as to the number of atoms per cubic centimetre, we are able to deduce the probable magnitude of the absolute atomic electric charges. It requires 96,540 coulombs of electricity passed through an electrolytic solution (say, dilute acid) to liberate 1 gramme of hydrogen, or 11,162 cubic centimetres of hydrogen at 0°C. and 760°C. Also 96,540 coulombs are equal to 9,654 electromagnetic units, or to $9{,}654 \times 3 \times 10^{10}$ electrostatic units.*

If then g stands for the *gramme-equivalent* of an element, that is the number of grammes chemically equivalent to one gramme of hydrogen, and if D is the absolute density, and n the number of molecules per cubic centimetre, and n^1 the number of atoms in a molecule, the electrostatic charge e of an atom of that element is given by the equation

$$e = \frac{9{,}654 \times 3 \times 10^{10} \times D}{g \times n \times n^1} \text{ electrostatic units.}$$

Thus for an atom of hydrogen the atomic charge is

$$\frac{9{,}654 \times 3 \times 10^{10}}{1 \times 10^{19} \times 2 \times 11{,}200} = \frac{1}{7} \cdot \frac{1}{10^8} \text{ of an electrostatic unit nearly.}$$

For iron in the ferric condition or tetrad iron if we assume two atoms in the molecule, the gramme-equivalent g is $\frac{56}{3}$, we have also $n = 10^{22}$, $n^1 = 2$, $D = 7{\cdot}8$, and hence the electrostatic charge e of the iron atom is

$$e = \frac{9{,}654 \times 3 \times 10^{10} \times 7{\cdot}8 \times 3}{56 \times 10^{22} \times 2} = \frac{6}{10^9} \text{ (of an electrostatic unit).}$$

Hence the charge of the tetrad iron atom is four times that of the hydrogen atom.

Hence these deductions from atomic theory lead to the conclusion that, in the case of metallic iron, the following numbers give the *order*, in a mathematical sense of the term, or probable magnitude of certain atomic constants. There are probably 10^{22} molecules of iron per cubic centimetre. The probable diameter of the molecule is $\frac{1}{10^7}$ of a centimetre. The electrostatic charge of the iron atom is then $\frac{6}{10^9}$ of an electrostatic unit. The absolute mass of the iron atom is about $\frac{3}{10^{24}}$ of a gramme.

The hypothesis of ferromagnetism I now wish to put before you is based upon the experimental fact that an electrified body in revolution is equivalent to an electric current and produces a magnetic field. The experiments of Rowland, Röntgen and others have shown that a disc having an electrostatic charge set in revolution round an axis acts as a very short magnet, having its magnetic axis perpendicular to the plane of the disc, or coinciding with the axis of rotation. Hence, if we consider an atom carrying its electrostatic charge to revolve in a circle round a centre it will create a magnetic field, the direction of which is the same as that of a very short magnet with its axis perpendicular to the plane of the orbit, and with its centre at the centre of revolution. Before, however, such a suggestion can be even worth a moment's consideration it must be shown that, with the probable electrostatic charges which may exist on iron atoms, and with some possible or not improbable structure of iron molecules, we can show that the known magnetic qualities of iron would result.

In the first place, we can show what kind of molecular structure would *not* produce any magnetic effect at all by its rotation. Suppose, for instance, that a molecule consists of two atoms, one carrying a negative charge and the other carrying a positive charge (*see* Fig. 4). Let these two atoms revolve round their common centre of mass, like the constituents of a double star. Whatever may be the magnetic effect due to the positive atom revolving round (say in the clockwise direction), it is exactly equal and opposite to the magnetic effect due to the clockwise revolution of the negative atom. Hence, if the electric charges are equal in quantity and opposite in sign, no magnetic effect at all would result from the revolution of such a binary molecule. Suppose, however, that the molecule consisted of four atoms, two carrying positive electric charges and two carrying negative charges, and let them be represented as in the diagram (*see* Fig. 5) where two tetrad positively-charged atoms are shown each united by four *bonds* to two tetrad negatively-charged atoms. These *bonds* must be taken simply as symbols of electric attractions of a certain intensity existing between the opposite atomic charges. Supposing that such a structure is dynamically possible, and that the molecule is in equilibrium when set in revolution round an axis drawn through the two negatively-charged

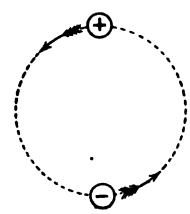

FIG. 4.—Ideal Non-Magnetic 2-atom Molecule.

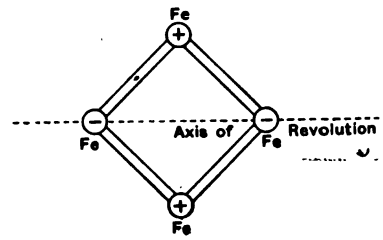

FIG. 5.—Ideal Magnetic 4-atom Molecule of Iron.

atoms. Then for a certain value of the angular velocity it will happen that the centrifugal action due to the masses of the positively-charged atoms will just balance the electric attractions due to the electric charges of opposite sign existing on the revolving positively-charged atoms and the negatively-charged atoms lying on the axis. Such a dynamical system would be subject to the laws of planetary revolution, and if the speed of revolution increases beyond a certain point the molecule would undoubtedly break up. The mean radius of the orbit of the positive atoms would be connected with the mass of the atoms, the intensity of the electric forces and the speed of revolution by certain well-known relations. If we take

m = as the mass of each revolving atom in grammes,
r = the mean radius of the orbit in centimetres,
e = the electrostatic charge in electrostatic units,
N = the number of revolutions per second,

then the force required to hold the revolving atom in its orbit is $4\pi^2 m r N^2$ dynes, and this must be produced by the electrostatic attraction of the positive and negative atoms. As in such approximate calculations nothing more is possible than to settle the *order* of magnitude of the various quantities, we need not enter into refinements of calculation. We will, merely as a first approximation, suppose the two negatively-charged atoms to act as the central mass, and attract the positively-charged atoms revolving round them at a distance r, each atom carrying a charge of e units.*

* An electrostatic unit of electric quantity is one which if collected on a small sphere repels another equally charged small sphere with its centre at a distance of 1cm. apart with a force of one dyne.

* It can easily be shown that with the masses, distances, and electric charges we have to consider in the case of atoms the electrostatic attractions are *billions of billions* of times greater than the gravitational or mass attractions. Consider the case of two atoms of hydrogen placed at a

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Hence the electric force on the revolving positively-charged atoms must be $\frac{2e^2}{r^2}$, because a total negative charge of $2e$ acts on a positive charge e at a distance r. Therefore, equating these two expressions for the force, we have—

$$4\pi^2 mr\mathrm{N}^2 = \frac{2e^2}{r^2},$$

or,

$$2\pi^2 mr^3\mathrm{N}^2 = e^2. \quad \ldots\ldots \quad \text{(iv.)}$$

It will thus be seen that the four quantities m, r, N and e are interconnected, and cannot be chosen arbitrarily. Let us in the first place consider what must be the value of N. An electrified atom revolving in an orbit would create electric radiation in the ether, the frequency of which may be taken to be that of the revolution. The frequency of ether waves producing just visible red light is 400×10^{12}. Prof. Langley has shown by bolometric experiments that the wave length of the radiation from a black surface at a temperature of 100°C. is about 20 times that of yellow light. Hence for iron molecules at ordinary temperatures it is not possible to assume that the frequency of revolution could be greater than about 3×10^{13}, but it may be something of that order.

Let us then calculate what must be the radius of the orbit of a positively-charged atom carrying a charge of $\frac{6}{10^9}$ units revolving round a pair of atoms negatively charged with $2\times\frac{6}{10^9}$ units 3×10^{13} times a second, the mass of the revolving atom being $\frac{3}{10^{22}}$ of a gramme. Since $2\pi^2$ is nearly 20 we have

$$2\pi^2 mr^3\mathrm{N}^2 = e^2$$

or

$$20\times\frac{3}{10^{22}}r^3\times9\times10^{26} = \frac{36}{10^{18}}.$$

Hence

$$r^3 = \frac{2}{3}\cdot\frac{1}{10^{23}} \quad \text{or} \quad r = \frac{1}{\sqrt[3]{150}}\cdot\frac{1}{10^7}.$$

This gives a value of $r=\frac{2}{10^8}$ nearly, or $\frac{4}{10^8}$ of a centimetre as the diameter of the atomic orbit, which lies well within the limits $\frac{2}{10^7}$ and $\frac{1}{10^9}$ of a centimetre laid down by Lord Kelvin for molecular diameters.

We are therefore justified in considering that the following are not improbable or inconsistent values for the atomic constants of an iron *atom*:—

The absolute mass $= (m) = \frac{3}{10^{22}}$ of a gramme.

The electrostatic charge $= (e) = \frac{6}{10^9}$ of an electrostatic unit.

The number of revolutions per second $= (\mathrm{N}) = 3\times10^{13}$ (at ordinary temperatures).

The semidiameter of the orbit and therefore of the molecule (taking the mean of Lord Kelvin's values.) $= (r) = \frac{1}{2\times10^7}$ of a centimetre.

If a small electrified body revolves round a centre N times a second, and if the electric charge carried by it is e electrostatic units, and if the radius of the orbit is r, then the electrostatic charge in revolution is equivalent to a circular electric current of strength $\frac{\mathrm{N}e}{3\times10^{10}}$ electromagnetic units, and the *magnetic moment* of the revolving charge will be equal to $\pi r^2\frac{\mathrm{N}e}{3\times10^{10}}$ absolute units C.G.S. Hence for *two* positively electrified atoms of iron, each charged with $\frac{6}{10^9}$ electrostatic units, revolving 3×10^{13} times per second round two negatively-charged atoms in an orbit of radius $\frac{1}{2\times10^7}$ of a centimetre, the magnetic moment of the molecule (m') is $\frac{2\pi\mathrm{N}er^2}{3\times10^{10}}$, or nearly $\frac{6\times3\times10^{13}\times6}{3\times10^{10}\times10^9\times4\times10^{14}}$ of a C.G.S. unit. Hence, $m'=\frac{9}{10^{20}}$, or about $\frac{1}{10^{19}}$. If, then, there are 10^{23} molecules of iron per cubic centimetre, the magnetic moment of a cubic centimetre of iron magnetised to saturation should be—

$$\frac{1}{10^{19}}\times10^{23} = 1{,}000 \text{ C.G.S. units.}$$

As a matter of fact, it is really about 1,500 to 1,700 C.G.S. units.

It is exceedingly unlikely that the real structure of the iron molecule is anything so simple as here assumed, but the above figures show, however, that on a not absolutely improbable hypotheses as to the structure of a molecule of iron, and by regarding it as built up of atoms carrying electric charges revolving round an axis, like planets round the sun, we need no other supposition to account for the magnetic properties of the iron molecule.

(To be continued.)

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distance of a molecular radius or diameter, say, $\frac{1}{10^7}$ cm. The absolute mass of each atom is, as we have seen, $\frac{1}{2}\frac{1}{10^{23}}$ of a gramme. The electric charge of each atom is $\frac{1}{7}\frac{1}{10^8}$ of an electrostatic unit. The constant of gravitation is $6{\cdot}6576\times10^{-8}$, according to C. V. Boys. That is to say, two small masses, each weighing 1 gramme, placed with their centres 1cm. apart, attract each other with a force of $\frac{6{\cdot}6576}{10^8}$ of a dyne. Hence, two atoms, each of mass $\frac{1}{2}\frac{1}{10^{23}}$ gramme, placed at a distance of $\frac{1}{10^7}$ cm. attract each other with a *gravitational force* of

$$\frac{6{\cdot}6576}{10^8}\cdot\frac{\frac{1}{4}\left(\frac{1}{10^{23}}\right)^2}{\left(\frac{1}{10^7}\right)^2} = \frac{6{\cdot}6}{4}\,\frac{10^7\times10^7}{10^8\times10^{23}\times10^{23}} \text{ of a dyne.}$$

or $\frac{2}{10^{40}}$ of a dyne nearly.

If the electric charges are equal, but of opposite sign, the atomic *electrostatic attraction* at the same distance would be

$$\frac{\frac{1}{49}\left(\frac{1}{10^8}\right)^2}{\left(\frac{1}{10^7}\right)^2} = \frac{1}{49}\,\frac{10^{14}}{10^{16}} = \frac{1}{50}\,\frac{1}{10^2} = \frac{2}{10^4} \text{ of a dyne nearly}$$

In other words, the electric attraction due to the electric charges would be 10^{36} times as great as the gravitational attraction due to the masses.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Oct. 15, 1897.*

Next Year's Electrical Exposition.—In recent correspondence reference was made to the organisation of a new company to hold an electrical exposition in this city in May, 1898. At the time of that announcement plans had not been definitely settled as to where the show would be held, but during the past few days Madison-square Garden has been leased by the Exposition Company for the entire month of May next. Madison-square Garden is the largest building in the city designed for entertainment purposes, and includes a very large amphitheatre, an arena circle, concert hall, assembly hall and machinery hall—all under one roof. The entire space has been secured for the Electrical Exposition, and it is the desire of the promoters of this show to make it surpass, if possible, anything of the kind ever before attempted in this country. The Electrical Exhibition which was held in this city in 1896 was very successful in every respect, and it is reasonable to assume that the one next year will be at least equally prosperous.

Consolidation of Large Electrical Interests.—For some time past rumours have been afloat to the effect that the Sprague Electric Elevator Company and the Interior Conduit and Insulation Company, of this city, were to be consolidated and conducted under one management. The work of amalgamation was consummated in this city a few days ago, and a new company, called the Sprague Electric Company, has been organised under the State laws of New Jersey, with a capital stock of £1,000,000, to take over the property and business of the two concerns which

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it supersedes. The Sprague Electric Elevator Company has a very large and valuable plant at Watsessing, N.J., a few miles out of the city, and it is the new company's intention to concentrate all the work at that point, closing up the present factory of the Interior Conduit and Insulation Company. The new company will continue the business of the two old companies, and will fulfil the contract for the electric elevators, which are to be installed at the stations of the Central Underground Railroad in London. The officers of the new company are: Mr. A. B. Chandler, President and Managing Director; Mr. E. H. Johnson, first vice-president and general manager; Mr. F. J. Sprague, second vice-president and technical director; and Mr. E. C. Platt, secretary and treasurer. Among the directors are Mr. J. E. Searles, commonly known in this country as the "Sugar King." Mr. Chandler, the president, is well known as the president of the Postal Telegraph-Cable Company, and no doubt represents the interests of Mr. J. W. Mackay, who is reported to be financially interested in the new concern.

The Street Railway Convention.—Next week, beginning on Tuesday, October 19th, the American Street Railway Association will hold its sixteenth annual convention at Niagara Falls, N.Y. The meeting will extend over Tuesday, Wednesday, Thursday and Friday, and there is every prospect that there will be a large attendance. Among the Papers to be read is one on "Municipal Ownership of Street Railways," by Mr. P. F. Sullivan. Mr. Charles Hewett, electrical engineer of the Union Traction Company, Philadelphia, will read a Paper on "The Application of the Storage Battery to Electrical Traction," and Mr. Maurice Hoopes will read one, entitled "Power Distribution and Use of Multiphase Current Transmission for Ordinary Street Railways." Some interesting information will probably be given in the Paper to be read by Col. N. H. Heft, of the New York, New Haven, and Hartford Railroad, who has chosen as his subject the "Application of Electricity to Railroads now operated by Steam Power." It will be remembered that Col. Heft superintended the work of equipping the branch lines of the New York, New Haven, and Hartford Railroad Company on the third rail system. These lines are working with remarkable success, although figures showing the economy of the system have never been published. It is hoped that Col. Heft will avail himself of this opportunity to unbosom himself and enlighten the electrical fraternity on this important point. The various points of electrical interest at and about Niagara Falls will be visited by the delegates. This is a matter of course. Niagara Falls has been particularly favoured this year in being selected as the meeting-place for conventions of all sorts. The Electric Light Convention was held there in June last, and various other conventions of all sizes—big and little—have visited this historic and interesting spot, and made it their headquarters for the time being.

CORRESPONDENCE.

THE CLARK CELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Prof. Callendar's courteous communication in your current issue, kindly permit me to state that, in my article upon the Clark cell in practice, I expressly mentioned that it was possible, when fuller particulars than appeared in your notes of the British Association meeting were to hand, much of the criticism made by me in the article in question might be subject to modification. This was added not as a loophole for escape from the main issues involved, but from the natural anticipation that on points of detail fuller information might to a certain extent render some of the remarks made superfluous. This appears to be the case, more particularly upon the question of mercury cups, dryness of cell, &c.

The nature of the lag in the Clark cell was well known to me, *i.e.*, that it was that of diffusion of the solution and not the difference of temperature between cell and thermometer; but the ultimate result in practical use is the same, *i.e.*, lag of *value* due to alterations in temperature.

In his letter Prof. Callendar gives an extreme case (due to a misconception of a portion of my article dealing with the question of variations in temperature), and mentions the sudden upheaval of a cell from 15deg. to 35deg., a proceeding rarely obtained in practice. What I wished to imply, and what *is* current practice, was, that the cell is usually placed in a test room where fluctuations of temperature of wide range rarely occur. Sometimes the test room, owing to the exigencies of the case, lies adjacent to or borders on some source of heat which renders the atmosphere of the same far higher in temperature than the normal; still such temperature is practically constant. However, granted the extreme case given, and taking Prof. Callendar's figures, the error for 20deg. is practically one per cent. Now, the only reason for submitting the cell to such a change of temperature (and it is quite unnecessary) would be on account of a machine or circuit-meter test occupying at most six hours. At the end of that comparatively short time how much would the cell have altered in value, or what discrepancy would there be due to lag in diffusion (caused by alteration in temperature) if the cell were contained in a wooden box of, say, 1ft. cube, the space between being filled up by suitable lagging? Would it be anything like what it would be if the cell were bare and unlagged?

As to extravagant praise being meted out to cells of Muirhead make, I wrote of facts as I found them from a commercial point of view; and surely a cell of commercial fitness is as worthy of scientific discussion at the British Association as one made in a private laboratory, more especially seeing that it is not a question of "makers'" rivalry, there being but one in the market to my knowledge.

The concluding paragraphs of Prof. Callendar's letter are very pleasant reading to anyone interested in the behaviour of Clark cells; the promise of the degree of accuracy mentioned in a laboratory is indeed good news; at the same time Prof. Callendar seems to be in agreement with the writer, that eventual solution will be found in the advocacy of two standards, one for commercial and the other for laboratory use.—Yours, &c.,

W. C. FISHER.

Ealing, W., Oct. 26, 1897.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The term elevated electrodes in connection with wireless telegraphy is not a happy one. It does not convey a clear idea of the apparatus used for long distance. Mr. Marconi attaches a vertical wire to one of the terminals of his instrument at each station, the other being put to earth. The wire is surmounted by a metal shape to give additional capacity. Experiment seems to show that slightly better results are obtained with the capacity than without it. However that may be, there is no doubt whatever that the vertical wire is the essential feature.

Prof. Minchin claims priority on this point because he used a horizontal "collecting" wire several feet long, attached to his receiver only, but if the apparatus were arranged as he describes in the letters in your issues of October 15th and 22nd, it was practically a "conducting" wire. To obtain good results the wire must be *vertical*, as may be seen from the following extracts from notes on actual experiments:—

1. Vertical wires 100ft. in height, earthed at transmitter and receiver. Distance signalled, four miles
2. Same wire placed horizontally, 150 yards.
3. Vertical wire 100ft. at transmitter and copper strips at receiver, 30 yards.
4. Same wire fixed at receiver, and transmitter fitted with spherical electrodes only, 40 yards.
5. Vertical wire 50ft., at both stations gave three miles.
6. Same wire placed horizontally, about 50 yards.
7. Vertical wires 50ft. at both stations, earthed at transmitter only, 1,100 yards.
8. Same wires earthed at receiver only, two miles.
9. Copper strips substituted at both ends, 30 yards.

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10. A horizontal wire 850ft. long was erected 12ft. from the ground at each station. The transmitter was placed one mile from the receiver. No signals were observed, even with the most sensitive coherer. The horizontal portion of the wire was then cut off, leaving a 12ft. vertical wire at each instrument; perfect signals were received on a much less sensitive tube.

It may be stated for the information of Prof. Minchin that the mathematical theory, that the distances signalled varies with the square of the height of the vertical wires, has been verified beyond a doubt by actual experiment. Trial seems to indicate that the section of the vertical wire is unimportant, which is also in accordance with theory.

Adverse criticism has gone so far as to doubt Mr. Preece's statement that signals were sent and received, although an intervening hill obscured the two stations. The fact that impulses can be imparted to a receiver placed in a sealed iron case is almost universally denied. Mr. Marconi will, at an early date, show that this is possible. It will be interesting then to note how many of the sceptics following their present tactics will lay claim to having done the very same thing long ago.—Yours, &c., J. N. C. KENNEDY, Capt. R.E.

LEGAL INTELLIGENCE.

Smith and Co. v. Barlow.

At the Kettering County Court, last week, Messrs. H. Whitmy Smith and Co., electricians, sued Mr. F. Barlow, J.P., builder, of Rothwell, for £23, for a supply of electric bells. The question at issue was whether defendant was entitled to 10 per cent. commission upon the cost of the work done by the plaintiffs, the contention being that it was the custom of the trade for the holder of the main contract to receive this commission from the sub-contractor carrying out the electrical part of the work. Mr. Smith, partner in the plaintiff firm, said he heard nothing of the 10 per cent. reduction when the arrangement was made with defendant's agent.—Mr. Ingham, the architect, said he had the power to sub-let the part of the work in question. There was a verbal agreement with the plaintiffs that the cost of the bells, &c., should be £23, and the defendant had received £23 through him as architect. He did not think that defendant was entitled by any custom to 10 per cent.—Mr. Harding contended that the architect had no right to deprive the defendant of the commission which he would ordinarily have received under the original specifications. The invariable custom was for the builder to have a trade commission. The defendant and Mr. A. G. Leighton (of Gotch and Saunders, builders) gave evidence that it was customary to give 10 per cent. in the county. After hearing evidence the judge decided that, while this might be a county custom, it was not a universal one, and gave judgment for the plaintiffs, with costs.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

READY TO-DAY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. See advertisement elsewhere.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. nett; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free,

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. *New Edition now ready.* These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

Notice.—There will shortly be ready a cheaper Edition of these popular "Notes and Forms," for the use of students at the Polytechnics and other teaching institutions throughout the country. The price of the new forms will be 2d. net, post free, or 2s. per dozen assorted forms.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations. Price 2s. 6d. net.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book for the electrical trades desires to contradict a rumour which he learns is in circulation that the issue of this work is to be discontinued. The Directory and Handbook for 1898 is already in course of preparation, and the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced.

Tenders Invited.—Tenders are invited for plant and works in connection with the scheme for the conversion of the Blackpool Corporation electric tramways to the overhead trolley system:—(*a*) steel columns, brackets and straining posts; (*b*) trolleys, trolley wire and insulators; (*c*) controllers, motors and gearing; (*d*) mains and section fuses. Some further particulars are given in an advertisement elsewhere, and specifications, &c., may be obtained from the Borough electrical and tramway engineer (Mr. Robert C. Quin), Corporation Electricity Works, Blackpool. Tenders, addressed to the Chairman of the Electric Lighting and Tramways Committee, must be delivered to Mr. Quin by 10 a.m. of Monday, Nov. 22.

——— As will be seen from our advertisement columns, the Corporation of Ayr are inviting tenders from firms willing to undertake the "free wiring" of premises in the streets of the burgh. Particulars as to districts in which the mains are laid can be obtained from the burgh electrical engineer (Mr. Arthur J. Fuller), and tenders must be sent in to the town clerk (Mr. A. G. Young), Municipal Offices, Ayr, by Thursday, Nov. 11.

——— The Agent-General for Victoria invites tenders for the supply of electric light cables and fittings for the railway department of the Colony. Specifications and conditions of contract can be had at the Agent-General's office, 15, Victoria-street, Westminster, London, S.W., and tenders must be delivered by Nov. 10, to be opened at Melbourne on Dec. 20. Further information will be found in an advertisement elsewhere.

——— The St. Pancras (London) Vestry invite tenders for supplying and fixing additional plant at the Regent's Park Electricity Works, comprising dynamos, engines and switchboard. Tenders to the clerk to the Vestry (Mr. C. H. F. Barrett), Vestry Hall, Pancras-road, N.W., by noon of Nov. 2.

——— The Corporation of Burnley require tenders for the supply and delivery of lead sheathed armoured underground cables. Tenders to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, by Nov. 17.

——— The Corporation of the City of Kingston-upon-Hull require tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half-mile single track. Tenders to the Town Clerk, Town Hall, Hull, before noon of Nov. 5.

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Tenders Invited.—The Cheshire Lines Committee invite tenders for the supply of various stores, including telegraph materials, instruments, wire, &c. Tenders to the Secretary, Central Station, Liverpool, by Friday, Dec. 3.

Tenders Accepted.—The London County Council on Tuesday accepted the tender of Messrs. Jackson and Coleby to maintain for three years the electric bells belonging to the Fire Brigade at £325 per annum for the number of bells existing at the end of October, 1897, at all the Fire Brigade stations, exclusive of Clerkenwell and Fulham, no additional charge to be made for the use of the combined bell and electric lighting call switches at any station.

——— The Brighton Town Council have accepted the tender of Mr. T. King, of Brighton, for wiring and fitting the administrative building at the new sanatorium for the electric light at £170. Five tenders, ranging from £170 to £225, were submitted for the work.

——— The tender of Messrs. Donnison, Barber and Co., has been accepted by the Wakefield Town Council for wiring the Town Hall, at £299. 12s.

——— The Huddersfield Town Council have accepted the tender of Messrs. Read, Holliday and Sons for wiring the free library and art gallery premises in Somerset-buildings at £87.

——— The tender of Mr. T. L. Hellyar has been accepted by the Hammersmith (London) Vestry for wiring and fitting up the Shepherd's Bush library for the electric light at £90. 1s. 6d.

Appointments.— Mr. Charles Augustus Midgley, of the Yorkshire House to House Electricity Supply Company, Leeds, has been appointed assistant electrician at Wakefield, subject to the approval of the City Council. There were 23 applications for the position.

——— On the recommendation of the Gas and Electric Lighting Committee the Burnley Town Council have appointed Mr. R. Birkett, of the Chelsea Electricity Supply Company, London, assistant engineer at the electricity supply works. There were 63 applications for the position, and this number was reduced to three, out of which a final selection was made.

——— Notwithstanding that, according to the official announcement, applications for the post of electrical engineer to the Glasgow Corporation have not to be sent in until the 9th prox., the *Dundee Advertiser* is responsible for the announcement that Mr. William Lackie, chief assistant to Mr. Arnot, has been appointed to the vacant position. Mr. Lackie is the fourth son of ex-Provost Lackie, and served his apprenticeship with Messrs. Mavor and Coulson, of Glasgow. He has acted as first assistant engineer at Glasgow since the Corporation electricity works were established. Some further reference to this matter will be found in a Glasgow note on another page.

Appointment Vacant.—The Glasgow Corporation invite applications for the position of chief resident engineer of their electricity department. The necessary qualifications for the post will be found set out in an advertisement on another page. The selected candidate will take entire general management of the department, at a salary of not less than £800 per annum, and will be required to devote his whole time to the duties of the office. Applications have to be sent in to Sir J. D. Marwick, Town Clerk, not later than Nov. 9.

Business Notices.—Messrs. Smith and Co., of Nottingham, have appointed Messrs. J. B. Guthrie and Son, West India House, Leadenhall-street, E.C., agents for their special manufactures of gun-metal, iron, steam, and water fittings, injectors, &c.

——— We are asked to state that, owing to largely-increased capital being required by the development of the business of Mr. A. B. Pescatore, of Haworth's-buildings, 5, Cross-street, Manchester, it has been decided to convert it into a limited liability company, bearing the title "The Tudor Accumulator Company (Limited)," of which Mr. Pescatore becomes managing director. The registered offices will be transferred from Manchester to London in the early part of November. All debts and liabilities of and all debts due to the old firm are taken over by the new Company. The conversion does not in any way affect the general conduct of the business.

——— The Société Anonyme le Carbone, of Levallois-Perret, near Paris, have established a branch factory at Frankfort-on-the-Main.

Dissolution of Partnership.—Messrs. George Edward Newton and Harry Charles Peirson, art metal workers, Hand-court, and 45, Bedford-row, London, W.C., have dissolved partnership.

Bankruptcy.—In the bankruptcy of Ronald Hope Bridie, consulting engineer, 8, St. Benet-place, Gracechurch-street, London, the trustee has been released.

Liquidations.—A meeting of the creditors of New and Mayne (Limited) was held on Tuesday, at the Westminster Palace Hotel, London, S.W., with Mr. Barden, the liquidator, in the chair. The affairs of the Company were freely—very freely—discussed. It would appear that the unfortunate motor car is at the bottom of the Company's troubles, as although the Company commenced business in 1892, it was not until Jan., 1896, that, owing to the motor car patents and other allied business not shaping quite as expected, affairs reached a stage when creditors began to ask for settlement of accounts. Then the crisis came. One creditor, a Mr. Rücker, who was thought by some of the other creditors to have some one with another name behind him, was stated to have advanced no less than £70,000 "to develop the business" of New and Mayne (Limited). This sum was advanced between January, 1896, and September, 1897. The assets represent moneys advanced to Motor Car, Laundry, Wind Motor, Electric Supply, Horseless Carriage, Accumulator and other "subsidiary" undertakings. The statement of accounts presented by the liquidator was subjected to comments of an anything but flattering character—chiefly on the score of "absence of details." A committee of four was ultimately chosen to look into the affairs of the Company.

Liquidations.—A meeting of the members of the Max Saturn Electrical Syndicate, Limited, will be held at 57, Gracechurch-street, London, E.C., on Nov. 24th, to receive an account of the winding up. Mr. W. S. Mackenzie is liquidator.

——— A meeting of the members of the Universal Electric Carriage Syndicate (Limited) will be held at 53 and 54, Fenchurch-street, E.C., on Dec. 2 to receive an account of the winding-up of the Company.

Deeds of Arrangement.—Thomas Cockerill, electrical engineer, trading as the Northern Electrical Company, 103, Derby-street, Bolton, has executed a deed of arrangement with a view to the payment of a composition of 15s. within 21 days. The liabilities are returned at £811. 4s. 4d. and the assets at £949. 7s. 11d.

——— George J. Shave and Benjamin H. Cordell, trading as electrical and mechanical engineers, at Castle-yard, Richmond, Surrey, have executed a deed of arrangement. Mr. E. F. Hunt, 17, Throgmorton-street, E.C., is trustee. The liabilities amount to £386. 2s. and the assets to about £410.

Companies Struck Off.—The *London Gazette* of the 22nd inst. contains a notification that the following companies have been struck off the register of Joint Stock Companies:—Alderson's Patent Day and Night Clock Company, British and Foreign Electric and Engineering Company, Egyptian Tramways Construction Company, Electric Battery Company, Electro-Hygienic Company, English and Colonial Electric Light Company, Fulgur Electric Lighting Company, Hull Electrical Company, Hampstead General Electric Fittings Company, Lancashire Rubber Company, Newport Electrical Engineering Company, Wallace (E.) and Co., and Wilkes' Contract Company.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 20 to Oct. 26, with the ports of destination:—

Australasia—Brisbane, £129; Canterbury, £28; Fremantle, £66; Hobart, £271; Melbourne, £1,420 (including £1,354 telegraph material); Sydney, £288 (including £33 telegraph material); Wellington, £1,077 (including £623 telegraph material). *Belgium*—Antwerp, £85; Brussels, £80 (telegraph material); Ostend, £30. *Canada*—Halifax (N. S.) £20,500 (telegraph cable). *Ceylon*—Colombo, £438. *Chili*—Boca, £112 (telegraph material). *China*—Shanghai, £298. *Colombia*—Santos, £476. *Denmark*—Copenhagen, £127. *Egypt*—Alexandria, £17. *Germany*—Cologne, £1,572 (telegraph core); Hamburg, £10. *Gibraltar*—£8. *Holland*—Amsterdam, £107; Rotterdam, £27 (telegraph material). *India*—Calcutta, £114; Madras, £30. *Japan*—Hiogo, £25; Yokohama, £10. *Portugal*—Lisbon, £50. *Russia*—Helsingfors, £29; St. Petersburg, £216 (telegraph material); Santa Catharina, £51 (telegraph material). *Siam*—Bangkok, £250. *South Africa*—Chinde, £13, Durban, £700; East London, £53; Port Elizabeth, £58 (telegraph material). *Spain*—Barcelona £11 (telegraph material); Malaga, £160; Pasages, £97. *Straits Settlements*—Singapore, £21 (telegraph material). *Sweden*—Stockholm, £39 (telegraph wire). *West Indies*—Trinidad, £19. Total £29,112, against £9,369 in the corresponding week last year (Oct. 21 to Oct. 27).

Tudor Accumulators.—We have received under date the 27th inst. the following letter:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been drawn to an advertisement of the Electrical Power Storage Company appearing in your paper. I do not wish to comment on the questionable taste shown in the framing of this advertisement, but think that the distinctly vague wording is liable to give rise to confusion between the "E.P.S." and "Tudor" cells among those who have not seen the latter. It has never been disguised by any of the firms manufacturing Tudor accumulators, either here or on the Continent, that all their *negative* plates were of the pasted or Faure type, but this is the sole point of resemblance between Tudor and E.P.S. cells. The Tudor positive plates, which are the most characteristic part of a cell, the method of mounting the plates, and, above all, the results that have been obtained with the Tudor cell are so different from those of other types as to merit some more distinct epithet than "so-called." In some countries, such as France, a licence has been granted by the E.P.S. or associated companies for the use of the Faure patent in the *negative* plates; in others, such as Germany, the Faure patent has, I believe, been invalidated, while in England no licence has ever been

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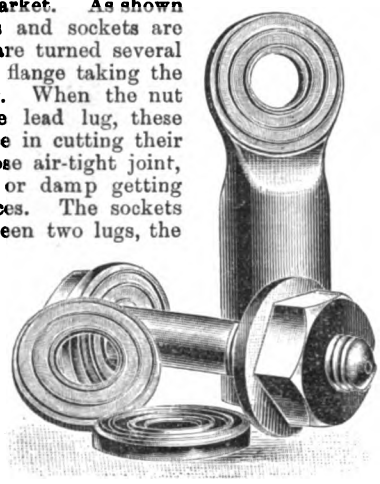
required, as the Faure patent had expired before any Tudor accumulators were manufactured here. It is gratifying to find that the Tudor accumulators have been so well appreciated in England, and that the E.P.S. Company can find no better way of advertising their cells than by pointing out their similarity to Tudor cells; unfortunately for the E.P.S. Company, this similarity is confined to the one point that I have mentioned. The rest of the advertisement may well give to statisticians ample scope for exercising their powers; but of this I will say nothing more, my principal object being to prevent any confusion which may arise from the mention of the Tudor cells in connection with those of the E.P.S. Company.—Yours truly, A. B. PESCATORE.

Manchester, Oct. 27.

"Consolidated" Telephones.—An excellent catalogue has just been issued by the Consolidated Telephone Construction and Manufacturing Company (Limited), of 186-188, Shaftesbury-avenue, London, W.C., which gives exhaustive particulars of the telephones and telephone parts, wall sets, desk sets, and all requisites for the equipment of telephone lines, either public or private, manufactured at the Company's fine works at Coventry. The list, which includes, besides telephones and telephone accessories, electric bells, indicators, pushes, burglar alarms, &c., is much more than an ordinary catalogue and list of prices. By an ingenious double printing telephone connections are shown in red, and dealers in these instruments and others who combine with their business the erection of telephones will find many useful hints conveyed by means of these illustrations and a set of "Instructions" which are also given. The Consolidated Company, which was inaugurated in 1881, is the oldest telephone manufacturing business in existence, and numerous testimonials received by the Company prove the estimation in which their apparatus is held by large users in various parts of the world. A large variety of telephones for use under various circumstances are clearly shown in the admirably-executed wood-block illustrations which accompany the letterpress. We notice particularly that the Company are manufacturing brass screws, terminals, &c., to B.A. or any thread, and the exceptional experience which for many years the workshops of this firm have had in the manufacture of delicate parts of apparatus should be of service to the trade in this important branch of work. The large reductions in the price of the Company's apparatus which have recently been made, together with the considerable discounts which are allowed to the trade (especially for spot cash), should lead to a largely increased demand for these goods. The catalogue is showy, well-printed, and is undoubtedly one of the best issues of purely telephone supplies ever offered to the trade.

Bolts for Storage Battery Connections.—Messrs. James Carter and Sons are putting a special type of bolt and socket for storage battery connections on the market. As shown in the illustration the bolts and sockets are made with flanges on which are turned several concentric ridges, the ridged flange taking the place of an ordinary washer. When the nut is screwed home on to the lead lug, these ridges not only clean the face in cutting their way in, but also make a close air-tight joint, which prevents acid vapour or damp getting in and corroding the surfaces. The sockets are preferably clamped between two lugs, the ridges acting in the same way. For large currents, double-ridged washers may be clamped between the lugs, thereby preserving the inner surface joint as well as the outer. For the attachment of flat bars or rods, single-ridged washers are used; they are sweated on to the bar, and then the whole is bolted home on to the lead lug as before.



Electricity in Buenos Ayres.—We have received from Mr. Carlos Bright, of 874, Calle Cuyo, Buenos Ayres, a long list of electric light installations carried out by him in the town and district of Buenos Ayres. Mr. Bright, who undertakes all kinds of electrical engineering work, is local agent for the General Electric Company of America. Mr. Bright is now in England.

Electro-Harmonic Society.—There will be a smoking concert at the St. James's Hall Restaurant (banquet-room) at eight o'clock this evening. A very good programme has been provided.

African Trans-Continental Telegraphs.—A recent issue of the *British Central African Gazette* gives some particulars of the progress made with the construction of this line. Work on the line from Blantyre northwards was commenced in April, 1896, and had in July last reached 85 miles beyond Fort Johnston. There are at present seven white men working on the construction, in addition to two survey parties, each consisting of a surveyor and one other white man, in front. One of these has just completed the survey to Kotakota; the other has commenced from there to Bandawe. Another party of six white men was to leave Blantyre about Aug. 5 to commence work from Karonga towards Tanganyika. 200 tons of material, representing 150 miles of line, arrived in Chinde at the end of July, and another of 450 miles is one month behind it; this will complete the line to the south end of Tanganyika. Major Forbes is of opinion that by March or April next the line will be completed to Abercorn, at the south end of Tanganyika. From there it will be pushed forward to Uganda. Owing to serious illness Major Forbes has been compelled to leave for Europe; but, as we have previously announced, Dr. Jameson has been appointed to fill the vacant position. Yesterday's advices were to the effect that a further 500 tons of material is to be ordered immediately, and that the line to Tete would be through within three months.

Bilston (Staffs.).—At the meeting of the District Council, on Wednesday, the Water and Baths Committee recommended that application be made to the Local Government Board for sanction to a loan of £1,000 for providing a telephonic fire alarm service.

Blackpool.—A long discussion took place at the meeting of the Town Council on Tuesday upon the proposal to lay a double line of tramways upon the east side of the middle walk recently constructed at North Shore. Eventually the scheme was carried by the casting vote of the Mayor.

Bolton.—The Town Council have decided to separate the gas and electricity departments, and in future a separate committee will have the management of the electric lighting undertaking of the Council. This decision has been adopted on the initiative of Mr. Proctor, who contended that the present Gas and Electricity Committee was much overworked, and consequently much of the work was performed in a perfunctory manner. The electric lighting department had not been developed to its fullest extent, and he instanced the success which had attended the division of the committees in Manchester and many other places. Mr. Alderman Miles (chairman of the existing Joint Committee) denied that work had been performed perfunctorily, and cited the case of Bradford in support of the existing system. The Committees had, he contended, worked together peaceably and successfully. The electric light mains are to be extended.

Bradford.—Major-General Crozier, R.E., held a Local Government Board inquiry, at Bradford, on Tuesday, into an application of the City Council to borrow £50,000 for electric light extension purposes. The application was supported by the Mayor of Bradford (Mr. T. Speight), who is Chairman of the Gas and Electricity Committee; the Town Clerk (Mr. G. McGuire), and the City Electrical Engineer (Mr. A. H. Gibbings). Of the sum required, £37,500 was for new mains. The Council desired that the repayment should be spread over 60 years, but the Inspector intimated that 30 years was the outside limit, and that 25 years was the customary period for such loans at present.

Brighouse.—A sub-committee has been appointed for the purpose of completing the arrangements for the acquisition of the electric lighting plant of Mr. A. B. Brook.

Brighton.—The following resolution has been passed by the Lighting Committee:—

That, as the Committee are not at present able to estimate the profit on the electricity undertaking for the current year, the Town Clerk be instructed not to include in the estimate for the next General District Rate any sum to be paid over from the electricity account in aid of the General District Fund.

Bristol.—The principal item before the meeting of the Electric Lighting Committee this week was the consideration of the estimates for the next half-year. It was decided to ask for £2,429 for street-lighting. Certain extensions of the mains are to be effected.

Cambuslang.—This district now enjoys the advantages of the electric light, as the electricity works were officially opened on Wednesday. The plant consists of an E.C.C. dynamo and Crossley gas engine. The installation was carried out by Messrs. Hunter and Jack.

Canterbury.—The City Council have received the sanction of the Local Government Board to borrow £23,000 for the purpose of establishing electricity supply works. The official inquiry was held early in May last!

Chelsea (London).—The surveyor to the Vestry (Mr. T. W. E. Higgens) has submitted a report on the subject of the public lighting of the parish. It is clear from this report that Mr. Higgens is of opinion that the Vestry would have been well advised when the subject of electric lighting was first discussed many years ago to have obtained a Provisional Order, even although nothing had been done to carry out its provisions. He calls attention to the offer made three years ago by the Chelsea Company to arrange for the public lighting of the district, an offer which was at that time declined by the Vestry; so that as matters now stand the Chelsea Vestry have to pay a high price (£32 per lamp per annum) for arc lighting if they decide upon accepting the quotation of the Chelsea Company. This report was discussed at the last meeting of the Vestry, and intimation was given by a member

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that he would move for the appointment of an Electric Lighting Committee to consider the whole question.

Clontarf (Dublin).—A successful trial trip was made on the new Clontarf electric tramway last week. The Board of Trade inspection will take place in a day or two.

Coventry.—The quarterly report of the Electric Light Committee was submitted at the meeting of the City Council on Tuesday. During the period 13,155 units of current were supplied, as compared with 8,869 in the corresponding quarter last year. The receipts amounted to £340. 4s. 9d., compared with £228. 5s., the customers having increased from 65 to 95.

Darlington.—The Council recently issued 800 circulars to prominent tradesmen in order to ascertain their views on the electric lighting question, and, in the event of electricity supply works being established, the amount of support likely to be accorded to the scheme. Of the number only about 400 have replied, 220 being favourable to the introduction of electric light, 130 against, and 50 indefinite. The Council have had this matter in hand since 1890.

Dewsbury.—Extensions of the public arc lighting in this town have been approved.

Dingwall (N.B.).—The Town Council have formally adopted the electric lighting scheme recently proposed by Mr. R. F. Yorke, of Glasgow. Provision is made for 8 arcs of 500 c.p. each, nine 32 c.p. incandescents, and thirty 16 c.p. incandescents, the annual upkeep cost being £103.

Electric Lighting of the Law Courts.—Arrangements are being made for obtaining a supply of electric current for lighting the corridors and offices occupied by the officials of the Crown Office and the Associates' Department at the Royal Courts of Justice, from the electric lighting company supplying the district instead of from the plant at the Courts as at present.

Exeter.—The Council have decided to increase the borrowing powers of the Electric Lighting Committee from £11,000 to £15,000. A satisfactory balance-sheet was presented by the Committee at Wednesday's meeting of the Council, showing an expenditure of £1,348 in excess of the authorised amount (£11,000). Various extensions of the mains are in contemplation, and it is consequently necessary to obtain further borrowing powers. The income for the year was £3,535, and the total expenditure £2,256, leaving a balance of £1,279 to meet interest and sinking fund. The period allowed for the repayment of the capital expenditure is only fifteen years.

Glasgow.—At the last meeting of the Corporation the Electricity Committee reported that Mr. W. Arnot had resigned his position as chief engineer of the electrical department, and that they had advertised for a successor at a salary of £800 per annum. It was also announced that Mr. William Lackie, the chief assistant to Mr. Arnot, had accepted an offer to become chief assistant to the borough electrical engineer of Edinburgh. The Committee, however, were endeavouring to try and arrange for retaining the services of Mr. Lackie. After a brief debate the Committee's report was adopted. The Corporation have decided to apply in the next Parliamentary Session to increase the borrowing powers of the gas and electricity department by £1,000,000, in view of probable demands for the extension of both the electricity and gas undertakings.

Guildhall (London).—The Library Committee recommend the Common Council to instal the electric light in the muniment room with a view to reducing the temperature there.

Hammersmith (London).—Although the electricity supply works have been in operation only a few weeks, there is an abnormal demand for current in some of the business thoroughfares. More than 100 tradesmen in King-street alone have already applied for current. A banquet was held at the Town Hall yesterday to celebrate the installation of the electric light and the completion of the municipal buildings.

Hampstead (London).—The Vestry are appealing to their electric-light customers not to use more current than absolutely necessary, especially between 6 and 8 p.m. during the present engineering crisis, as they cannot obtain the delivery of the additional plant which was ordered to meet the increasing demand. It was stated that the plant should, according to contracts, have been in working order a long time ago, and the Vestry's engineer was instructed to withhold any certificate for work done until the decision of the Vestry in the matter should be given.

Hanham (Bristol).—An inquiry was held here on Saturday by the Light Railway Commissioners into the application of the Bristol Tramways and Carriage Company for permission to construct a light railway from St. George to Hanham. Mr. C. A. Cripps, Q.C., M.P., and Mr. H. Holman Gregory represented the promoters. The Corporation of Bristol, who opposed the application, were represented by the Town Clerk and Mr. Wise. The Bristol Waterworks and Gas Companies were also represented. Mr. Cripps said the line would be 1 mile 4 furlongs and 9·13 chains in length, and the local authorities of St. George and Kingswood were in favour of the line, but on Nov. 1 the parish of St. George would come into Bristol under the Bristol Extension Act, and the Bristol Corporation now sought to apply the principle of the powers of purchase under the Tramways Act, 1870, to this light railway. The line could never be made under the Tramways Act, for the reason that the terms of purchase were very harsh against tramway promoters, and they could not in these semi-rural districts extend the facilities which were undoubtedly needed under such terms. With regard to the Corporation's position he contended that the Light Railways Act was meant to make the conditions as easy as possible in order to encourage the promotion of these light lines where they were much needed. The Gloucestershire County Council also endorsed the proposal. The Bristol Corporation at first contended that the line was really a tramway, but later agreed to waive that contention if the promoters would agree to insert a clause applying the tramways purchase conditions. At this stage the Commissioners drew attention to the order made by them in the Potteries application, and Mr. Cripps said he would submit it for the consideration of his clients. Counsel for the water and gas companies stated that as the promoters had agreed to certain clauses being inserted they did not oppose the application. Mr. George White, general manager for the promoters, said his Company had about 20 miles of tramways, 12 worked by horses and the remainder by electricity. They were carrying about 22 millions of passengers a year. The Tramways Act required them to run two workmen's cars on the Kingswood line, and they ran as many as nine cars the whole distance of four and a quarter miles for 1d. The new district was not developed as Kingswood was, and the gradients were very heavy. It would be very expensive to work, but it would be operated from the existing power station at St. George. The Hanham people had entreated the Company to extend their line, but under the Tramways Act they could not do so, because the traffic would be light and the cost of working would probably be double that of working the existing electrical lines. The Company were prepared to make it as a light railway, but they could not do it if the contention of the Corporation prevailed. They had not considered the order in the Potteries case, but he saw broadly that the order was for purchase at the end of thirty-five years as a going concern. The Kingswood authority and the County Council were strongly in favour of the scheme. The promoters felt that the present position under the Tramways Act of 1870 was an iniquitous one. They wanted an opportunity of getting a return upon their capital and for their trouble. If there were fair terms to both parties he would not take up an absolute refusal to consider purchase. As to the time for construction after the land was acquired, they could complete the works in six months. Eventually the Commissioners fixed upon two years for the acquisition of the land, and one year for the execution of the works. Other evidence in support of the application was taken, after which the Bristol borough engineer (Mr. T. H. Yabbicom) opposed. He said that the dates for the purchase of the tramways by the Corporation were 1912 and 1915. Then the greater portion of the Kingswood line would be purchasable, but not this portion, while it would be worked from the power station which the Corporation would then own. A Committee of the Corporation was considering the question of purchasing the tramways forthwith. For the Corporation Mr. Wise contended that the line was merely a tramway and an extension of the existing lines, which could be carried out as well under the Act of 1870 as under the Light Railways Act. It would run along highways for its entire distance, and not over lands. It was important to draw a distinction between the two kinds of line, for besides the rights of those who wished to have this line there were the rights of the people who used vehicles, and of public bodies as to sewers and highways, to be considered. If applications of this sort were granted to go along urban roads, every tramway extension would be made under the Light Railways Act, and the Tramways Act would become obsolete. He suggested that the Commissioners should give the Corporation power to purchase at the end of 21 years, so that they could acquire the whole of the system at the same time. In reply, Mr. Cripps said the Corporation could not construct the line to Hanham, because it would go beyond the city boundaries. He asked the Commissioners to grant the application without a purchase clause. The Commissioners reserved their decision.

Harrogate.—Major-General H. D. Crozier, R.E., held an inquiry this week into the application of the Town Council to borrow £17,500 for electric light extension purposes. The town clerk (Mr. J. T. Taylor) and the borough electrical engineer (Mr. G. Wilkinson) supported the application. It was stated that the Corporation, during the early part of the year, put down an electric light installation, £25,246 being borrowed for the purpose in 1896. A portion of the centre of the town had been lighted, and though further applications had been made for current it was impossible to meet these demands without an extension of the plant. At present there were 7,366 8-c.p. lamps connected to the mains, and during September the income was £251, whilst the expenditure, including repayment of interest and a portion of the sinking fund, was £253.

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Heavitree (Exeter).—The District Council have instructed the surveyor to consider and report upon the question of the electric lighting of the district, and more particularly as to whether there is sufficient water power available in the vicinity for the purpose of generating current.

Hull.—At a meeting of the Electric Lighting Committee last week an application was received from the borough electrical engineer (Mr. A. S. Barnard) for an increase of salary. After discussion it was decided to obtain information as to the salaries paid by other Councils, and in the meantime the matter has been postponed. It was decided to obtain a boiler for the electricity station from Earle's Shipbuilding Company, the cost being £835. Messrs. Hammond and Co., of Osborne-street, are about taking current for 300 lights.

Leeds.—For some time past extensions of the plant of the Yorkshire House-to-House Electricity Company have been in progress, and as the new machinery is now in operation a much greater output is now possible, and it has been decided to reduce the charge for current. The present price is 6d. per unit, but after Jan. 1 the maximum price will be 5d., and 4¾d. in cases where the consumption for the quarter is not less than 1,000 units. In future, consumers' premises situate within 10ft. of the public road will be connected to the mains free of charge.

Some inconvenience was caused on Saturday last owing to a strike of the drivers and conductors of the electric cars. The strike, however, was of short duration, and after a conference between representatives of the men and the Highways Committee on Monday the matter was satisfactorily arranged. The drivers obtained an advance of ½d. per hour.

Light Railway Notices.—Several notices of intention to apply to the Light Railway Commissioners for sanction for the construction of light railways have been announced during the week. Included in these are a scheme for the construction of a light railway connecting the towns of *Chatham*, *Rochester*, *Strood*, *New Brompton*, *Gillingham*, &c., in Kent. The gauge of this line is to be 4ft. 8½in., and the motive power electricity. The promoters are the Rochester, Chatham, Gillingham and District Electric Railways Company, a notice concerning the registration of which appears in another column. Powers are sought to construct a light railway between *Hastings* and *Bexhill*, the promoters in this case being the Bexhill and District Light Railways (Electric) Company (Limited), some particulars of the registration of which are also given in the present issue. In this case the gauge is to be 3ft. 6in. An important proposal has been made for the construction of a light railway between *Leeds* and *Bradford*, which would run along the Leeds and Bradford main road. At the meeting of the Calverley District Council on Tuesday a notice was received intimating that application would be made for an Order under the Light Railways Act for the construction of this line. The Clerk was instructed to suggest that a branch from the proposed railway at Whitecote, passing along the Shipley and Bramley main road to Shipley, would be of much local advantage, and would be as profitable as the projected line. In this case also the motive power is to be electricity. The Finchley (Middlesex) District Electric Traction Company notify their intention to apply to the Light-Railway Commissioners for permission to construct a line from Canfield-gardens, near the Metropolitan railway station in Finchley-road, to *Finchley* and *Hendon*. The gauge is to be 4ft. 8½in. The British Electric Traction Company have notified the *Brighton* Town Council that they propose to establish a system of electric tramways in the town. The proposed lines are to run from the Old Steine up Lewes-road, up Preston-road as far as the north end of Preston Park, and from the Clock Tower (top of North-street), up the Dyke-road, as far as the Upper Drive. The Company propose to proceed under the Light Railways Act. The same Company propose to apply for Orders authorising the construction of light railways in the suburban districts of *Acton*, *Ealing* and *Hanwell* (the gauge to be 4ft. 8½in.) and for a light railway from *Coalbournbrook to Kinver* (Worcs.).

Liverpool.—The final meeting of the Lighting Committee for the present municipal year was held on Thursday last. The monthly report of the City Electrical Engineer stated that on Sept. 30 the equivalent number of 16 c.p. lamps connected to the supply mains was for private lighting 54,810, and public lighting 5,640, total 60,450, an increase of 1,674 lamps on the month. The number of units supplied during the month to private consumers was 122,284, and for public lighting 28,353, total 150,673, against 103,790 for the corresponding month of 1896.

The North Western Co-operative Cold Storage Company (Limited), which has recently been formed for the purpose of erecting cold storage premises in Liverpool, have decided to put down a complete electric lighting plant. The lifts will also be worked electrically.

Manchester.—The consideration of the report of the Special Tramways Committee on the municipalisation of the tramway, and the introduction of electric traction, has been postponed till the first meeting of the Council in December. The Electricity Committee presented a report on their recent continental trip at Wednesday's sitting of the Council. The report, which is given in full in another column, was adopted. It has been decided to make considerable extensions of the arc lighting system for the winter of 1898-99. Arcs are to be erected in Downing-street, London-road, Piccadilly, Market-street, Victoria-street, Great Ducie-street (as far as the Assize Courts), Deansgate (as far as Peter-street), Peter-street and Oxford-street (to All Saints), Portland-street, Whitworth-street, Princess-street (from Whitworth-street to Albert-square), John Dalton-street and King-street. The Committee further recommended that, as the whole of the city and some of the outlying districts had to be lighted electrically under the Act of Parliament, and that the information gained by the deputation during their recent visit to the Continent had shown them clearly that current could be transmitted long distances without much loss by several systems, steps should be at once taken for acquiring a site for an additional generating station where land was cheap and water convenient for condensing purposes; this generating station to be utilised both for lighting and traction purposes. The Chairman of the Committee (Alderman Higginbottom) said that an additional station was needed, apart altogether from any prospect of having to use electricity as the motive power for the tramways, and as land was so dear in the centre of the city the Committee proposed to go somewhere in the outskirts. The site of the present station cost £60,000, and that constituted a very heavy charge on the capital outlay. The Committee had not, however, yet fixed upon a site. The work was absolutely necessary, on account of the demand for electric current. They were in the unfortunate position, owing to the engineering dispute, of not being able to supply current this winter to any new areas. The new plant with a capacity of 50,000 additional lamps would not be ready before January. The new arrangements indicated would enable the Committee to supply electric current for the tramways to Stockport, Swinton, and other districts.

Middlesborough and Stockton-on-Tees.—A contract for the complete equipment of the tramways now being constructed to run between Middlesborough and Stockton-on-Tees has been placed with the British Thomson-Houston Company. The order includes the whole of the power house machinery, complete line equipment with 45 cars and the necessary distribution system.

Paddington (London).—Considerable extensions of the mains in this district are announced. The Metropolitan Company intend laying mains in and across Sutherland-avenue, Castellain-road, Warwick-road, Formosa-street, Amberley-road, Shirland-road, Bristol-gardens, Clifton-villas, gardens and road; part of Warrington-crescent, Clarendon-gardens and terrace; Portsdown-road, Lanark-villas, Edgware-road, Hamilton-terrace and mews, St. John's Wood-road, Northwich-terrace, Aberdeen-place, Crompton-street, Hall-place, Hall-park. Mains are also to be laid by the Notting Hill Company from the corner of Archer-street along part of Westbourne-grove.

Peterborough.—As foreshadowed in our last issue, the City Council have decided to again apply to the Local Government Board for sanction to borrow £15,000 for the erection of electricity supply works. This decision was come to after a long and acrimonious discussion, and after a proposal to sell the Council's Provisional Order had been defeated. At the outset it is proposed to supply current for private lighting purposes only, the street-lighting portion of the original scheme having been abandoned.

Port Adelaide (South Australia).—Contracts have been entered into by the Municipal Council for the establishment of an electricity supply station. The work will be carried out to the plans and specifications of Mr. W. W. Crawford, of Sydney. The plant, of the latest and most improved type, will be supplied by Messrs. Johnson and Phillips.

Provisional Order Notice.—The usual official notice appears in the *London Gazette* of the intention of the Leatherhead Union District Council to apply for a Provisional Electric Lighting Order in the forthcoming session of Parliament.

Provisional Orders.—During the week formal resolutions to apply for Provisional Orders have been passed by the *Bridgwater*, *Burslem*, *Hamilton*, *Montrose* and *Warrington* Town Councils, and the *Stourbridge* and *Tipton* District Councils. The *Finchley* (Middlesex) District Council have decided not to obtain an Order, but Messrs. Crompton and Co. intimate their intention of applying for one for this district.

Rangoon (Burmah).—For the past year the Municipality of Rangoon have had under consideration the report of their engineer, Mr. J. Stirrat, upon the advisability of undertaking the supply of electricity within the city. In August last the sub-committee reported on the whole subject to the Council, and made the following recommendation:—"That a full statement of particulars of the electric lighting required be sent through the municipal agents for the purpose of obtaining a report and an estimate from an electrical expert on a scheme for electric lighting for Rangoon, alternative estimates to be given for including and omitting the

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lighting of 30 streets. The fee to be paid to be limited to £50, and the consultant to be Mr. Robert Hammond, or, failing him, Mr. Shoolbred, or, failing Mr. Hammond or Mr. Shoolbred, Dr. Hopkinson." This recommendation the Council adopted, and we understand that Mr. Robert Hammond has accepted the appointment as consulting engineer to make a preliminary report upon the scheme. As soon as this report is submitted the municipality will at once proceed with the establishment of the necessary works.

St. Helens.—In the Omnibus Bill which the Corporation propose to promote next session application is to be made for considerable extensions of the present tramway system. The Tramways Company have already intimated their intention of introducing electric traction on the lines, and of course a similar system of traction will be adopted on the proposed new municipal lines.

Shipley.—A committee has been appointed to consider the question of the electric lighting of the streets of this town.

Shoreditch (London).—The Vestry have decided to borrow a further sum of £15,000 for extensions of the electric lighting.

Skipton.—Some time ago, in consequence of the receipt of a notice from the local gas company of an increase in the price of gas, the District Council appointed a committee to consider the question of introducing the electric light, and at the last meeting of the Council this committee recommended the appointment of Dr. Hopkinson to prepare a report on the matter. After discussion, however, it was decided to further postpone the matter for twelve months!

Southampton.—The extension of the electric light mains up Above Bar, towards the Ordnance Office and in the direction of Portswood, is being proceeded with.

Spanish Tramways.—We are informed that the contract for the electrical equipment (power house and rolling stock) of both the Barcelona and Madrid tramway systems has been placed with the British Thomson-Houston Company. On the former line 85 cars, and on the latter 55 cars, will be operated on the overhead system.

Taunton.—The Light Railway Commissioners held an inquiry on Friday into the application to construct a light railway in this district. The promoters (the Taunton and West Somerset Electric Railways and Tramways Company), the Somerset County and the Taunton Town Councils were all represented by counsel. Mr. Frere, for the promoting Company, explained that the proposed railway would be two miles in length, and the gauge would be 3ft. 6in. The motive power would be electricity, and it was proposed to adopt the overhead trolley system. A memorial in favour of the scheme, signed by 1,600 ratepayers, was presented, and it was pointed out that the Town Council were in favour of the principle of the scheme, although they raised slight objections as to the manner in which it should be carried out. Evidence in support of the scheme was given by Mr. C. J. Wharton, the Company's engineer, who stated that the estimated cost of construction and equipment was £11,220, and it was proposed to use granite blocks for the permanent way, with wood opposite the churches and hospitals. Mr. Broomhead pointed out that the Town Council approved the scheme solely on the understanding that wood and not granite blocks were used for the permanent way. They were also of opinion that a guarantee should be given by the promoters that once the scheme was started it should be properly completed, and to meet this they desired a deposit by the Company of £1,000. They also objected to the trams in certain portions of the route, on the ground that the road was not sufficiently wide. At this stage a consultation took place between the various parties, with the result that the Council agreed to withdraw their opposition to the scheme on the promoters agreeing to accept their conditions. They contended that a permanent deposit should be made by the Company for the purpose of re-instating the roads in the event of the trams being discontinued. While the inquiry was in progress, the Chairman raised a question as to the jurisdiction of the Commissioners, and he expressed the opinion that the scheme, inasmuch as it was confined to the town, and would not be used for the carriage of produce from outside to the markets or elsewhere, should have been dealt with under the Tramways Act. After some discussion the Commissioners decided to reserve their decision on this point until they had given it further consideration, and gave the Company's counsel (Mr. Frere) the opportunity of forwarding them a written statement of his case.

The Strike.—The chief interest in relation to the strike of the members of the Amalgamated Society of Engineers and the lock-out by the Employers' Federation has this week centred round a letter from the Board of Trade inviting the parties to the dispute to consider a "rough draft" of a proposal for a conference between representatives of the employers and the strikers. This rough draft was as follows:—

1. The Employers' Federation, while disavowing any intention of interfering with the legitimate action of trades unions, will admit no right of interference with the management of their business. The trades unions, on their part, while maintaining their right of combination, disavow any intention of interfering with the management of the business of the employers.

2. The demand for a forty-eight hours' week made by the Joint Committee on the Federated Employers in London, without previous request for a conference with the employers, is withdrawn.

3. A conference between representatives of the Employers' Federation and the engineering unions concerned in the dispute shall be held forthwith, to discuss and settle the hours of labour.

4. The constitution of the conference shall be arranged between the chairmen or other selected representatives of the parties.

This first step towards conciliation has not met with the approval of the fighting sections of either party, but, notwithstanding, there is a general feeling that the action of the Board of Trade has opened the door for negotiations. Several leaders of the "Radical" party, who are assumed by the public to represent the men's views, have spoken during the week and have counselled peace. Meanwhile large subscriptions towards the men's funds are announced, and a number of the chief engineering firms of the country have, during the week, joined the Masters' Federation.

Torquay.—Prof. Ayrton will advise the Council as to the appointment of a resident engineer at the electricity supply works.

Wolverhampton.—Col. C. H. Luard, R.E., held a Local Government Board Inquiry on Tuesday into the application of the Town Council to borrow £9,000 for electric lighting extensions. The Town Clerk (Mr. H. Brevitt) and the Borough Electrical Engineer (Mr. F. Harman Lewis) appeared in support of the application. Mr. Brevitt explained that the original loan in respect of the electric light undertaking amounted to £30,000; but it had been exceeded by £882, which formed one of the items of the proposed loan. There was also required £5,330 for the buildings and foundations for a 140-unit steam dynamo and other works, £1,000 for extension of mains, and £1,500 for the extension of the service to Chapel Ash. He pointed out that there was now an increasing demand for electric current, and the extensions were absolutely necessary. Last year a clear profit of £220 was made. Technical details were given by Mr. Lewis, after which the inquiry terminated.

Worthing.—The Electric Lighting Committee have received a communication from Prof. Kennedy to the effect that since his report in 1894 an important improvement in the manufacture of incandescent electric lamps had been made, and having reconsidered his estimate for the erection of the proposed electricity works, he considers a saving of £4,000 might be effected on his original estimate, and a further sum of £400 per annum in the annual maintenance cost. A communication has been received from Messrs. Crompton and Co., asking if the Council would entertain the question of the transfer of their Provisional Order. Before making any recommendatien the Committee have decided to ascertain the probable demand for electric current in the district.

York.—At the special meeting of the City Council on Monday it was decided to establish joint electricity supply and refuse destructor works, and to apply to the Local Government Board for sanction to borrow £20,000 for carrying out the proposal. Prof. A. B. W. Kennedy is consulting engineer for the electrical portion of the scheme.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia and China Telegraph Company (Limited).

The forty-eighth half-yearly ordinary general meeting of this Company was held on Wednesday at Winchester House, London, E.C., the Most Hon. the Marquis of Tweeddale in the chair.

The MANAGER and SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting and the minutes of the last meeting, which were approved.

The CHAIRMAN then said: I have now to ask your approval of the report and accounts, which I presume you will take as read, and in doing so I shall, as usual, offer a few observations on the operations of the past half-year, which closed on June 30th. In the first place, however, I have to refer with deep regret to the death, through an unfortunate accident, of Mr. Charles William Earle. Mr. Earle was one of the original Directors of the Company—an able, painstaking, conscientious man, thoroughly acquainted with the business of the Company, and ever watchful of the interests of the shareholders. We have sustained a great loss through his death. The vacancy which was so unhappily caused has been filled by the appointment of Mr. Clement Sneyd Colvin, who lately occupied the important office of Secretary to the Government of India in the Public Works Department. He will bring to our counsels wide administrative experience, as well as an intimate knowledge of telegraphy in all its branches, acquired during his tenure of the important office to which I have referred. I am sure he will prove a great addition to our Board. Turning to the report and accounts, I have to state that the gross revenue for the half-year under review has amounted to £290,749, showing a decrease of £23,165, as compared with the corresponding period of 1896. This result is, however, much more favourable than was anticipated when we decided to make the extensive reductions of tariff that were brought into force last year and at the beginning of the current year. The loss estimated from these reductions was in round numbers £31,000

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for the half-year, and the actual loss amounted to £29,745, in addition to which there was a falling-off in the Australasian and other traffics amounting to £9,304, bringing up the total loss for the half-year to over £39,000. On the other hand, however, the Manila traffic, owing to the recent disturbances in the Philippines, was abnormally heavy during the half-year, and there were also substantial increases in the Japan and China traffics. Consequently there would have been but a comparatively slight decrease to report had there not been a further heavy fall in the value of silver, which caused us a loss of nearly £17,000 through short collections at the currency stations. The principle of collecting in currency the full equivalent of the sterling charges has been explained to you on former occasions, and it was fully recognised at the last International Telegraph Conference; but to avoid the inconvenience that would inevitably result to the telegraphing public if the rates of collection were altered whenever the dollar fluctuated, your Directors some time ago decided to adopt a fixed collecting rate for the whole year, based on the average of the actual rates of exchange ruling at the end of each month of the preceding year. Under normal circumstances this average or standard rate would approximate very closely to the actual rate of exchange of the day, but with such violent fluctuations as we have recently witnessed our existing standard rate is considerably in excess of the actual average of the current year. Consequently the rates of collection now in force will have to be proportionately raised on January 1st next. We cannot, of course, recoup the loss we have sustained in that manner; but we can protect ourselves, and probably shall protect ourselves, from any such loss occurring in the next year. The working expenses have amounted to £99,425, showing an increase of £12,169 as compared with the corresponding period of 1896. This is mainly accounted for by the expenses attending maintenance of the cables (which, as I have said on several occasions, is always a fluctuating item) having been considerably higher during the past half-year than they were in the corresponding period of 1896, in addition to which the accounts under review show several items of exceptional expenditure in connection with donations, negotiations, &c., that were absent from the accounts for the corresponding half-year. The usual interim dividends at the rate of 5 per cent. per annum have been paid for the past half-year amounting to £62,500, and after transferring £75,000 to the general reserve fund the sum of £34,812 is carried forward to the next account (applause). As you will have doubtless learned, with great satisfaction from the report, the Queensland Government, having at last decided to take part with the other Australasian Governments in the guarantee arrangements entered into with the Company, your Directors have been able to give the colony of Queensland the benefit of the cheap tariff established a few years ago for the guaranteeing colonies, and on July 1st last the tariff between Queensland and Europe was reduced from 9s. 5d. to 5s. 1d. per word. We understand that this arrangement has given much satisfaction throughout the colony (hear, hear). When I last had the pleasure of addressing you I referred to the Commission appointed by the Imperial and Colonial Governments to consider the question of laying an "All British" cable across the Pacific having concluded its labours, but that its report had not then been made public. This report is still withheld, but from newspaper statements, which you have doubtless seen, the question was under consideration at the Conferences held between Mr. Chamberlain and the Colonial Premiers a few months ago, together with a counter-proposal which the Eastern, Eastern Extension, and South African Companies had submitted to Her Majesty's Government for an "All British" Cable between Australia and Great Britain viâ the Cape of Good Hope. This cable would at the same time bring into telegraphic communication the important coaling stations St. Helena and Ascension, as well as other British possessions at present unconnected by cable. This project has many advantages over the proposed All-British communication with Australia from Canada viâ Fanning Island, and it appears to be preferred to the Pacific scheme—at any rate by some who are interested in the communication with the Colonies. The whole question is, however, to be considered by a Departmental Committee, and I am not therefore at liberty to discuss the matter in any detail at the present moment. You may, however, rest assured that your interests are being carefully watched by your Directors, and that any decision that may be come to in relation to this important matter will be intimated to you as soon as possible (applause). The contract made with the Dutch Government, and to which reference was made at the last meeting, for the manufacture and laying, on behalf of the Netherlands Government, of two short cables in Netherlands-Indian waters has been carried out during the half-year under review to the entire satisfaction of the Authorities. Now, gentlemen, I have dealt with every matter of importance or of interest to you which has taken place during the past half-year. I think you will consider the report which I have been able to submit to you a satisfactory one (hear, hear). Your cables are in very good condition; the traffics are very satisfactory, having regard to the large reductions in rates which have taken place—reductions, as I have pointed out to you, amounting to less than we had anticipated; and altogether I think your Company is in a condition which appears to be gratifying to every shareholder in it (applause). With these observations I beg to move—

"That the report and accounts of the Directors now submitted be received and adopted."

Mr. FRANCIS A. BEVAN briefly expressed his pleasure in seconding the motion.

The CHAIRMAN put the resolution in the usual manner, and having declared it carried unanimously, said: Gentlemen, this being the first half-yearly meeting there are no other resolutions to be submitted to your consideration.

Mr. GIBB then proposed a vote of thanks to the Chairman, the Directors, and the Staff. The business of the Company was, he remarked, clearly prosperous, and it had been well managed. Perhaps he might suggest to the Directors that in this Jubilee year, when the services of so many had been recognised by the leading banking and other firms, it might be right, in the interests of the Company, that the services of their employés should be specially recognised on such an occasion.

Mr. W. BLABER seconded the motion, which was carried unanimously.

The CHAIRMAN: On behalf of my colleagues and myself, I beg to thank you very warmly for the way in which you have received this vote. With regard to the suggestion of Mr. Gibb, I am sure it is one we sympathise with very warmly and heartily, and if the shareholders approve it, we will take it into our consideration and give you the result on a future occasion.

The proceedings then terminated.

Brazilian Submarine Telegraph Company (Limited).

The forty-eighth ordinary general meeting of the shareholders in this Company took place on Wednesday at Winchester House, Old Broad-street, London, E.C., under the presidency of Sir Albert J. Leppoc Cappel, K.C.I.E.

The SECRETARY (Mr. Richard Collett) read the notice convening the meeting and the minutes of the last meeting, which were approved by the present meeting and signed as correct.

The CHAIRMAN then said: I have now to invite your approval of the report and accounts, which I presume you will take as read, but before moving the resolution I will go through the principal items in the usual manner. The receipts for the half-year ended June 30, 1897, were £79,133; for the previous half-year they were £88,973, showing a decrease of £9,840. The receipts from messages show a decrease of £10,050, and those from interest, rent, transfer fees, and dividends on shares in other telegraph companies an increase of £210, resulting in a net decrease, as I before stated, of £9,840. This decrease is hardly matter for surprise, as its probability was pointed out at the last meeting. It is due to the same causes that have worked against us for some considerable time—namely, stagnation in trade in South America, keener competition for the smaller traffic available, and a still further fall in the gold value of the Brazilian currency. During the half-year under review the value of the milrei ranged between 8⅞d. and 7½d., and averaged 8d., or about eleven-sixteenths of a penny less than in the previous six months. Compared with the receipts for the corresponding half-year of 1896—namely, £92,071—the decrease is £12,938, but the difference in the exchange value of Brazilian currency was still greater. In the first half of last year it averaged $9\frac{5}{16}$d. against 8d. this year. Turning to the expenditure side of the accounts, we find that the total expenses were £20,505, which, compared with those for the previous half-year, £21,090, show a decrease of £585, namely, a decrease in working expenses at stations and general expenses in London, £854, less an increase in other heads and special items of expenditure, £269. I have here a statement showing the increases and decreases under each head, but unless you wish it I do not think it is necessary to occupy your time in dealing with the details, which result finally in the decrease of £585, beyond reminding you that £605, the sums voted by the shareholders at their last general meeting to the International Telegraph Memorial and the Prince of Wales' Hospital Fund, are included in the expenditure here referred to. After providing for the debenture interest, sinking fund and income tax, there is a balance of £53,947. To this is added the balance to credit of revenue account on December 31, 1896—namely, £15,274—making together £69,221. The interim dividend paid for the March quarter absorbed £19,500, and a transfer to the reserve fund has been made of £10,000, leaving a balance to be dealt with of £39,721. From this amount your Directors recommend the distribution of a final dividend for the year of 3s. per share, with a bonus of 2s. per share, both free of income tax, which together will amount to £32,500, leaving the sum of £7,221 to carry forward to the current half-year. In concluding my observations upon the accounts, I am glad to inform you that from July 1st last, the loss falling upon the telegraph companies in realising their charges collected in Brazilian currency will be greatly diminished, and in time practically cease. The International Telegraph Convention, which was signed by the representatives of most States at Budapest last year, provided for an increased collection of currency whenever it was below the par of gold, and the Brazilian Government being a party to the Convention, this regulation is now enforced in Brazil, to the benefit of the Government telegraph department and of the telegraph companies. I am happy to be able to add that the operations of the current half-year already show not only an improvement in the receipts owing to this cause, but also an increase in the amount of traffic dealt with, and there is every indication of this improvement continuing. The absence of any event of consequence in the history of the half-year makes my position a little difficult, because it deprives me of any chance of making my remarks at all interesting to you. It is, no doubt, matter for congratulation that nothing has happened which calls for explanation, but this lack of incident leaves me little or nothing to say. The defect in the No. 1 Lisbon-Madeira cable, referred to at the last meeting, still exists, but as the cable continues to work satisfactorily, we do not at present propose going to the expense of attempting to remove the fault, which will involve the lifting of the cable from a depth of 2,500 fathoms, or nearly three miles. During the last half-year we were happily free from interruptions, and consequently from any expenditure for repairs to cables, but during the current period we have been less fortunate. On the afternoon of October 7th, a break occurred in the St. Vincent-Pernambuco No. 1 cable. The repairing steamer "Duplex," belonging to the Eastern and South African Telegraph Company, was at once chartered, and reached St. Vincent on the evening of the 15th, put through the repair on the night of the 17th inst., and the cable is now working perfectly. This, gentlemen, must be satisfactory to you—it was, indeed, a very smart piece of work—but (and there generally is a but) our satisfaction at this rapid repair is qualified by the fact that the break occurred in shallow water

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(a little over 100 fathoms), and a few miles only from shore, and the repair, consequently, was free from those difficulties and uncertainties which are inseparable from disturbances of old cables in very deep waters. The allied Companies in which we have interests connecting our system with the coast of Africa, the South African Colonies, and the West Coast of South America, continue to act as efficient feeders to our system. The cable of the German Submarine Telegraph Company between Emden and Vigo, which was referred to at the last meeting, has worked satisfactorily, and fully justifies our having taken so large a share in the undertaking. It has not only brought valuable traffic to our system, but there is no doubt we shall further benefit by the receipt of a dividend on our investment at the end of the year. I think I have made it clear that our position is a strong one, and our prospects very promising. I have shown you that even under the disadvantages of an abnormally low exchange, keen competition, and depressed trade, from which we have suffered for some time, we have been able, without neglecting to put a reasonable sum to reserve, to continue to distribute out of profits 7 per cent. in dividend and bonus. I have also shown that the work of the current half-year is being carried on under much more favourable conditions, both as to rate of exchange and volume of traffic. A glance at our balance-sheet cannot fail to produce a feeling of satisfaction, and I am happy to congratulate you, gentlemen, on the possession of a property in so sound and healthy a condition. The growing appreciation in the market price of your shares is a good indication of what investors and those well versed in such matters think of the value of your property. I am by nature an exceedingly cautious man, but I do not hesitate to say that I look forward with the utmost confidence to the future of this Company. It seems to me beyond question that the vast countries of South America, with their enormous capacity for production, must continue to progress in spite of all drawbacks. The improvement is hardly likely to be immediate, but is to my mind, sooner or later, inevitable, and I expect the coming years will bring a great increase in their wealth and commercial activity. In this increase of prosperity we may confidently expect to share. It is true we have competition to reckon with, but this causes us no alarm. We are splendidly equipped, we have an excellent staff, and we have acquired a deservedly high reputation for efficiency, while, thanks to the wise policy of maintaining a large and increasing reserve, we shall be strong to protect and advance our interests and cope with any emergency. I do not think there is anything else I need detain you for. I think I have touched upon everything which is of real interest to you, and I will now read the resolution, which is as follows:—

"That the report of the Directors and the accounts to June 30, 1897, now submitted, be approved and adopted, and that a dividend be now declared of 3s. per share, making, with the interim dividends already paid, a total dividend of 6 per cent. for the year, and also a bonus of 2s. per share, making in the aggregate a distribution of 7 per cent. in respect of the profits for the year ended June 30, 1897, the said dividend and bonus to be respectively free of income tax."

Mr. F. YOULE: I have much pleasure in seconding that.

The CHAIRMAN said he should be very glad to answer any question, but no shareholder rising to address the meeting, he put the motion, which was carried unanimously. He then proposed the re-election as a Director of the Rt. Hon. St. John Brodrick, M.P.

Lord SACKVILLE A. CECIL seconded the resolution, which was carried unanimously.

On the motion of Mr. J. DENISON PENDER, seconded by Mr. FREDERICK YOULE, Sir Albert J. Leppoc Cappel, K.C.I.E., was also re-elected a Director of the Company.

Mr. W. T. ROUGHTON proposed the re-election of the auditors, Messrs. Deloitte, Dever, Griffiths and Co. and Messrs. Gane, Jackson, Jeffreys and Wells.

Mr. J. D. HAYTON seconded the motion, which was carried unanimously.

Mr. A. C. STEWARD then proposed, and Mr. JAMES BULL seconded a cordial vote of thanks to the Chairman and Directors for their efficient conduct of the Company's affairs in the past half-year.

The motion was carried unanimously.

The CHAIRMAN briefly acknowledged the vote, and the proceedings then terminated.

Roller Bearings Company (Limited).

The ordinary general meeting of this Company was held yesterday at Westminster Palace Hotel, London, S.W., Major-Gen. Hutchinson, C.B. (Chairman) presiding.

The SECRETARY (Mr. Thomas W. How) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, the accounts of the Company relate, as will be observed from the balance-sheet and profit and loss account, to a period of fifteen months, from July 2, 1896, to September 30, 1897, and bearing in mind that the Company was started to build up an absolutely new business, and had not the advantage of taking over a working concern, it will, we trust, be allowed that the results obtained during that period are not unsatisfactory, although from a shareholder's point of view, they might no doubt be better. In the starting of a new undertaking there were many details to be considered and carefully worked out, and the time of the Board has been fully occupied at its weekly meetings in dealing with the many aspects of the business which have presented themselves from time to time, and especially at the outset. One of the first matters which engaged the attention of the Directors was the question of manufacture. With a due regard to economy in manufacture, negotiations were entered into with certain firms, as the Directors considered it more expedient to make contracts for the time being for the manufacture of these bearings than to spend a large sum upon the acquisition of works and machinery until, at any rate, the increasing business of the Company justified so large an expenditure of the shareholders' money. They have the satisfaction to state that the cost of the bearings has been considerably reduced from what it was in the first instance, as the result of the experience gained in their manufacture, and the directors have reason to believe that still further economies in this direction may be accomplished, and they are fully alive to the importance, with regard to extension of business, of reducing the cost of the bearings to the lowest possible figure, consistently with a fair return to the shareholders. It must be borne in mind, however, that there must necessarily be a great difference in price between these bearings and the ordinary axle boxes or plummer blocks which are now upon the market, having regard to the extra working parts and the nature of the bearing itself, as well as to the materials of which it is composed; but the economies in machinery and manufacture, which follow a large and increasing demand, cannot fail to exercise a beneficial effect in this respect, and when it is borne in mind that longer life and economy is effected, both in lubrication and cost of labour in maintenance, the greater first cost will be more than compensated for in ultimate annual expenditure. With reference to that paragraph in the report dealing with the number of bearings supplied, it may be interesting to state the various uses to which the bearings manufactured by this Company are being put. For railway work considerable progress has been made during the last twelve months with the railway companies, both in this country and on the Continent. The London, Brighton and South Coast Company, after experimenting with these bearings for upwards of two years with satisfactory results, have now decided to adopt them for main line passenger traffic, and they, it is hoped, will shortly be fitted to their bogie stock. The South-Eastern Railway have also determined to give them an extensive trial. The North-Eastern Railway have been supplied with these bearings, and the Lynton and Barnstaple Railway, now approaching completion, has fitted the whole of its rolling stock with these bearings. With regard to electrical railways, the City and South London Company have fitted trains with them, and the Directors are glad to announce that they have secured the contract for the whole of the rolling stock for the Waterloo and City Railway, and the whole of he carriages upon the Liverpool and Overhead Railway are being tgradually fitted with their bearings. The "Mono-rail" lightning express train at the Brussels Exhibition was fitted throughout with these bearings, and the Directors believe that the results were satisfactory. The Company was awarded a silver medal diploma at the Exhibition for their exhibits. With respect to tramway works, the bearings have been supplied to gas, traction, and electrically-worked cars for Blackpool, for cable cars at Edinburgh, and for horse tramways at Burnley, Worcester, Deptford and Northampton. For motor car work the bearings have already been supplied to Scarborough and Queensland, and bearings for shafting, furnace cars, trollies, cranes and ventilating fans for machinery have also been supplied by this Company, and negotiations are now in progress for fitting up electrical cabs, omnibuses, and other vehicles. Space has been taken at the Crystal Palace, where two loaded waggons are on view, one fitted with ordinary axle boxes, and the other with roller-bearings, and these can be seen at any time by any of the shareholders or their friends. With regard to Continental business, the Western railway of France have fitted a complete train, and are now conducting extensive trials with these bearings. The Northern railway of France and the Paris-Lyons and Mediterranean railway, as also the Paris-Orleans railway, have these bearings under consideration, and negotiations are now in progress for supplying them to these companies. The bearings have also been supplied on the Continent for shafting and furnace car work, as also for tramway work, &c. The directors are already in negotiation for the acquisition of the French patents by a French syndicate or company, and look forward to these negotiations being successfully carried through. With regard to America, they have recently deputed an experienced engineer to visit the United States, and his report is now under consideration, and is of an encouraging character. Negotiations are also in progress for the sale of the American patents. It is, of course, not advisable for the Board at the present juncture to say more, but the shareholders may rest assured that the Directors are alive to the importance of energetically pushing the introduction of roller bearings in the United States, and in other parts of the globe wherever possible. Agencies have been appointed for London, North of England, part of Scotland, Germany, France, Holland, Canada, South Africa, Japan, India and Australia, with centres at Birmingham, Manchester, Liverpool and Scotland. The accounts are, no doubt, self-explanatory, but there is one item which I feel I should draw attention to and explain for the benefit of the shareholders who may require information on the subject—that is, the amount of £2,000, which has been deducted from the purchase price of the patents. Under the contract of sale, the Directors had to recognise an option granted by the vendor syndicate in respect of the Brazil River Plate and Uruguay patent. This option was duly exercised, but the capital of the purchasing Company was limited to a small amount which controlled the purchase price payable to this Company under the option. The Board could not consider the sum of £2,000 as adequately representing the value of these patents, and for this reason they have deducted the whole sum of £2,000 from the purchase-price paid for the patents, which amount they regard in the light of an asset, partly in cash and partly in invested shares. They have taken the value of these shares at par, as they consider they are at present of the same relative value as the Company's shares, and may be regarded as an investment of equal value. The balance of the amount—namely, £750 in cash—will be held in the light of a reserve. With regard to the profit and loss account, the loss of £1,865. 4s. 5d. must not be regarded as a fixed figure, as the net value of the contracts in hand at September 30, when the accounts were made up, would reduce this sum by at least one-half. In conclusion, I am able to say that the demand for these roller-bearings is steadily increasing, and the results obtained

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from their practical application in every-day use justify the directors in believing that the experimental stage of roller-bearings is now passed, and that as their many advantages become more widely-known and appreciated their success is assured, and their general adoption is only a question of gradual, if not of rapid, development. I now move—

"That the report and statement of accounts of the Company, to September 30th, 1897, as printed and issued to the shareholders, be, and they are hereby approved and adopted."

Mr. W. SHELFORD, M.Inst.C.E., seconded the motion, which was adopted without discussion.

Mr. CARRUTHERS WAIN moved the re-election of the auditors (Messrs. Fulier and Wise) for the ensuing year at a fee of 25 guineas. In doing so, he complimented the Board on the success which had so far attended their management of the Company's affairs.

Mr. NEWMARSH seconded, and the Resolution was agreed to.

A vote of thanks to the Chairman, proposed by Mr. Jones, C.E., brought the proceedings to a close.

NEW COMPANIES, STATUTORY RETURNS, &c.

BINKO, RIDSDALE AND COMPANY (LIMITED).—This Company was registered on Oct. 25 with a capital of £24,000, in £1 shares (of which 3,750 are Preference), to acquire and carry on the business of electric, telegraph, lighting, mechanical and general engineers, lamp manufacturers, metal workers, ship's fitters, signal manufacturers and ship suppliers now carried on under the styles of H. Binko and Co. and Ridsdale and Co. at 54 and 120, Minories, and 34, Leadenhall-street, London, E.C. The first Directors include Henry Binko and George H. Gibson.

BOURNEMOUTH, POOLE AND DISTRICT LIGHT RAILWAYS (ELECTRIC) COMPANY (LIMITED).—This Company was registered on Oct. 23, with a capital of £10,000, in £10 shares, to acquire the necessary authority to make and construct any light railways or tramways in the county of Hants or elsewhere, to equip and work the same with electrical or other mechanical power, and to carry on the business of railway and tramway proprietors, suppliers of electricity, &c. The first subscribers are: William M. Murphy, J.P., J. Barber Glenn, James Hall, Stacy Bates, A. L. Hoskins, Arthur A. Tyler and Edmund F. Vesey Knox, M.P.

FINCHLEY DISTRICT ELECTRIC TRACTION COMPANY (LIMITED).—This Company was registered on Oct. 23, with a capital of £10,000, in £10 shares, to acquire the necessary authority to make and construct any light railways or tramways in the county of Middlesex or elsewhere, to equip and to work the same with electrical or other mechanical power, to carry on all business usually carried on by tramway, omnibus, railway and electrical companies, and to supply electricity. The first subscribers, with one share each, are: William M. Murphy, J.P.; J. Barber Glenn; Arthur A. Tyler: Edmund F. Vesey Knox, M.P.; Edmund Wragge, civil engineer; A. L. Hoskins and Stacy Bates.

FOLKESTONE DISTRICT ELECTRIC RAILWAYS COMPANY (LIMITED).—This Company was registered on Oct. 20, with a capital of £20,000, in £10 shares, to construct, lease or otherwise acquire any light railways or tramways in or near Folkestone or elsewhere, to equip, maintain and work by electrical or other power, all light railways or tramways belonging to the Company, and to carry on the business of carriers of passengers and goods, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The first subscribers, with one share each, are: E. Lazarus and A. R. Monks (Chairman and Managing Director respectively of the British Thomson-Houston Company), T. R. Thompson, W. Martindale, J. F. Nauheim, James Devonshire, and W. Morris, jun. Registered office, 83, Cannon-street, London, E.C.

HASTINGS, BEXHILL AND DISTRICT LIGHT RAILWAYS (ELECTRIC) COMPANY (LIMITED).—This Company was registered on Oct. 23 with a capital of £10,000, in £10 shares, to obtain and acquire the necessary authority to construct and maintain light railways and tramways in the county of Sussex or elsewhere, to equip and work the same by electrical, mechanical, or other power, and to carry on the business of railway, tramway and electricity supply companies. The first subscribers are: William Anderson and William Carter, J.P., Secretary and Manager and Chairman respectively of the Dublin United Tramways Company; William M. Murphy, J.P.; J. J. O'Connor; J. Edward Waller, engineer; J. Barber Glenn, and J. Hall.

ROCHESTER, CHATHAM, GILLINGHAM AND DISTRICT ELECTRIC RAILWAYS COMPANY (LIMITED).—This Company was registered on Oct. 20, with a capital of £20,000, in £10 shares, with objects similar to those of the Folkestone District Electric Railways Company, except with regard to the sphere of operations, which are sufficiently indicated by the title. The subscribers, registered office, &c., are also the same.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 27½d. per oz. (Oct. 28). Consols (2¾ per cent.) 111⅛—111⅝ for money, 111 9/16—111 11/16 for account; 2½ per cent. 104⅞—105¼ (Oct. 28). Stock Exchange Settling Days; Consols, Nov. 4: Stocks and Shares Continuation Days, Nov. 9 and 24; Ticket Days, Nov. 10 and 25; Pay Days, Nov. 11 and 26; Mining Share Carry-over Days, Nov. 8 and 23.

CITY OF BIRMINGHAM TRAMWAYS COMPANY (LIMITED).—At a meeting of the Directors of this Company last week, Mr. J. A. Christie was elected a Director, Mr. Granville C. Cuningham, M.I.C.E., was appointed Managing Director of the Company, and Mr. F. W. Warren, who has acted as Chairman's assistant since the formation of the Company, was also appointed to a seat on the Board. Mr. Cuningham was until recently managing and chief engineer of the Montreal Street Railway.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The revenue return of this Company for the quarter ended Sept. 30 is as follows: Gross revenue from sale of current for public lighting, £3,146, against £3,158 in the corresponding period of last year; private lighting, &c., £21,978, compared with £17,274; estimated revenue from other sources, £1,000, against £750, making a total of £26,124 against £21,182, an increase of £4,942. On Sept. 30 there was an equivalent of 278,162 8-c.p. lamps connected, being an increase of 7,264 during the quarter, against an increase of 13,181 in the corresponding quarter of 1896.

COVENTRY ELECTRIC TRAMWAYS COMPANY (LIMITED).—The first ordinary general meeting of this Company, which was adjourned from October 5, was held on Friday last at Bank-buildings, Lothbury, E.C. The chairman (Baron E. B. D'Erlanger) said that the whole of the share capital had been subscribed, and half of it was ready to be paid up, and the other half would be paid up as the works proceeded. The work of construction would be pressed forward without more delay than was absolutely necessary. The tramways would be a great boon to the inhabitants of the city. Captain Francis Pavy, Baron E. B. D'Erlanger, Mr. E. A. Hopkins, the Hon. Arthur G. Brand, Baron A. von Cramm, and Mr. T. M. Thackwaite were then appointed Directors.

MANCHESTER CARRIAGE AND TRAMWAYS COMPANY (LIMITED).—At the half-yearly meeting of this Company, on Tuesday, it was announced that the Corporations of Manchester and Salford had obtained powers (subject to existing leases) to work and use the tramways in their respective districts. The Acts, however, did not in any way apply to the tramways outside the city and borough, and no feasible scheme has as yet been suggested for carrying on the important tramway service of the Company. By arrangement the lease of the Salford tramways would be extended to April 27, 1901, when the lease of the Manchester lines expired. The Corporations of Manchester and Salford have powers to adopt electric traction, and the Tramways Committee of the former body have already pronounced in favour of the overhead trolley system.

NORWICH ELECTRIC TRAMWAYS COMPANY (LIMITED).—The adjourned first ordinary general meeting of this Company was held on Friday last at 4, Bank-buildings, E.C., Baron E. B. D'Erlanger presiding. The business was purely formal, and the following gentlemen were appointed directors:—Baron E. B. D'Erlanger, Captain F. Pavy, Hon. Arthur G. Brand, and Messrs. E. A. Hopkins, T. M. Thackthwaite, and Baron A. Von Cramm.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have appointed Thursday, Nov. 4, as a special settling day for 12,000 shares (Nos. 1 to 12,000) of the Blackpool and Fleetwood Tramroad Company (Limited), and have ordered the same to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Oct. 22 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,954.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Oct. 23	3,678	+474	...	...	...
Bristol Trams & Carriage	,, 22	2,613	+625	16	43,458	+5,360
City & South London Ry.	,, 24	970	— 33	17	15,520	— 175
Dover Tramways	,, 16	129	...	6	797	...
Dublin United (Southern)	,, 22	492	+ 68	16	11,790	— 670
Liverpool Overhead Rly.	,, 24	1,335	+243	17	24,725	+3,235
Sheffield Tramways	,, 24	1,014	+190	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Oct. 20.		Price Wednesday, Oct. 27.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 23. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.					£ s. d.			
£19,12 0	£10	3/0	Central London Ordinary	9¾	10¼	9¾	10¼	2 17 2	June and December	9¾	..
143,1C6	10	1/3	Do. (£6 paid)	5½	6	5½	3	3 0 0	,, ,,	..	..
£880,000	Stock	2	City and South London Railway Con. Ordy.	69	71	69	71	2 12 10	January and July	71	70
8,419	£10	5%	Do. 5% Perpetual Preference	15½	15¾	15¼	15¾	3 4 6	,, ,,	15¾	..
£135,701	Stock	4%	Do. 4% Perpetual Debenture	138	140	138	140	2 17 8	May and November	..	..
54,000	10	7/6½	Waterloo and City Ordinary	12¾	13½	12¾	13½	2 5 3	June and December	13	12¾
97,500	10	3	Liverpool Overhead Railway Ordinary	11½	11¾	11⅝	11¾	2 12 2	February & August	..	..
15,000	10	5%	Do. 5% Preference	16	16½	16	16½	3 0 7	,, ,,	..	..
125,000	Stock	4%	Do. 4% Debenture	110	113	110	113	3 11 5	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price Oct. 20.		Price Wednesday, Oct. 27.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 23.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£923,960	Stock	14/0	Anglo-American ..... xd	58	60	57	59	4 13 3	Feb., May, Aug., Nov.	58½	58½
£3,038,020	Stock	23/0	Do. Preferred ..... xd	104½	105½	104	105	5 6 6	" "	105½	104½
£3,038,020	Stock	5/0	Do. Deferred	12¾	13¼	12⅝				13⅛	12⅝
£ 37,400	£100	4%	*African Direct Telegraph (Red)	101	105	101	105	3 16 11	January and July ..	..	..
£25,000	10	..	Amazon Telegraph	5½	6½	5½	6½	..	..	..	..
130,000	10	3/0	Brazilian Submarine	16	16½	16	16½	4 4 10	Mar., June, Oct., Dec.	16½	16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	114	118	114	118	4 5 10	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	178	183	178	183	4 7 5	Jan., Apr., July, Oct.	..	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105	107	105	107	3 14 9	" "	106⅞	105⅝
16,000	10	8/0	Cuba Submarine	8½	9½	8½	9½	8 8 5	February and August	9½	8½
6,000	10	10%	Do. Preference 10 per Cent.	18½	19½	18½	19½	5 2 7	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October ..	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	10 5/16	10 3/16
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July ..	..	..
60,710	£20	3/0	Direct United States Cable, 1877 ..... xd	10½	10⅝	10½	10⅝	5 12 8	Jan., Apr., July, Oct.	10⅝	10½
400,000	£10	2 6	Eastern ..... xd	16⅜	17½	16⅜	17½	3 15 4	" "	17½	17
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference .. xd	18	19	18	19	3 3 8	" "	18½	18 1/16
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131	134	132	135	3 0 0	May and November	..	..
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 14 9	February & August	..	..
250,000	10	2/6	Eastern Extension ..... xd	18	18½	18	18⅜	3 17 9	Jan., Apr., July, Oct.	18⅜	17⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	129	132	131	134	3 0 0	February & August	..	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 ..	100	104	100	104	4 17 4	January and July ..	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900 ..	100	104	100	104	4 17 4	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103	106	103	106	3 15 8	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	109⅞	112⅞	109⅞	112⅞	3 12 9	May and November	..	..
180,227	10	3/6	Globe Telegraph and Trust	11½	12	11⅝	12	3 15 0	Jan., Apr., July, Oct.	..	..
180,042	10	6%	Do. 6 per Cent. Preference	17½	17⅝	17½	17⅝	3 8 7	" "	..	..
150,000	10	5/0	Great Northern of Copenhagen	26½	27½	26⅜	27½	3 13 1	January, April, July	27	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B" ..	104	105	102	105	4 15 3	March & September	..	..
17,000	25	37/6	Indo-European	54	57	54	57	4 7 9	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1901.	107	110	107	110	5 9 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs (red) 1942 ..	107	110	107	110	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October ..	7 13/16	7⅞
3,381	£100 Cert.	6%	Submarine Cables Trust	135	140	136	141	4 5 1	" "	..	..
15,609	10	6/0	West African Telegraph	5	6	5	6	5 0 0	.. ..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 14 4	March & September	..	..
30,000	10	..	West Coast of America	¾	1¼	¾	1¼	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	107	106	108	3 14 10	June and December	..	..
88,321	10	-/6	West India and Panama	⅛	1	⅛	1	..	May and November	1	1/16
34,563	10	6/0	Do. 6 per Cent 1st Preference	9¾	10½	9¾	10½	6 0 0	" "	10½	10
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	" "	7¾	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 12 2	January and July ..	..	..
64,256	15	3/0	Western and Brazilian	9¾	10¼	9¼	9½	3 2 6	May and November	9 13/16	9⅝
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	8	7⅜	8	3 15 2	" "	7⅞	7 7/16
33,129	7½	1/6	Do. Deferred Ordinary	2¾	3¼	2¼	2⅝	..	" "	3	2½
£382,220	..	4%	Do. 4 per Cent. Debenture Stock	106	109	106	109	3 14 1	June and December	107	106⅝
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	106	110	106	110	6 9 8	Feb., May, Aug., Nov.	..	..
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3½	3¾	3½	3¾	5 6 8	August	..	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance ..	1/16	1/16	1/16	1/16	..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent Preference ..	2	2½	2	2½	8 0 0	October	..	..
484,597	5	3/0	National	6⅝	6¾	6⅝	6¾	4 10 7	February & August	6 11/16	6¾
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 10 7	" "	16 5/16	15½
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid) ..	15	17	15	17	3 10 7	" "	15½	..
20,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fullypaid)	6	6½	6	6½	3 16 11	" "	6 5/16	6¼
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	105	110	104	109	3 5 0	June and December	106½	105½
171,504	1	0/3	Oriental	1/16	1/16	1/16	1/16	4 2 4	April and October ..	..	..
58,000	5	5/0	United River Plate	3¾	4¼	3¾	4¼	5 17 8	July	..	..
£146,733	Stock	0%	* Do. 5 per Cent. Debenture Stock (red.)	102	107	102	107	4 14 4	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.								
£150,000	5	4½%	Birmingham Electric Supply (fully paid)		12		11⅞	..	March	..	..
£50,000	5	..	Do. (New Issue) £3. 10s. paid		11		..	..	..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid) ...	25	26	25	26	2 13 10	February & August	25⅝	25⅛
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17	18	17	18	3 6 8	January and July ..	17⅝	17 3/16
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131	136	131	136	3 14 3	June and December	133⅞	132⅛
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp..	12	13	12	13	2 0 0	February & August	12⅜	12⅛
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 6 8	" "	6⅝	6½
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)		—		—	—	January and July ..	..	..
£26,000	5	2 6	Chelsea Electricity Supply Ordinary	10¼	10¾	10	10½	3 11 5	March	10¼	10½
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	110	113	110	113	3 19 8	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	12¾	13½	12¾	13½	..	..	13⅛	12 13/16
20,000	£10	6/0	Do. 6% Cumulative Preference	15½	15⅞	15½	15⅞	3 16 2	March & September	15 7/16	15⅜
10,000	£5	..	House-to-House Electric Lighting Supply Ord. ..	9	9½	9	9½	..	..	..	..
10,000	£5	7%	Do. 7 per Cent. Preference	10¾	11¼	10¾	11½	3 2 1	March & September	10⅞	10¾
111,000	£5	..	London Electric Supply Ordinary	2	2¼	2	2¼	..	..	..	..
48,050	£5	..	Do. Preference	4⅝	4¾	4⅝	4¾	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary ..... xd	17½	18½	17½	18½	2 19 6	April and October ..	18⅜	..
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	17	18	17	18	..	" "	..	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119	123	119	123	3 13 6	June and December	120½	119½
6,452	10	8/0	Notting Hill Electric Ordinary	15	16	15	16	2 10 0	March	15¼	..
275,000	1	..	Rand Electric	1 7/16	1 9/16	1 7/16	1 9/16	..	..	..	..
£125,000	Stock	..	River Plate Elec. Lt. Tr ct'n, Ltd., 5% 1st Mor. Deb.	93	98	93	98	..	..	..	..
150,000	$100	..	Royal Electric Company of Montreal Shares	148	150	148	150	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	103	106	103	105	4 5 9	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electricity Ordinary	16	17	16	17	3 7 8	February & August	16⅝	..
20,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	" "	..	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	103	106	103	106	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	14½	15½	14½	15½	3 4 0	March & September	15¼	14⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	1/6	Brush Electrical Engineering	1	1½	1⅛	1⅜	..	—	1 7/16	—
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	1⅞	2⅛	1⅞	2⅛	..	—	2	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	105	109	107	111	4 1 8	February & August	107	4 1/16
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	98	102	98	102	4 9 7	June and December	..	..
10,000	£10	..	British Aluminium Ordinary	—	—	—	—	—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference	—	—	—	—	—	—	—	—
20,000	£5	6/0	Callender's Cable Construction, Limited, Shares ..	7	8	7	8	3 15 8	June and December	..	..
£90,000	Stock	4½	Do. 4½% Mort. Deb. Stock	108	113	103	113	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1¼	1½	1½	1½	—	—	1 7/16	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref. .	1⅞	2	1½	2	—	—	..	..
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	89	94	89	94	5 6 5	January and July ..	—	—
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)..	2½	2¾	2½	2¾	5 8 8	February & August	2 1/16	2½
17,139	5	2/9⅜	Do. (£5 paid)	4	5	4	5	5 6 0	" "	..	..
£200,000	Stock	..	Do. 4% Debenture Stock (red.)	101	103	101	103	3 17 8	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2	2¼	2	2¼	4 13 4	February & August	2 1/16	2 1/16
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3⅝	3½	3⅝	4 3 4	August	3½	..
91,186	1	10/0	Elmore's Patent Copper Depositing	⅜	⅝	½	⅝	..	..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	19	20	19½	20½	4 16 3	February & August	—	—
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 12 0	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.) ..	110	115	110	115	3 18 10	" "	..	..
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	23½	4 8 11	" "	2 1/16	22½
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	103	107	3 14 9	March & September	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	36	39	36	39	4 12 4	March and July	38	37⅛
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July ..	..	..
£22,500	£5	3/6	Willans and Robinson Ordinary ..... xd	8½	8⅝	8½	8⅝	4 0 0	April and October ..	8 9/16	8½
£22,500	£5	3/0	Do. 6% Cumulative Preference ..... xd	7	7⅛	7	7⅛	3 17 5	" "	7⅛	..
£100,000	Stock	36/7	Do. 4½% First Mort. Debs.	106	108	106	108	4 4 1	May and November	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

THE Report of the Post and Telegraph Department of Queensland for the year 1896 is just to hand; and, following as it does upon the similar document issued by the British Postmaster-General, suggests comparisons not on the whole unfavourable to the mother country. We notice the same demands for extensions of the telephone system, which, so far as they have been acceded to, have adversely affected the revenue of the telegraph service. This has been followed by a reduction of telephone rates in the hope of securing a compensating revenue from that source—hope which at present shows no sign of being fulfilled. Troubles similar to those at the Cape with the electric tramways and the telephone and telegraph lines have arisen, necessitating a considerable expenditure in placing these wires underground. Another item of expense, owing to the ravages of the white ant upon the wooden telegraph poles, is a trouble peculiar to the colony, and might be avoided in future, one would suppose, by the substitution of iron supports. Queensland is also not free from the burden of departmental franked messages, meteorological intelligence alone passing over the wires without charge amounting annually to the value of £24,000; and, including service rendered to other departments, the sum is estimated at over £50,000 per annum. This, for so small a colony as Queensland, is a very heavy tax upon the revenue of its Telegraph service. Failing in his endeavours to induce "other" government departments to pay for their telegrams, the Queensland Postmaster-General is turning his attention to reducing expenses; and, amongst other things, skilled telegraphists are being withdrawn from the less important stations, a telephone service being established instead.

IN another column will be found a description of a neat and practical form of type-printing telegraph. The instrument possesses several new features, the most notable being the simple and effectual device for bringing the machines at the two ends of the line into synchronism. We hear that Messrs. SIEMENS and HALSKE, who have acquired the German patent rights, are experimenting in the direction of increasing the speed of transmission, and that the German POSTMASTER-GENERAL is taking a lively interest in the invention. The machines are usually fitted with telephones for ringing up and notifying the other end when it is desired to send a message, and the Telescriptor Syndicate are wishing to extend the use of their machines to telephone exchange subscribers. There are, however, at present two impediments to this application of it. In the first place, the terms of the National Telephone Company's licence emphatically prohibit the conveyance of written messages, and stipulate that the transmitting and receiving instruments be telephones and "no other kind or description of telegraphs." In the second place, the intermittent currents from the type printing instruments would actuate the ring-off indicators on the line to which they were connected, and modifications in the exchange switchboard arrangements would be necessary.

WHEN Profs. AYRTON and VIRIAMU JONES read before Section A of the British Association, at Toronto, their Paper on "A Determination of the Ohm Made in Testing the Lorenz Apparatus of the McGill University," fear was expressed that the standard resistances of the Board of Trade were steadily deteriorating, and one of the authors stated that such standards had been found actually to have a lower resistance than when measured a few years previously. This liability to deterioration we ourselves, in common with the authors of the Paper, have long held to warrant the replacement of metal standards by the exactly reproducible mechanical standard afforded in the Lorenz apparatus. We took occasion, at the time the Paper was read, to point out to our readers the danger to which the legalised electrical units are exposed by the fact that the final

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referendum, in the event of their value being disputed, is dependent upon a standard which by its very nature is susceptible of change. Intimately connected with this matter is the communication we publish this week, wherein Prof. AYRTON sets forth the degree of permanence exhibited by the four resistance coils used in the determinations of the ohm in 1894 and in the present year. A comparison has been made between the constants of the coils as determined in 1894, in 1896, and in the present year. The results show that these coils can be relied on to give a value of the International Ohm with an error not exceeding 0·01 per cent.

THE Rhodin apparatus for the electrolysis of brine and the production of alkali and bleach, briefly described in our issue of last week, is of the mercury type, in which that metal acts as a carrier of sodium from the brine whence it is derived, to an external compartment where it comes into contact with water, producing caustic soda. Whether it acts as a final or an intermediate electrode is not made plain by the descriptions of the apparatus which have been circulated. Indeed, these were chiefly distinguished by their essential vagueness, and there are many points on which fuller and clearer information must be forthcoming before any definite opinion can be pronounced. The only expert reports which we have seen are little more than a general statement that the apparatus has merits, and give no particulars of working or estimate of cost. There are, however, obvious advantages in the apparatus—viz., that the circulation of the mercury is rotatory, and that it is a simple matter to heat the contents of the cell should a moderately high temperature be found advantageous for electrolysis. The most important claim made is that a greater output per unit of plant can be obtained than by any existing process. If this can be substantiated, the apparatus is a notable one.

ARC lighting is, in America, a matter of more importance relative to the other duties of a central station than it is at present in this country; and, as a consequence, the methods principally adopted for carrying it out differ widely on the two sides of the Atlantic. The number of English stations boasting of a load of over a hundred public arc lamps is extremely limited; whereas, in the United States, it not unfrequently happens that a station has to run several thousand lamps and the number of stations feeding over a hundred arcs is legion. Time was when the method *par excellence* of arc lighting in English cities was the continuous current series system; and in those days the amount of arc lighting was so small that the voltage required was not dangerously high, notwithstanding the imperfect appliances then in use. Even to-day it would not be impossible to run the public lamps of most of our towns on that original system; though other considerations often render it inadvisable to do so. With a load of lamps running into thousands, however, it is another matter; and American electrical engineers have been compelled to turn their attention to a means of satisfactorily running a number of series circuits in parallel on one generator. Perhaps the latest, if not the most satisfactory, solution of the problem is that recently evolved by Mr. RUSHMORE, of Jersey City, some account of which will be found in another column.

IT remains yet to be seen to what degree Mr. RUSHMORE'S multi-circuit arc dynamo system can compete with open-coil machines, in actual practical use; for it would appear that up to the present it has only been tried on a small "second-hand machine, fitted to a commutator from another old machine and to fields of still a third machine, and with regulators of still a fourth type." Obviously this was a temporary and tentative arrangement; while the smallness of the load may justify the doubt, whether equally satisfactory results would occur were the number of lamps in series increased from six to, say, fifty, or one hundred. One is naturally inclined to scrutinise the commutator, and to suspect vicious sparking, when a closed-coil machine is coupled to a multiple series circuit of arc lamps at a high voltage. Nor are we convinced to the contrary, even though the entire switching-off of one circuit, or its short-circuiting, produced no ill-effect on the lamps in the other circuit. It would have been more to the point had each circuit been equipped, with, say, 10 per cent. of bad lamps. One would then have been able to judge how the customary vagaries of the apparently inevitable black sheep would affect the equilibrium of the others.

SOME time ago a rascally fellow made capital out of a number of electric tramway companies in America by claiming to have been injured by their cars, and carried on his nefarious trade with considerable success, until the curious coincidence was discovered of his making claims upon two distinct companies for having been knocked down by two distinct cars, far apart from one another, at one and the same time. A similar fraud was practised some time ago upon gas companies in this country by an enterprising but misguided individual whose eye was repeatedly alleged to have been damaged by their workmen while carrying out repairs in the street. One of that ilk appears to have been lately in Dublin, and to have attempted a fraud on the Corporation electric light department. The following startling announcement appeared in *The Times* of Tuesday last:—

> A singular accident took place in Dublin on Saturday night. At about half-past nine o'clock a clerk was walking near one of the electric lamps at the corner of Nassau-street, when he got a severe shock, which, as he states, paralysed him, and he fell to the ground. Two other young men came to his help, but each as he touched him had the same experience. They lay helplessly on the ground surrounded by a crowd, who, realising the danger, did not venture to touch them. After a short time the current was turned off, and they were released from its power.

Inquiry as to the authenticity of this report elicited from the Corporation electrical engineer the following commentary:—

> SIR: I am obliged for your inquiry of 2nd inst. *re* the sensational reports current in the local press, and which are absolutely untrue. Shortly, I may say that we had, on Saturday evening, several breakdowns in our street mains, but it was quite impossible for anyone of the public to have received a shock in consequence. The only element of fact I can trace is that a man came to the station during the evening, with his clothes muddy, and asked for compensation, saying he had been knocked down by an electric shock. I could find nothing the matter with him, and he finally went to an hospital, where the doctors could find no sign of anything of the sort; and, in fact, attributed his fall to a more common source on Saturday evenings. So far as we can learn, it is simply an attempt to make a little money.—Yours, &c., M. RUDDLE.

A PROSPECTUS of the Direct West India Cable Company (Limited) was issued yesterday, inviting applications for £60,000 in £5 Ordinary shares at par and £120,000 Four

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and a-Half per Cent. Debentures at 95. We are informed that the lists (which were to have remained open till Saturday) closed yesterday afternoon, except for country applications then *en route*. Further reference to the Prospectus is given in in another part of our issue this week.

City and Guilds Technical College, Finsbury.—It is announced that a special course of six lectures on electric traction will be delivered by Mr. Phillip Dawson on Thursday evenings, from eight to nine o'clock, beginning on Thursday next, the 11th inst. Some further particulars appear in an advertisement elsewhere.

Civil and Mechanical Engineers' Society.—On Saturday last several members of the Civil and Mechanical Engineers' Society paid a visit to the testing and experimenting works of Messrs. Kirkaldy and Co. The visitors were shown round by Mr. Kirkaldy, who explained the working of the testing machines, and made several tests on samples of iron and steel.

The Röntgen Society.—As announced in our leading article this week, the inaugural meeting and conversazione of the new Röntgen Society will be held this evening at 9 p.m., in the St. Martin's Town Hall. The first president, Prof. S. P. Thompson, will deliver an address. The honorary secretary of this Society is Dr. David Walsh, of 5, Pump-court, Temple.

Accident on the Bulawayo Railway.—A Reuter's telegram from Cape Town yesterday stated that the electric light dynamo van of the Johannesburg (Eastern Province) special train to Bulawayo caught fire at Gaberones. The van was totally destroyed, and the electrician and his assistants were severely burned. None of the passengers, however, were injured. The line was formally opened yesterday, and it was, we presume, on the trial trip that this accident occurred.

Cable Interruptions.—	Date of Interruption.
Obidos—Parintins	Dec. 7, 1896
Hong Kong—Macao	Sept. 28, 1897
Cayenne—Pinheiro	Sept. 29, 1897
Otranto—Vallona	Oct. 11, 1897
Alemquer—Santarem	Oct. 21, 1897
Paramaribo—Cayenne	Oct. 25, 1897
Cadiz—Teneriffe	Oct. 26, 1897
Santiago de Cuba—Guantanamo	Oct. 29, 1897
Bundaberg—New Caledonia	Nov. 4, 1897

Electric Lighting in China.—The Celestial empire does not seem to be going ahead very fast with the applications of electricity for lighting and power, but the *Elektrotechnischer Anzeiger* now announces some new undertakings. A Chinese syndicate has been formed for introducing electric light in Hang-Chow Fu, the capital of Chi-Kiang, and in the town of Han-Kau, on the Yang-tse-Kiang. An electric light works has also started supplying current for private lighting in Chang-sha-Fu, in the anti-European province of Hunan.

The Utilisation of Iron Stone.—During the course of an inaugural address delivered to the members of the Engineering Society of the Goldsmiths' Institute, New Cross, Mr. Bryan Donkin made mention of a visit he had paid to Edison's iron-ore works in Sussex, New Jersey, U.S.A., some 90 miles to the West of New York. The works, he stated, treat iron stone by an electrical process, producing a useful iron ore, which is sent to the blast furnaces. The plant at present erected is said to be capable of treating over 6,000 tons of iron stone per diem; but Mr. Donkin did not say how many tons of useful ore this corresponds to, nor did he give any details of the process, so that we have no means of judging whether the game is worth the candle.

Society of Chemical Industry.—The opening meeting of the present session of the Liverpool section of this society was held recently in the University College Chemical Laboratories, when the chairman (Dr. Kohn) gave an address on "The Manufacture and Properties of Carborundum." He traced the development of carborundum manufacture since its discovery by Mr. E. G. Acheson in 1891, and indicated the properties and industrial uses of the material. Although it has to compete with emery in almost all of its applications, it had done so successfully in many cases in spite of its higher price, chiefly on account of being able to do more work than its rival in the same time. The address was illustrated by specimens, diagrams and lantern slides.

Electric Motors for Emergency Work.—Messrs. Nalder Bros. and Thompson write informing us that on Thursday last week a curious accident happened to a gas engine in use at their works. Owing to a flaw in the shaft it suddenly snapped off short outside the bearing. The flywheel, weighing 7cwt., and the pulley were thus dropped on the floor while running at a rate of 300 revolutions per minute. Fortunately the belt remained on the pulley, and pulled up the flywheel without any serious damage resulting. The accident happened at a most awkward time, as the firm are extremely busy and were under a penalty for a considerable portion of the work in hand. The Davies Motor Company were immediately telephoned, who forwarded at once an alternating-current motor, by the aid of which the shops were running again the same evening, current being taken from the City of London Company's mains, which fortunately supply current to the premises for other purposes.

The Institution of Civil Engineers.—The first ordinary meeting of the 79th Session was held last Tuesday, when the President, Sir John Wolfe Barry, K.C.B., delivered a short address dealing with various matters concerning the present and future welfare of the Institution. In the course of the address he spoke of the increasing duties devolving upon the Council in proportion to the growth and importance of the Institution, now numbering on its roll 7,075 persons. The President next referred to the Engineering Conference last May, the estimated attendance at which was 850. He thought it would be acknowledged that the interest exhibited in the numerous subjects brought forward for discussion, in which upwards of 300 speakers took part, and the fact that 2,000 tickets of admission were applied for in respect of the visits arranged in connection with the gathering, justified the Council in believing that it had given general satisfaction to the members. The division of the Conference into seven sections, representing more or less distinct lines of engineering thought and practice, afforded a useful means of meeting the overlapping of ideas and treatment in the various departments of engineering activity embraced by the Institution. Among the names of those who have been awarded medals and prizes during the last session we note that of Mr. H. W. Ravenshaw, who has been awarded a Telford premium for his Paper on "Electric Lifts and Cranes."

The Adulteration of Portland Cement.—At a meeting of the London Section of the Society of Chemical Industry, held in the rooms of the Chemical Society on Monday last, a Paper was read by Messrs. W. H. Stanger and Bertram Blount on "The Adulteration of Portland Cement." This Paper embodied the chief facts and deductions drawn from experiments by the authors, and instituted at the request of the London Chamber of Commerce in consequence of the practice of many makers of adding ragstone or other material to Portland cement, for the alleged reason that such an addition improves its strength. The practical results of the authors' investigations are thus summarised: "(1) Ragstone is not a cementitious substance, and its addition to cement is an adulteration. (2) Perfectly sound cement is weakened by the addition of ragstone. (3) This weakening is not fully proportional to the percentage of ragstone added, because the latter acts as a fine filling material and fills up the interstices naturally present in set cement. (4) Cement which is not perfectly sound may be temporarily improved by the addition of ragstone." When the cement has become sound by aëration this improvement is found to disappear. The Paper, generally, concludes that "All materials added to Portland cement, after the clinker comes from the kilns, are adulterants, with the exception of gypsum which is a recognised addition for a specific purpose in quantities not exceeding 2 per cent. Of the two adulterants which have been specially dealt with, viz., ragstone and blast-furnace slag, the latter is by far the more objectionable and it should be condemned and rejected by makers and users alike." In this view the authors believe they are supported by the great majority of engineers and manufacturers.

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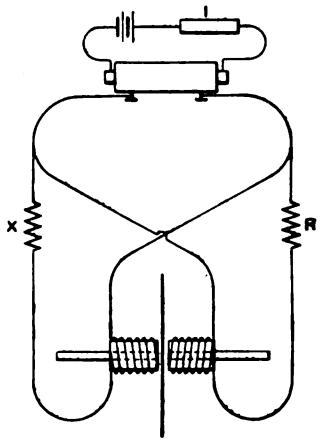
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

A Differential Telephone Method.—The measurement of electrolytic resistances by Kohlrausch's telephone method is subject to inconveniences arising from the lack of definition of the minimum at the neutral point. As in all such cases, a differential method is called for, and such a method has been devised by R. Federico, who claims that it surpasses all the other improvements hitherto proposed, being more exact and applicable to a wider range of resistances. A telephone disc is mounted between two electromagnets (*see* diagram). When the same alternating current traverses both coils, the disc is silent. The current is supplied by a simple battery current rendered alternating by a stretched-wire interrupter and a rocking commutator, or, better still, by an induction coil fed with a current provided with the wire interrupter I. The advantage of the wire interrupter is that it can be "tuned" to the natural period of



vibration of the disc, its period being varied within wide limits by altering the thickness, length, or tension of the wire. For high unknown resistances, X, it is necessary to employ standard (liquid) resistances at R free from inductance. The accuracy in measuring resistances of the order of 10,000 ohms is 0·1 per cent., and the measurements only occupy a few seconds.

[Federico, *Nuovo Cimento*, September, 1897.]

Magnetism and Electrolytic Conductivity.—Some 18 years ago Neesen announced that a strong magnetic field is capable of modifying the conductivity of a solution of ferric chloride. If true, this effect would be of paramount importance to the theory of electric conduction. But, according to G. Milani, it is not true. He used for his experiments a U-tube, carrying the liquid, and provided with side tubes, through which a pair of unpolarisable electrodes were introduced. The latter formed the terminals of a very sensitive capillary electrometer, and consisted of the capillary ends of siphon tubes leading into bottles containing saturated $ZnSO_4$ solution and a rod of amalgamated zinc. The magnetic field was generated by a large horseshoe magnet 1·2mm. long. Alterations of temperature were precluded by the rapidity of the measurements. The dimensions of the tubes, the concentration of the solution, the currents and magnetic fields were varied in every possible manner. A difference of resistance of about ½ per cent. was apparently produced, but this was almost entirely suppressed by a perfect insulation of the electrometer wires. Neesen's effect, therefore, either does not exist, or it is so small that its existence cannot at present be demonstated.

[Milani, *Nuovo Cimento*, September, 1897.]

Coherers.—Prof. Temistocle Calzecchi, of the Liceo of Fermo, claims priority over Branly himself in the discovery and employment of coherers. As long ago as July, 1884, he says he made known the characteristic properties of metallic filings in the pages of the *Nuovo Cimento*. Subsequently, in conjunction with Prof. Auerbach, of Breslau, he employed his coherer for various practical purposes, but not, apparently, for wireless telegraphy. One of his Papers was entitled "On a new form which may be given to the Microseismic Indicator." He says in it: "A slight tremor communicated to the table holding the tube, a small tuning-fork standing on it and vibrating, and sometimes a note sung are sufficient to deprive the filings of their conductivity."

[Calzecchi, *Nuovo Cimento*, September, 1897.]

Resistance of Iron Oxides—A large number of iron ores, mostly oxides and sulphides, collected from the mines of Siebenbürgen, have been examined by A. Abt as regards electric conductivity. Prisms of magnetite, pyrrhotite, chalcopyrite, and hematite were pressed between lead plates to obtain a good contact. The values obtained were fairly consistent. On repeating the measurements 20 times, the resistances of chalcopyrite were found to diverge about 0·9 per cent. throughout the series, while those of magnetite diverged about 2 per cent. But while consistent in themselves, it was found impossible to attribute a certain definite conductivity to each mineral. Two magnetite prisms were examined, each 14·6cm. long and 196mm. in sectional area. One of these had a resistance of 52·56 ohms between the end surfaces, while the other had a resistance of 86,500 ohms. This enormous difference was found to be due to the dissemination through the specimen of fine layers of silica, which, while presenting no microscopic or chemically important difference, had the effect of breaking up the mineral into strata separated by practically non-conducting partitions.

[Abt, *Beiblätter*, No. 9, p. 744, 1897.]

Specular Iron Ore.—This iron ore is peculiarly interesting from the facility with which it lends itself to the study of a variety of physical vectors depending upon crystalline structure. Some time ago, Bäckström studied the phenomena of thermal expansion, thermal and electrical conductivity, and thermo-electric force in their relation to the axis of symmetry. This was done by cutting rods of the substance in various directions. These studies have now been extended to the magnetic properties by J. Westmann. He found that slabs of the ore immersed in a strong magnetic field were magnetised, but that the magnetic axis often made a small angle with the direction of the original field. The magnetic permeability was 0·2 per cent. of that of wrought iron, and the ore showed high coercive force. It was paramagnetic in every direction.

[Westmann, *Beiblätter*, No. 9, 1897.]

Permanent Magnets.—Some elaborate experiments have been carried out by C. Chistoni and G. G. de Vecchi, with a view of testing the alleged excellence of Valtrompia tungsten steel as regards permanence of magnetisation and high permeability. One specimen examined contained 6·25 per cent. of tungsten, 0·99 per cent. carbon, 1 per cent. manganese, 0·19 per cent. silicon, and the rest iron. Another specimen contained 4·15 per cent. tungsten, and somewhat less manganese and more carbon. Comparing their magnetisations in various fields with those obtained by Barus and Strouhal, they are certainly superior to the latter. The specific magnetic moment quoted by these authors as the maximum is 23·5, whereas the maxima obtained from the Valtrompia specimens were 47·6 and 55·6. As regards the demagnetising influence of time, this is not felt at all except after magnetisation in the strongest fields, and the authors go so far as to assert that after exposure to a comparatively weak field the magnetic moment goes on increasing independently for some time. After saturation the time required to reach a stationary condition differs in various specimens, being longer in thick rods than in thin ones. The settlement may be accelerated by repeatedly heating from 0deg. to 70deg.

[Chistoni and De Vecchi, *Nuovo Cimento*, September, 1897.]

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THE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

BY F. CHARLES RAPHAEL.

VI.—Mixed Circuit Exchanges.

Leeds.

The central exchange at Leeds may be regarded as a thoroughly typical English provincial exchange. It is in the centre of an area of 140 square miles, in which are 11 branch exchanges in connection with the central. There are nearly 1,900 subscribers connected directly to the central exchange, and a total of 2,250 subscribers within the borough, of which the population is about 400,000. Fig. 45 is a sketch map of the district, showing the positions of the branch exchanges. The numbers in the figure denote the number of inter-exchange lines. In addition to these 62 junction lines, there are 71 post office junction lines connected to the central exchange. The load curves shown in Fig. 46 do not differ much in shape

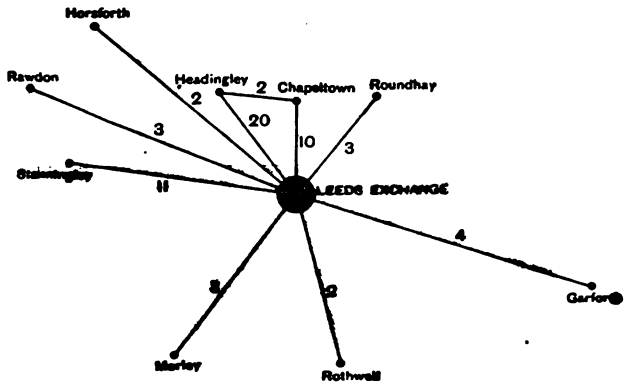

Fig. 45.—Telephone Exchanges in the Leeds District.

from those for the Avenue Exchange in London. The following table gives details of the calls received, &c.:—

Incoming Junction Calls.	
No. of incoming junction wires	63
„ „ operator positions	4
„ „ wires per ditto ...	15·75
„ „ calls.....	2,729
„ „ „ per position...	682·25
„ „ „ „ junct. wire	43·31

Originating Local and Junction Calls.	
No. of subs. lines	1,821
„ operator positions ...	30
„ lines per operator position	65
„ originating local calls.	32,481
„ „ junct. (outgoing)	2,566
Total originating calls	35,047
Per cent. of outgoing junction calls.....	7·9
No. of outgoing junct. wires	58
„ calls per outgoing junction wire	44·24
„ calls pr. operator position	1168·20
„ calls pr. subscribers' line	19·24

Operator hours.....	269·25	Total junction lines in and out	121
Total No. of calls, all kinds	37,776	No. of subscribers' lines per junction line	15·04
Calls per operator hour	140·30	„ operators absent .	1

In addition to these, some 1,430 trunk connections are made through the exchange per diem.

The lines are at present mostly single wire, there being four times as many single-wire as metallic circuits. It is intended, however, to replace all the circuits in the town by metallic circuit underground cable, the cables running to 50 distributing centres, from which overhead lines are led to the subscribers. This underground work has already been commenced; some of the main cables contain 204 pairs of conductors, and are 2½in. diameter over the lead covering. This system of underground running is similar to that at present in use in Manchester, and it will be described more in detail in a subsequent article. The lines are brought to a distributing board in the exchange and are from there led to a testboard across a cross-connecting field. They are joined to the distributing board in the order they enter the exchange, but are arranged on the testboards according to the numbers of the lines. This is similar to the method employed at the London exchanges, and already described, with the difference, however, that the lightning arresters are on the testboard instead of being on the distributing board.

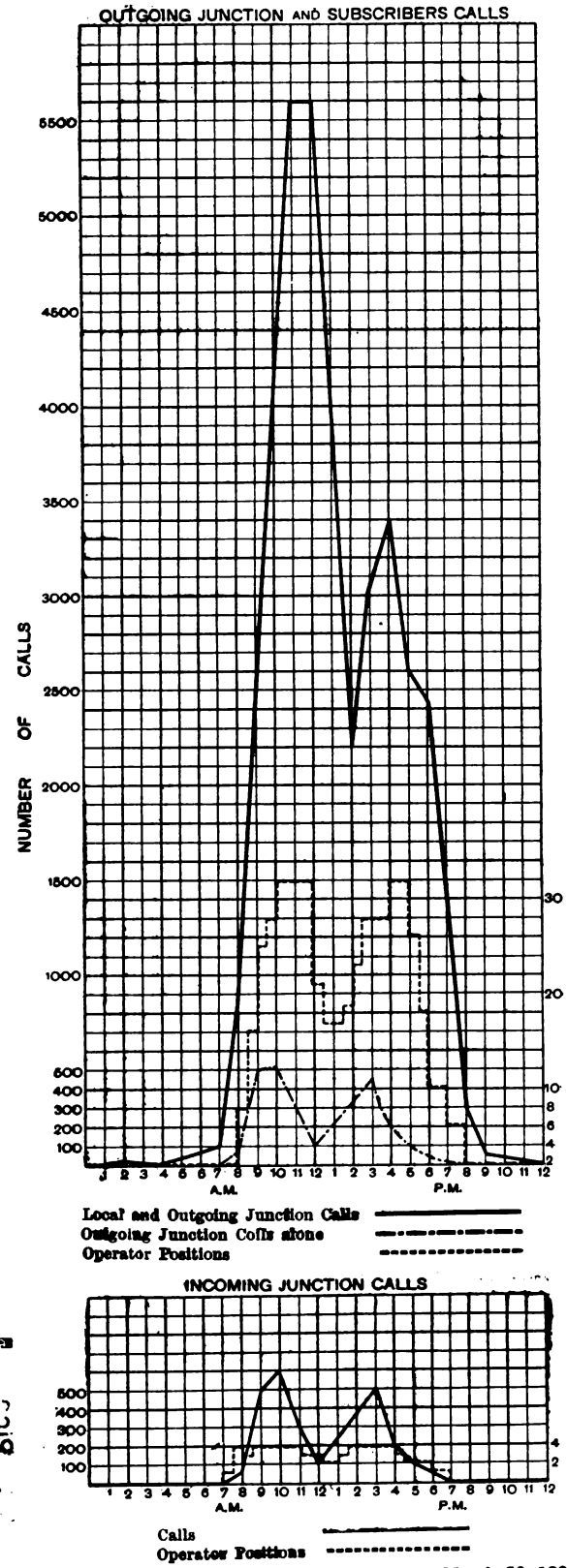

Fig. 46.—Calls Recorded at Leeds Exchange, March 30, 1897.

From the testboard two wires are led from every subscriber's line into the switch-room. This is also done in the case of single-wire circuits; that is to say, the single-wire circuits are wired on the switchboards in exactly the same manner as the metallic circuits, and the only difference is that the B lines are connected to earth on the testboard, so that the work of

* All Rights Reserved. For Articles I., II., III., IV. and V., see *The Electrician*, July 2, 9, 30, August 13, 27, September 17, and October, 1.

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metallic circuiting is completed as far as the exchange is concerned. Fig. 47 is a sketch showing the position of the switchboards, and Fig. 48 gives a general view of the switch-room. There are in all 17 sections, on each of which all the subscribers' lines and outgoing junction lines are multipled.

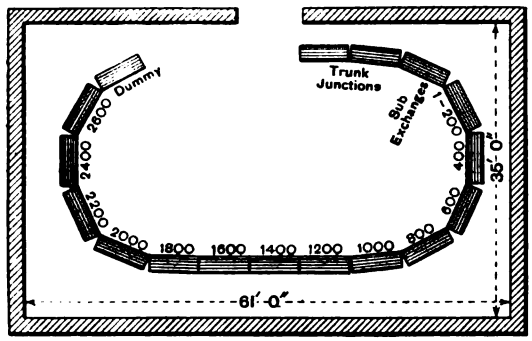

FIG. 47.—Sketch showing position of Switchboards in the Leeds Exchange.

This includes two boards for trunk (post-office) junctions, and one for the incoming junctions from the sub-exchanges. Each section has the local jacks of 200 subscribers, and is served by three operators at the busiest periods of the day.

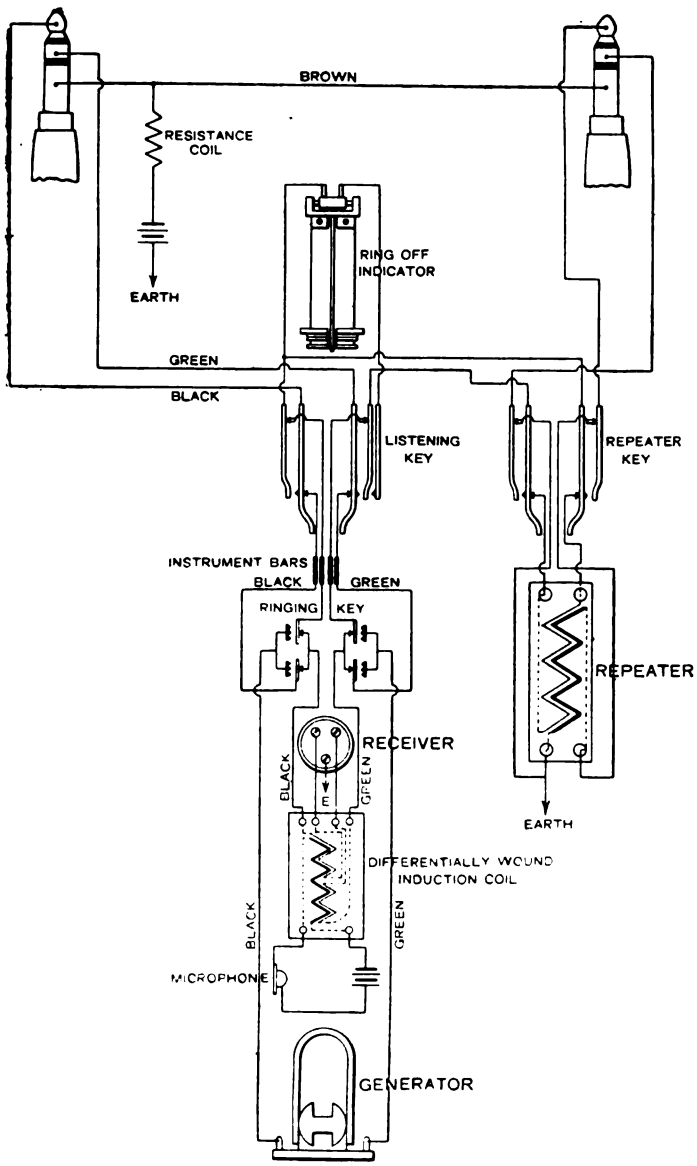

FIG. 49.—Connections of Operator's Set at Leeds Exchange.

The boards are fitted with five-point series jacks, and the only distinction made between the jacks of the metallic and single-wire lines is that the faces of the former bear a white mark. The reason of this is that, when a single-wire line is connected to a metallic circuit, a metallic connection is not made, but the circuits are each connected to the coils of a translator by means of a special "translator key," which is only depressed when such connections are made. The translator is a 2 : 1 transformer, with coils of 150 and 300 ohms resistance, but otherwise not differing much in construction from the differential induction coil described on page 507. Fig. 49 shows how the translator and its key are connected in the operator's set. The repeater or translator key, shown in diagram to the right of the figure, is constructed on the same lines as the listening keys. The difference is that the instrument bars are replaced by four plates connected to the repeater and that the indicator spring is removed. In the diagram the listening key is shown in the listening position, but the repeater key is in the position for a "mixed" connection, the outer springs of the listening key being connected to the one coil of the repeater and the right-hand plug to the other coil. On switching over the listening key each of the plugs would be connected to one winding of the translator; on switching over the repeater key the plugs would be in direct connection with one another. Each operator has 12 pairs of plugs and a ring-off indicator and translator and listening key for each pair. The 12 translators for these are at the back of the board. One pair of ringing keys suffices for the 12 cords.

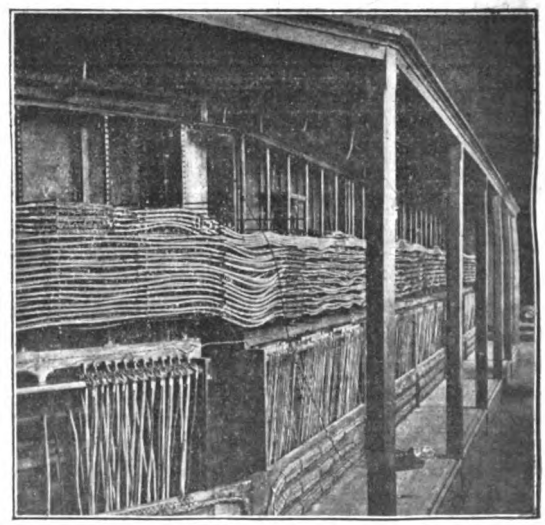

FIG. 50.—Back of Switchboard at Leeds Exchange.

On each section or multiple of the board there is room for 4,800 jacks; 2,600 are fitted at present, of which about 1,900 are in use. The following figures are interesting as showing the amount of work requisite in erecting such a switchboard:—

—	In use.	Spare.	Total.
Five-point jacks	27,080	15,920	43,000
Indicators	2,474	708	3,182
Listening keys	400	108	508
Translator keys	480	108	588
Three-way plugs and cords	880	216	1,096
Double ringing keys	34	9	43
Retardation coils	440	108	548

Total number of moving contacts	124,746
Total number of joints	352,484
Length of 63-wire cable used in switchroom	5·0 miles.
Length of 42-wire cable used in switchroom	3·6 ,,
Battery and other single wire	1¼ ,,
Total mileage of single-wire	466·0 ,,

Fig. 50 is from a photograph of the back of the switchboard.

The junction working is conducted in the manner described in Art. IV. (Fig. 34). Grid indicators are used, however, in place of lamps. The key boards of the operators at the junction board are provided with translator keys, in addition to the listening keys shown in Fig. 34, and all single-wire

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subscribers are connected through the translator to junction lines. Metallic-circuit subscribers are connected directly.

The post-office trunk board has provision for 120 junction wires, and 71 are at present in use. There are four call-wires, permanently connected with the record operators at the post-office, which are multipled on every section of the switch-board, and are used by the exchange operators when a subscriber desires a trunk connection. Demands for trunk connections are treated in rotation, and when the call "matures" the post office communicates with the post office trunk board at the exchange, and the subscriber who desired the connection is notified. In this way all trunk connections, whether demanded from or to Leeds, are treated as incoming calls on the trunk board. The details of trunk working will be entered into more fully in a future article.

The operators number 36, but at night and on Sundays they are replaced by two male operators. In the centre of the room there is a night board, to which each section of the switchboard is connected. If at night a call is received at any section an indicator on the night board bearing the number of the section drops, and the operator on duty knows at once to which part of the room he must go to answer the call.

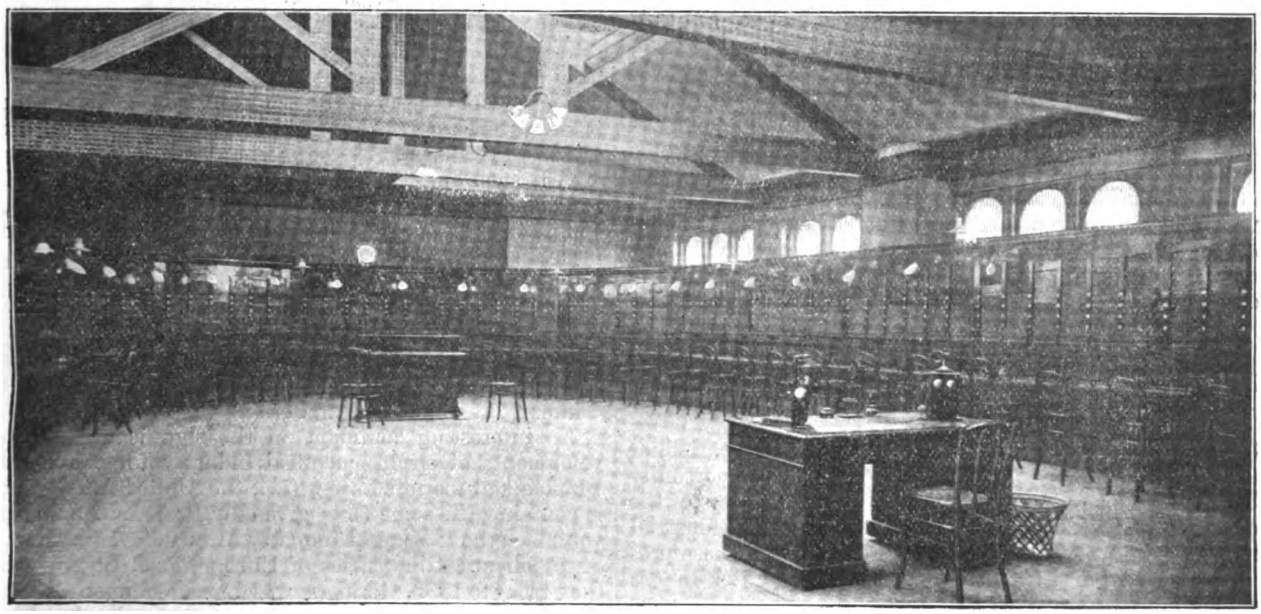

FIG. 48.—General View of Switchroom in Leeds Exchange.

THE PERMANENCY OF RESISTANCE COILS.

BY PROF. W. E. AYRTON, F.R.S.

In order that an idea may be formed of the change that may have occurred in the resistance of the four coils used by Prof. Viriamu Jones in his 1894 determination of the ohm at Cardiff, and in our determination this year in London, I append the actual values in ohms given for these coils by Mr. Glazebrook and by Major Cardew, to both of whom we have to express our thanks for their kindness in making the measurements :—

Coil.	A	B	C
	Mr. Glazebrook. Jan.—March, 1894.	Board of Trade. November, 1896.	Board of Trade. August, 1897.
No. 3,873	9·9919 at 14·8°C.	9·992994 at 14·86°C.	10·00712 at 19·3°C.
„ 3,874	9·9926 at 14·9°C.	9·993213 at 14·91°C.	10·00775 at 19·3°C.
„ 4,274	0·100050 at 15·2°C.	0·1000595 at 14·77°C.	0·100078 at 19·4°C.
„ 4,275	0·100053 at 15·2°C.	0·1000722 at 15·14°C.	0·100081 at 19·4°C.

The coils Nos. 3,873 and 3,874 were stated by the makers, Messrs. Nalder, to be wound with platinum-silver wire and the two others, Nos. 4,274 and 4,275, with manganin.

On comparing the results obtained at Cambridge in 1894 (A) with those given by the Board of Trade in 1897 (C) we see that there is a good agreement. For example, in both cases the temperatures of the third and fourth coils, Nos. 4,274 and 4,275, were the same, and in each of these two cases the resistance of the fourth coil exceeded that of the third coil by 0·000003 ohm. Again, in 1894, the second coil, No. 3,874, was slightly warmer than the first, No. 3,873, and its resistance was 0·0007 ohms higher, whereas in the test of 1897 these two coils had the same temperature, and the resistance of the second exceeded that of the first by 0·00063 ohm.

On calculating the temperature coefficients from the results A and C, and comparing them with those given originally by Messrs. Nalder, we find :—

Coil.	Temperature coefficient of resistance per 1°C.	
	From tests A and C.	As given by Messrs. Nalder.
No. 3,873	0·000360	0·000276
„ 3,874	0·000344	0·000300
„ 4,274	0·0000667	0·0000127
„ 4,275	0·0000667	0·0000127

The values calculated from tests (A) and (C) are, therefore, somewhat higher for the platinum-silver coils than those given by Messrs. Nalder, and much higher for the manganin. But there is this similarity about them, that, just as Messrs. Nalder obtained exactly the same values of the coefficients for the two manganin coils, viz., 0·0000127, so the tests (A) and (C) give exactly the same values, viz., 0·0000667.

But when we compare the results of the 1894 tests (A) with the 1896 tests (B) we see that there is a want of agreement. For example, the temperature of coil No. 3,873 was practically the same on both occasions, and yet the 1896 result exceeded the 1894 result for the same coil by 0·001 ohm. Similarly, although the temperature of the second coil No. 3,847 was also practically the same on both occasions the 1896 result exceeded the 1894 one by 0·0006 ohm. Further, although the temperatures of the two manganin coils Nos. 4,274 and 4,275 were slightly lower in 1896 than in 1894, the resistances were respectively 0·000009 and 0·000019 ohm higher.

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Lastly, if we calculate the temperature coefficients from the 1896 tests (B) and the 1897 tests (C), we obtain :—

Coil.	Temperature coefficients per 1°C., from tests B and C.	Coil.	Temperature coefficients per 1°C., from tests B and C.
No. 3,873	0·000318	No. 4,274	0·0000399
„ 3,874	0·000331	„ 4,275	0·0000207

This makes the coefficient for the manganin coil No. 4,274 almost double of that for the manganin coil No. 4,275.

There seems, therefore, reason for concluding that the coils were in some abnormal condition when tested in 1896. Surprise may be felt that such small discrepancies as those referred to are worthy of comment, but it must be remembered that Prof. Jones and I were aiming at obtaining the true value of the International Ohm with an accuracy of 0·01 per cent., and, judging from the results given above, it would appear that these four coils manufactured by Messrs. Nalder could only be relied on to transmit the value of the international ohm with an accuracy of about this amount. One of my students is at present engaged in ascertaining what is the present value of the temperature coefficient of these four coils.

INDUSTRIAL NOTES ON ELECTROLYTIC ALKALI.

BY JOHN B. C. KERSHAW, F.I.C.

The publication of the interim report of the Castner Kellner Alkali Company seems to provide a convenient opportunity for discussing the present position and future prospects of the three electrolytic soda processes at work on an industrial scale in this and other countries. Full details of these processes were given in an article by the present writer in *The Electrician* of February 12, 1897.

As regards the Castner-Kellner process, the report indicates that all is going well. The 1,000 H.P. plant started in March of this year has been continuously at work since that date, and the caustic and bleach produced are of satisfactory quality. The cost of production (the chief point in all industrial developments) is stated to be satisfactory, and as the Directors are arranging for the extension of the plant to the limit originally planned, one can hardly doubt the truth of this statement. A second 1,000 H.P. installation will be at work in January, 1898, and capital is to be raised forthwith for the additional 2,000 H.P. installation required to bring the capacity of the works up to 4,000 H.P. The whole of the chlorine products of the plant in the form of bleaching powder, have been sold for a period of three years, so that the position of the Company with regard to one of its manufactured articles is secure for a fairly lengthy period. The process, however, will have to earn profits on a very large capital. The present capital is £800,000, and this has only sufficed to purchase the patent rights for this country (costing £125,000), and to erect plant absorbing 2,000 H.P. The output of this, taking the figures given in the prospectus as correct, will be 3,150 tons, 70 per cent. caustic, and 6,800 tons bleach per annum. At the present market prices this output will yield about £66,000 per annum. The interest payments on a capital of £300,000 at 5 per cent. will, however, absorb £15,000, and 10 per cent. depreciation on the £100,000, which may be assumed to have been spent on the plant and machinery of the first two 1,000 H.P. installations, represents another £10,000. We thus find that £25,000 of this £66,000 is demanded as surplus if the process is to prove an economic success, and the actual cost of manufacture for the quantities named, must, therefore, not exceed £41,000, or £13. 1s. per 1 ton 70 per cent. caustic soda, and 2·10 tons 35 per cent. bleaching powder. A reference to the table of costs given in the article already named (see *The Electrician*, February 12, 1897) will prove of interest in view of these figures. Time will show whether alkalies and bleach can be manufactured by the Castner-Kellner process at a cost not exceeding this sum.

With regard to the operation of these patents in U.S.A., the Niagara Electro-Chemical Company is already at work, and this Company is hoping to be in a position to pay a dividend as the result of their first year's work. The Matheson Alkali Company have also erected works at Niagara, designed to utilise 2,000 H.P. when fully completed, and their plant was expected to commence operations in September. This Company is to pay to the Aluminium Company, of Oldbury, England, a minimum royalty of £4,000 per annum for use of the Castner-Kellner process.

There have recently been rumours to the effect that the Electro-Chemical Company of St. Helen's, who own and work the Richardson and Holland process, were not prospering, and that the production of electrolytic alkali under these patents had ceased. These doubtless originated as a consequence of the non-publication of the last annual report, and of the retirement of the manager who had had control of the works from the date of the earliest experiments at Snodland, in Kent. On direct inquiry as to the truth of these rumours the writer is, however, informed that the Company is still producing alkali and chlorine by the Richardson and Holland process "with such improvements as experience has suggested." A Le Blanc soda plant has been added to the works in order to enable the Company to meet all demands for caustic soda, but bleaching powder is made *alone* by the electrolytic process. Chlorate of potash has been added to the products of the firm. The rumours are therefore—only rumours.

The Hargreaves-Bird process is still working upon an experimental scale at Farnworth, near Widnes. A much larger plant is, however, in course of erection by the St. Gobain Company at Chauny, near Paris.

An interesting comment on the significance of these developments of electro-chemical industry for the English Le Blanc alkali manufacturers (*i.e.*, the United Alkali Company) is contained in some facts given by Prof. Lungé in the 1896 volume of the "Mineral Industry Annual." In a short review of the chemical industries of Europe, Prof. Lungé points out that, prior to 1892, Germany was dependent upon Great Britain for her supplies of bleaching powder. In the year 1895 the production of bleach in Germany exceeded the home consumption by 2,500 tons; and in 1896 the excess of exports over imports was estimated to reach 6,000 tons. This change in the balance of trade is ascribed by Prof. Lungé to the progress of electrolytic methods of alkali and bleach manufacture in Germany since 1892.

MULTI-CIRCUIT ARC DYNAMO.*

The evolution that has taken place during the last few years from the small high-speed belted dynamo to the large low-speed direct-connected unit for incandescent lighting has left the generation of arc-light current in a comparatively very crude state. The arc-light dynamo has, to be sure, gradually increased of late years in size and capacity. As, however, any such increase necessitates a proportional rise in the voltage of the machine, the capacity of the dynamo, as ordinarily constructed, is necessarily limited by the maximum permissible voltage. If the pressure which is certainly fatal to human life is taken for a limit, the ordinary series machine is still far too small for a direct connection to large engines of high steam economy. Any means which are devised for increasing the capacity without increasing the voltage is therefore a notable gain. Such a means is the multi-circuit arrangement worked out by Mr. S. W. Rushmore, of the Rushmore Dynamo Works, Jersey City, New Jersey.

The accompanying illustration shows diagrammatically the machine as designed for two independent circuits. The machine is of the ordinary multipolar type, such as used for constant potential work, with the exceptions noted below. There are in these machines always just twice the number of poles that there are circuits to be supplied. The armature is of the closed-circuit single-winding gramme ring type. Around every alternate pole is mounted a pair of brushes. These brushes are supported on a bell-crank lever as shown, pivoted concentrically with the armature. This lever is free to swing under the control of an electromagnetic current regulator. The method of regulation is by moving the brushes under the pole faces, in that manner obtaining a back E.M.F. sufficient to reduce the pressure as desired. The lower pair of brushes shown in the figure are moved back to points almost centrally located between the neutral points. These brushes are working as indicated on a short-circuited line. The upper pair of brushes is working on full load, and is shown in the proper position for such a load—that is, on or near the neutral points of the commutator.

* Abstract of an article from the *Electrical World* of New York.

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It might be thought at first sight that the current entering through one brush would pass immediately under one pole to the opposite brush of the same circuit and thence to the lamps. This would give currents under alternate poles, the other half sections of the armature being entirely idle. Such, however, is not the case, as an inspection of the figure showing the current distributions will show. The current entering the armature from any brush divides, part going directly under the pole and part going the other way round under all the other poles. The division is, of course, inversely proportional to the resistance by the two routes, as the E.M.F. around both routes is under normal conditions the same. The

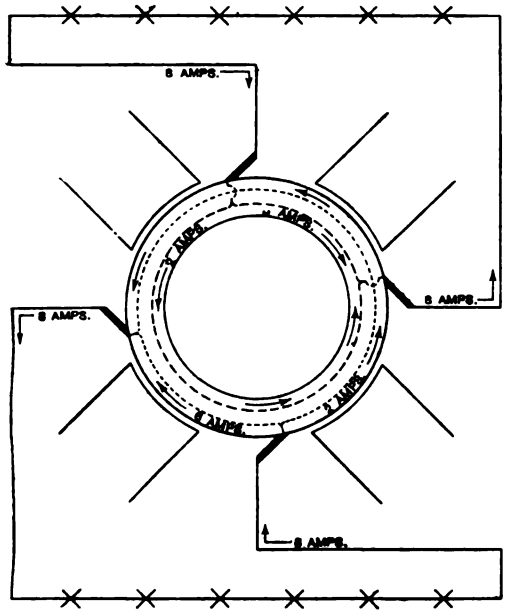

FIG. 1.—Diagram Showing Division of Currents in Armature.

division of 8 amperes current, for example, in a four-pole machine would be 6 amperes by the short route and 2 amperes by the long route, as the resistance of the latter is three times that of the former. By laying out these currents under the various poles and obtaining a proper algebraic summation of them it will be noticed that the current distribution is uniform under all poles, as in ordinary constant-potential machines.

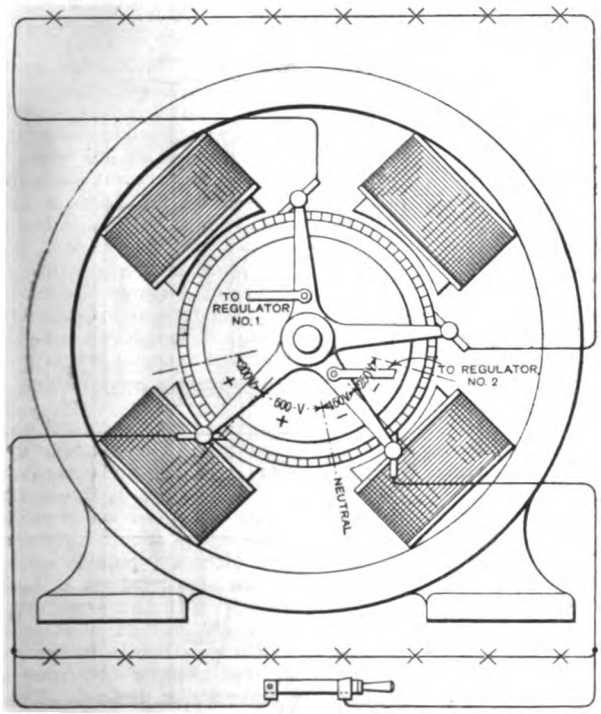

FIG. 2.—Two Circuit Dynamos, with one side loaded and one side light.

Tests have been made on a machine arranged on this principle at the Rushmore Dynamo Works. The machine was only an experimental one, and like most machines of that nature was rather a crude affair. The armature was a second-hand one, fitted to a commutator from another old machine and to fields of still a third machine, and with regulators from still a fourth machine of the arc type. The fields were separately excited. The machine was of the four-pole type, with two independent circuits, and was loaded with six arc lamps on each side. The arc lamps were of the shunt-control type, designed only for constant-potential work and quite unsuited for series work. In spite of all these disadvantages the machine showed remarkable results. With both sides fully loaded, one side was abruptly short-circuited; the lamps continued to burn steadily on the other side, showing almost entire independence. Both sides were then short-circuited, and one side abrutly opened; the machine ran on, giving no trouble. With one side carrying full load, the other side was intermittently short-circuited and pulled wide open, the lamps burning steadily on the first side. All possible combinations of short-circuit, closed and open-circuits were tried with ammeters and voltmeters in the circuits. The machine behaved admirably, adjusting itself to the different conditions as rapidly as the regulators could move under the influence of their dash pots.

Such tests seem to show that independent arc-light circuits can be operated from a machine in this manner without in any way mutually interfering with each other's proper action. If further experimenting with a larger and more perfect machine verifies this supposition, the arrangement will make an admirable one for very large units direct connected to large, slow-speed engines similar to the large units now used in lighting and railway work. Such a consummation is greatly to be desired, as the losses, rapid deterioration, and frequent accidents with small, high-speed belted units now in use, are a serious factor in arc-light working.

THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT'S ELECTRIC LOCOMOTIVE FOR HEAVY RAILWAYS.

This locomotive, shown in detail in the accompanying drawing, is intended either for goods or passenger traffic, or for shunting purposes. It is built for standard gauge (4ft. 8½in.), and in its design the standards and conditions for rolling stock laid down by the Prussian State Railway and the other German railway associations have been followed, so that the locomotive can be forwarded as part of a goods train on any line. To allow of this the current collector can be removed, so as to reduce the height of the locomotive to within the prescribed limits. The locomotive can draw a train weighing 120 tons at a speed of 31 miles an hour on the level. For adhesion under these conditions the total weight of the locomotive must amount to 20 tons. Ballast boxes are therefore provided, which can be filled with sand or other ballast. With the exception of the upper part of the cab and the flooring, the whole locomotive is made of iron and steel.

Underframe.—The underframe consists essentially of two longitudinal girders, formed of iron plates, well stiffened by strong ⊏-iron and plates framed with ⌊-iron. These girders carry the buffer boards and the fenders. The latter extend to within 2½in. of the upper edge of the rails, the distance between the buffers being 3ft. 4½in. The means of connection between the locomotive and the carriages follow more or less the lines of the rolling stock used on the Prussian State Railways. The principal plates of the framework carry brackets of sheet iron, strengthened with angle irons, which serve to support the body of the locomotive. The whole under frame is covered in with smooth and corrugated sheet iron. There are two axles, and the wheel-base is 8ft. 2½in., so that the locomotive has no difficulty in negotiating the sharpest curves. The diameter of the wheels is 3ft. 3½in., and they are made either of machined cast steel of such a construction as to allow tyres to be drawn on later, or of wrought iron with spokes and cast-steel tyres. The weight of the locomotive is supported by the journal boxes, on springs made up of fluted steel plates 3½in. wide and ½in. thick, held together at their centre by a strap. In order to distribute the load as well as possible between the two axles an equalising bar is fitted on each of the longer sides of the framework. This serves to transfer any excess of load from one of the springs to the other. The spring suspension is provided with nuts, by means of which the height of the buffers can easily be regulated. The brake presses two shoes against each of the four wheels. There is no difficulty in equipping the locomotive with an air brake; in that case the compressed air is obtained from a pump driven by a separate electric motor.

Cab.—The cab is shut in to protect the driver from inclemency of the weather, and it is provided with a sufficient number of windows. It is so situated in the middle of the truck that a platform 9ft. 10in. wide is left at each end. Each platform is accessible from the cab by a door, and the whole train can be seen from it. The platforms are surrounded by a tubular iron ballustrade, and there are two sheet-iron steps for mounting. As already mentioned the upper part of the cab is wooden. Within are the electrical

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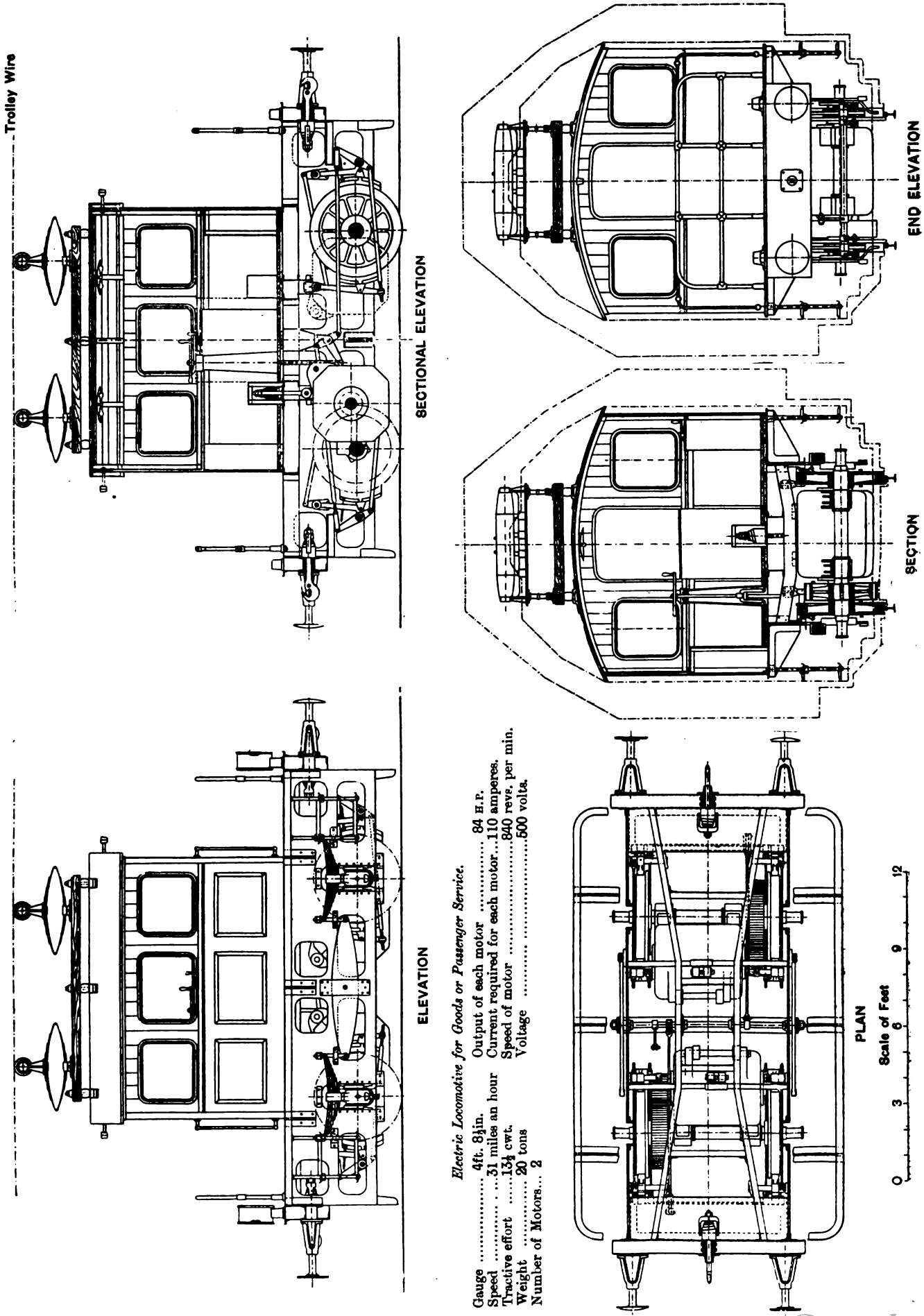

Electric Locomotive for Goods or Passenger Service.

Gauge	4ft. 8½in.	Output of each motor	84 H.P.
Speed	31 miles an hour	Current required for each motor	110 amperes.
Tractive effort	13¼ cwt.	Speed of motor	840 revs. per min.
Weight	20 tons	Voltage	500 volts.
Number of Motors	2		

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appliances described below and the brake lever. The latter is borne by a cast-iron pillar and controls all eight of the brake-shoes. On the walls under the windows are the ballast-boxes mentioned above, and a cupboard for the necessary tools. A signalling whistle is provided, worked by air from a small hand pump; if a locomotive is provided with an air-brake, the air for blowing the whistle is obtained from the air chamber. The floor of the cab is wooden and there are trap-doors through which the parts of the motor requiring lubrication are easily accessible. On the fore and hinder walls of the cab are supports for lanterns, to be used for two petroleum signalling lamps in case special signals should be required for some purpose.

Electrical Equipment.—Current is led to the locomotive from an overhead wire through two bronze rollers fixed on flat springs on the roof and pressing vertically upwards. A departure had to be made from the usual trolley construction to allow for the direction of motion being continually reversed, and also to avoid turning-points in the trolley wire as much as possible. A contact bar was considered inadvisable on account of the wear it occasions on the trolley wire at faster speeds. The use of a third rail and contact shoe is possible on overhead railways, but it could not be considered for the present purpose, first on account of the difficulties in insulation, and secondly because of the dangers of contact between the driving rails and the third rail. It would also be necessary to break it at points, crossings and at level crossings. To maintain sufficient contact surface between the wire and current collector as flexible wires as possible had to be employed. In order, therefore, to have the wires thinner and flexible, two wires are used instead of one. The wires are of 8mm. hard-drawn copper wire, their distance apart is 6in., and they are not insulated from one another. The wires are hung on special cables, and at their lowest point are 14ft. 6in. from the top of the rails. As no rolling stock may reach higher than 14ft. above the top of the rails a safe margin of 6in. is left. Wooden or iron posts with arms are used to carry the line, these being placed 130ft. to 262ft. apart, and the suspension cables are borne on insulators. The rails are used as return, and they are bonded for this purpose, and if necessary provided with feeders. The two motors are held between the axle boxes and underframe; they are directly supported by the axle boxes, but are suspended from the underframe by springs in such a way that only one-eighth of their weight is borne by the axles. The gear is single reduction, the ratio being 1:3. The motor pinion is of phospor-bronze, and the toothed wheel on the axle is in two parts and made of cast steel. These wheels have machine-moulded helical teeth to ensure smooth running, and the gear is boxed in.

The motors are, of course, series wound with cast-steel magnets, and iron clad, or rather steel clad. The upper parts of their cases are hinged so that the internal parts are easily accessible, and there is a special trap-door for the commutator. Slot winding is used on the armature. The motors can be removed from underneath without removing the cab or lifting the locomotive.

The controller is provided with two levers, one of which determines the direction of motion, and the other the speed. In the "off" position the motor is disconnected from the line and bridged by a resistance, so as to act as an electric brake. The controller levers can be removed only when they are in the latter position, and this automatically locks the controller drum. The speed is governed by the controller switching the motors in series or parallel and by regulating the excitation. The first step connects the motors in series with a resistance. This resistance is contained in a perforated sheet-iron box in the middle of the cab. The normal current required is about 150 amperes for each motor at 500 volts. The output with this current is about 84 H.P., and the maximum output some 150 H.P. In addition to the electrical equipment described there are cut-outs for each motor in an easily-accessible place within the cab, a lightning protector, and a switch to cut out either motor in case of its breaking down. The lamps on the locomotive are moreover electric, being connected to the line four in series. There are two lamps in each of the signal lanterns on the front and back of the locomotive, and four in the cab. The two lamps in the same lantern are in different circuits so that if one circuit becomes broken there is no great inconvenience.

CONDUIT CONSTRUCTION IN ST. LOUIS.*

BY FRANK CLARK COSBY.

(Concluded from page 871, Vol. XXXIX.)

Cement-lined wrought-iron pipe, the kind of duct selected for this work, has the characteristic of being easy to lay and joint, and can be rapidly installed, as it is made in 8ft. lengths, is very light in weight, which enables it to be handled with ease, and requires no particular skill in jointing. In a trench in St. Louis, in which twenty ducts were to be put in, 12,820ft. of pipe were laid in one day, requiring the services of an ordinary gang of men—36 concreters, 52 labourers, six bricklayers, and six helpers, with six overseers. The trench in this case was open and the work included the building of one and one-half manholes and four handholes as well. But on the preceding day, with a gang of 108 labourers, 40 concreters, five bricklayers, and five helpers, with seven overseers, a ditch 1,177ft. long was opened, five ducts put in, and the whole filled in and finished before quitting-time that night, including work upon the manholes and handholes intervening. These "runs" are to be considered more in the light of "record runs," than common practice, perhaps, but show what can be done under favourable conditions—an average of 5,000 duct feet a day, complete, being the usual run.

The pipe itself consists of a wrought-iron shell of No. 26 B.W. gauge, tarred upon the outside to prevent rusting, rivetted every 2in. for security, and lined inside with a layer of pure Rosendale cement $\frac{3}{8}$in. thick. The internal diameter is 3in., making the external diameter approximately 4$\frac{1}{2}$in., and by some special process the interior surface of the cement is highly polished, thus removing all roughness, which would be a source of considerable trouble when it becomes necessary to draw in cable. This pipe is made in lengths of 8ft., which weigh between 40lb. and 48lb., and is fitted with an iron casting on each end for a male and female joint. After the pipe is made at the factory it is allowed to harden from ten days to two weeks before being sent out for use.

In laying this pipe, the general plan adopted for all such work has been followed: grading the trench so as to drain properly, putting in a bed of concrete 3in. thick, then the pipe, surrounding it on the sides with 3in. of concrete, and covering it on top with a layer also 3in. thick. This concrete is made of one part American Portland cement, 2$\frac{1}{2}$ parts sand, and five parts crushed stone; the pipe is laid 5$\frac{1}{2}$in. between centres, with a 1in. bed of concrete between layers. The joints in adjacent ducts and layers are not broken, and so occur in the same vertical plane, the individual joints being surrounded by a mould or casing of cement mortar, mixed one part cement to two of sand. The usual depth at which the pipe is placed is 5ft. below the surface for the bottom layers, though, of course, this depth is dependent upon the number of ducts to be used, as care must be exercised not to get the top layer too near the surface.

On top of this pipe is placed the "three-wire Edison tubing," which is used to a certain extent by the light and power companies doing the work for local distribution, and is therefore placed as near the surface as possible, leading into shallow handholes which are located wherever most convenient for connection to buildings, usually averaging 80ft. apart. This tubing consists of sections of iron pipe 20ft. 6in. long, and of a diameter dependent upon the size of the conductors inclosed—2$\frac{1}{2}$in. in diameter for a pipe containing three conductors of 250,000 circular mils. each, the size most generally used, though these conductors range from 200,000 to 500,000 circular mils. This tubing is made by taking three conductors of the desired size and insulating them from each other, usually by means of a wrapping of jute or cotton string, pulling them into the tube with the ends projecting for connecting and sealing the ends with some special compound. The short sections are then joined together by a stranded flexible coupling, soldered to insure good contact, and then surrounded by a cast-iron coupling box of two parts, bolted together and afterwards filled with hot compound to seal it and keep out moisture. The handholes are made 3ft. by 3ft. and 3ft. by 4ft., and are 2ft. deep, and support an iron frame weighing about 800lb., which carries a small solid cover, weighing perhaps 250lb. The walls are 9in. thick and are made of hard-burned sewer brick. The bottoms are concreted to a depth of 3in., and in many instances the top layer of the cement-lined pipe opens into the handholes beside the Edison tubing, which affords a twofold system of distribution.

The regular manholes are placed at the intersections of streets, and range in size from 8ft. by 8ft. the larger, to 5ft. by 5ft. the smaller, both having 6ft. 6in. head room in the clear. They are built with 13in. walls of hard-buredn sewer brick, have a concrete bottom 8in. thick, with a sewer connection where practicable, consisting of a trap and valve. Where it is impracticable to put in a sewer connection a pipe 18in. in diameter is sunk in the bottom and the bottom graded down to drain into this pipe, from which the water can be easily pumped out when necessary; this pipe or sump is usually covered with a grating to keep out dirt and refuse matter. The roof is made of 5in. I-beams and brick arches, and supports a heavy iron frame weighing between 800lb. and 900lb.; this frame carries a rectangular cover weighing 200lb., grated for purposes of ventilation, of dimensions 30in. by 30in.

THE BELL TELEPHONE COMPANY'S CONDUITS.

The Bell Telephone Company of Missouri, at present the only local telephone company in operation here, has always borne in mind the advantages and possibility of placing its wires under-

* Abstract of an article in the *Electrical World* of New York, Aug. 21, 28 and September 4, 1897.

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ground, which is shown by the fact that its telephone building was erected with a view to having an underground service—an arch being made in the walls and space being left in the cellar for the entrance of the ducts, and a cable shaft built from the basement to the sixth floor, where the exchange was to be located. The general plan upon which its system is laid out is as follows: there are three main trunks or backbones, and from these trunks the mains branch out, the secondaries or distributing lines coming off these mains. In the busy district these mains run to manholes at the entrances to the alleys and from these manholes up the alleys through secondary distributing ducts to a manhole in the centre of the block, the necessary number of wires being tapped off through underground laterals to the buildings they are required to feed. These laterals may take either a single circuit for one telephone or a cable of any number of circuits for all the telephones in an office building. In the less busy districts the mains run on alternate east and west streets to a manhole at the intersections of the alleys, from whence a secondary line is run either way to a pole at the entrance of the alley, and the distribution effected from a cable box by short overhead lines in the alley to the telephones of the subscribers.

This company selected the hollow brick tile conduit as the best for its purposes, considering it the most durable, easiest for drawing in cable, and on account of its short length when well laid making a straighter and truer system, and with a very much lower percentage of loss due to breakage. This saving, however, is partly counterbalanced by the cost of laying and jointing a conduit of single duct formation, though it proves most serviceable when obstructions are met and have to be circumvented, where curves in the conduit construction are found to be necessary, and where "tapering" is desired. The tile furnished was made by a local firm in 18in. sections, 3¾in. circular opening, §in. wall and octagonal exterior, at a price of about 3½ cents per duct foot, from sewer pipe clay burned moderately hard and glazed inside and out. It is laid 5½in. between centres, the interstices being filled with cement mortar and with a half-inch layer spread on top of the tier of ducts. The joints are made abutting with a layer or casing of mortar surrounding them, one part of cement to two of sand, and are broken vertically and horizontally, a mandril being drawn through to preserve the alignment and prevent the mortar from entering the duct. The mandril consists of a piece of wood, 3ft. long, that will just clear the duct, and has a cleaning washer attached to the inner end and a hook for withdrawing at the working end.

The conduit is laid upon a concrete foundation ranging from 4in. to 6in. in depth, according to the number of ducts to be laid, the width of trench being almost uniformly made to accommodate four ducts laid side by side, and is protected upon the sides with from 3in. to 4in. of concrete with 4in. on top as an encasement. This concrete consists of one part cement, three parts sand, and six parts broken stone, all the cement used being a superior brand of American Portland. Although the city regulations only require a space of 20in. from the top of the pavement to the top of the ducts, the practice of the engineers of this company has been to place their ducts an average of about 36in. below the surface where heavy traffic in the streets is expected. It is also their practice to go under rather than over obstructions, although under exceptional circumstances a "split" might be made, going both over and under the obstruction.

The average length of a block in St. Louis is from 300ft. to 400ft., and unless something unforeseen arises the street is not kept open over three days, one day being required to open the trench and put in the concrete foundation, which is left over-night to set; a second day allowed for the laying of the duct and putting in the concrete encasement, which is also allowed to set over-night; and on the third day the filling-in is done, concrete for the street put in and repaving completed, finishing the work on the street, with the exception of the manholes. This trench work requires the employment of about 30 labourers, 6 pipe-layers and their helpers, 10 concrete men, and 6 pavers and helpers for a trench in which 20 ducts are installed.

Besides this hollow brick tile two other styles of conduits are to be used in this work, "four-duct tile" and "distributing conduit," both made in St. Louis by the Blackmer and Post Pipe Company, and composed of hard-burned clay, with a salt-glazed surface. The four-duct tile consists essentially of a clay trough with three partitions, forming four rectangular compartments 3¾in. wide by 4in. high, the walls being 1in. thick. It has been made in 2ft. lengths only, weighs about 85lb. to a section, and costs between 4 cents and 5 cents per duct foot. It can only be economically used as at present made where multiples of four ducts are installed, and is built up one section on top of another, the bottom of an upper layer forming the top of an under layer, the bottom being fitted with a groove to tongue into the walls of the section underneath. As in laying all styles of conduit, the concrete encasement on the sides is put in with each successive layer of conduit, the foundation and general work being the sameas for the hollow brick tile. The top of the top layer consists of a plane sheet of mild steel, No. 22 gauge, bent to lap over the sides to keep it in place and then covered with concrete. The tile was made as an experiment and proved eminently satisfactory, as it can be very rapidly laid, about 2,500ft. being put in by one pipe layer and helper in a day. Of this style of conduit about 2,000ft. have been put in.

The distributing-duct conduit is another kind which has been laid down here for the first time. It consists of a trough divided by two vertical partitions into three ducts, with openings 4in. wide and about 7in. high. The centre one of these ducts is divided again by a horizontal partition, the opening of the lower portion being 4in. square. This lower central duct is for the main cable running to the manhole in the alley in the centre of the block. From here it branches out through a junction box to the distributing wires, which are run in the two 4in. ducts on either side of the central one. The service wires are run out to the buildings, to be connected on either side through underground laterals consisting of 3in. iron pipe. The shallow upper duct over the main cable duct is for the rodding and the drawing in of additional wires in the distributing ducts, a runner with projecting arms extending over the distributing duct being pulled in here, the rod wires being drawn into the distributing ducts from these arms without in the least disturbing the wires already in place. This duct is simply for the use of this runner, and when not in service remains empty. The cover for the trough, like the four-duct tile, consists of an arched sheet of mild steel, No. 22 gauge, lapping over the sides and supporting a concrete roof above until it sets. It is expected to use this distributing duct in conjunction with the main feeders of hollow brick tile, as the secondary conduits in minor streets and alleys, this plan of distribution and the form of the conduit being designed by Mr. W. H. Johnston, an engineer of the telephone company, who has the direct supervision of all this work. It costs the same at the four-duct tile, is made in 2ft. lengths, 15in. wide and 6in. high, and about 60,000 tile feet will be put underground. Where obstructions have to be surmounted or circumvented, the distances being short and curves sharp, the use of iron pipe, 3½in. in diameter, has been decided upon, about 12,000ft. being employed throughout the system, joints being made by the usual iron coupler.

In the construction of manholes four sizes have been adopted, depending upon the number of ducts entering the hole, 3ft. by 3ft., 4ft. by 4ft., 5ft. by 5ft. and 6ft. by 8ft., the 5ft. by 5ft. predominating, and all having 5ft. head room. The smaller sizes have 9in. walls, and the larger 13in. walls, all having 4in. concrete bottom with sewer connections, where practicable, and a 10in. concrete roof, supported by I-beams, with rectangular opening, having a 24in. by 30in. cover. Under this roof rests a cast-iron frame weighing 350lb., having a 200lb. steel cover fitted with a gravity latch to lock the cover when closed. The brick used is a hard-burned sewer brick, making the vault moisture proof, and where there seems to be no indications of gas collecting in the manhole a solid cover is used; where gas is anticipated a ventilated grated cover is put on, having a dirt pan underneath to catch surface dirt.

Where the ducts lead into the telephone building on Tenth-street a very large vault has been made, 12½ft. by 24ft., with 8ft. head room and 18in. walls. These walls are made with a 1in. air gap on the inside course to exclude moisture, a sewer trap and connection being placed in the bottom of the vault. The bottom is concreted and the top made of the usual I-beam and concrete construction, an entrance being effected through an opening in the top. In the south wall of this manhole 25 ducts open, in the north wall 86 ducts open, being three sets of ducts, four ducts to a layer, each set having a separate and distinct concrete encasement and being separated from the next adjoining set by 1ft. of concrete. The easternmost set consists of 23 ducts, and is for the main trunk supplying the eastern part of the city; the middle set contains 24 ducts, and is the main line providing for that part of the city north of the centre of distribution; the westernmost set has 39 ducts, and is the backbone going west, and taking in all the western end of the city, the main residence portion.

This work when completed will comprise about 20 miles of trench, 600,000 duct feet of conduit, and 425 manholes, and will cost at a rough approximation $400,000. The cost of the manholes, including covers and sewer connections, is estimated to be as follows: 3ft. by 3ft., $55; 4ft. by 4ft., $60; 5ft. by 5ft., $75; and 6ft. by 8ft., $90; it being shown that two masons and a helper can construct one of the large-size manholes in a day.

BOOKS RECEIVED.

"The Bibliography of X-Ray Literature and Research." 1896-97. By C. E. S. Phillips. (London: "The Electrician" Printing and Publishing Company. Price 5s.)

"Students' Guide to Submarine Cable Testing." By H. K. C. Fisher and J. C. H. Darby. (London: "The Electrician" Printing and Publishing Company. Price 6s. nett.)

"Fortschritte der Elektrotechnik." By Dr. Karl Kahle. Year 1897. Second Number. (Berlin: Julius Springer.).

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A LIGHTNING PROTECTOR FOR TELEPHONE INSTRUMENTS.

The Western Electric Company have sent us a description of a compact and useful lightning protector, which is the outcome of practical tests on the American Bell Company's systems. Fig. 1 illustrates its general appearance, its weight being but 35oz., and the dimensions of its base 7½in. by 4in. Its price is also very

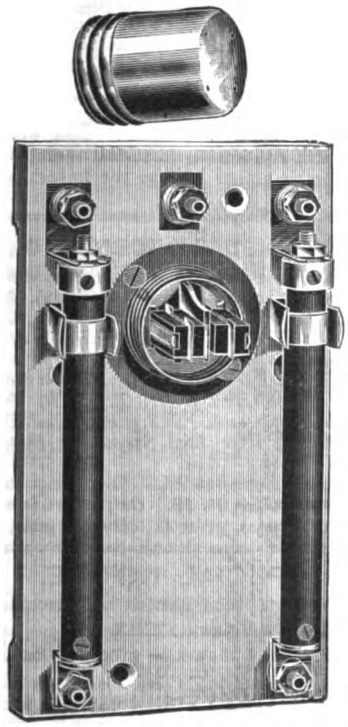

FIG. 1.

moderate. Each line is connected through a fuse and "heating coil" to the terminal of the subscriber's telephone instrument, and the junction of the fuse and heating wire is connected to one plate of a carbon lightning arrester, the other plate being earthed. High-pressure discharges will be conducted to earth through the

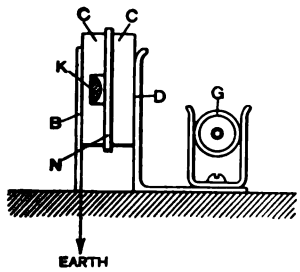

FIG. 2.

lightning arrester, currents of over 5 amperes will melt the fuse wire, and prolonged currents of lesser value will cause the "heating coil" to break the line connection.

The carbon-plate arrester consists of two rectangular blocks of carbon CC (Fig. 2), between which a definite separation of

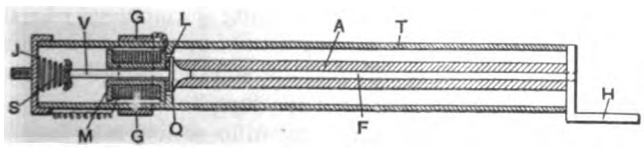

FIG. 3.

0·0055in. is maintained by means of a U-shaped mica separator, N, whose thickness is, of course, considerably exaggerated in the diagram. Carbon plates are used in preference to metallic ones because they do not get welded together, and also because for a given voltage the separation between them may be greater than with metallic plates. The carbon plates are clamped between two flat springs B and D, one of which is connected to earth and the other to the metal ring G of the tube which contains the fuse wire. One of the carbon plates is made with a slight cavity in its sparking surface, and a small globule, K, of low-melting alloy is placed in this cavity. When a sudden discharge occurs, the device operates in the same manner as an ordinary lightning arrester; that is to say, an arc is formed between the two carbon plates. If the discharge is prolonged, the globule of low melting alloy fuses, and flowing between the plates, puts the line to earth, extinguishing the arc. When this happens it is, of course, necessary to renew the carbon plates.

The fuse-tube T (Fig. 3) is made of vulcanised fibre, and contains a fuse wire, F, made of a special alloy and surrounded with an asbestos braiding A. The asbestos prevents sparking. The diameter of the wire is such that it fuses with a current of 5 amperes. One end of the tube is provided with a terminal, H, for connection to the line binding post. Near the other end is the metal ring GG, set in the clamp, from which earth connection is made through the carbon-plate arrester. At the extremity of the tube is another terminal J, from which connection is made to the subscribers' apparatus. Between the metal ring GG and the terminal J is placed the heating coil M.

Around a small metal tube, M, is wound 27 ohms of german-silver wire, R. Within the tube is a glass pin, V, which is pressed against the disc Q by a spiral spring, S. The disc Q is soldered with a low melting alloy, L, on one side to the metal tube M of the coil, and on the other side to the fuse wire F, before described. A current passing through the german-silver wire for a sufficient length of time heats the tube, melts the alloy, and so releases the disc soldered to the tube L. The disc Q is thus forced back by the glass pin V, which is acted upon by the spring S. The connection of the fuse F with the heating coil and the arrester is severed, and the line is automatically broken.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 5th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Inaugural Meeting of the 17th Session at the Westminster Palace Hotel. Presidential address by John A. F. Aspinall.

RÖNTGEN SOCIETY.

9 p.m. Opening Meeting and Exhibition at St. Martin's Town Hall, Trafalgar-square, W.C. Presidential address by Prof. Silvanus P. Thompson, F.R.S.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. First Business Meeting of the Session in the Lecture Hall of the Literary and Philosophical Society of Newcastle-upon-Tyne. Business: (1) Minutes of the Closing Business Meeting of last Session will be submitted for confirmation; (2) The ballot for New Members will then be taken; (3) The Council will submit for adoption the Thirteenth Annual Report and Financial Statement; (4) Opening Remarks by the President.

MONDAY, November 8th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Palatine Hotel, Hunt's Bank, Manchester. Paper to be read: "The Distribution of Electrical Energy," by C. H. Wordingham.

TUESDAY, November 9th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Four Papers on "The Manchester Ship Canal," by Sir E. Leader Williams and Messrs. Whately Eliot and W. O. E. Meade-King will be read.

THURSDAY, November 11th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting at 25, Great George-street, Westminster, S.W. Paper to be read: "Accumulator Traction on Rails and Ordinary Roads," by L. Epstein.

FRIDAY, November 12th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Isothermals of Ether," by J. Rose-Innes; (2) "On the Variation with Temperature of the Electromotive Force of the H-form of Clark Cells," by F. S. Spiers and F. Twyman.

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Wednesday noon.

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The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878)

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SCIENTIFIC SOCIETIES.

Once more has commenced the cycle of activities of the numerous scientific societies in London and the provinces—to say nothing of America and the Continent—and in a few days they will be in full swing with their brand-new programmes for the winter session. At such a time it is instructive to take a comprehensive view of these institutions—to study these products of modern civilisation as a number of correlated units forming an organic whole. What is the relationship of their several individual purposes to their purpose as a combined organisation? Perhaps it may be contended that they have no unified purpose, that the idea of combined organisation has never entered into the scheme of their existence. Yet, even though there be no such inter-relationship professed and openly practised, it can scarcely be denied that such exists, as it were, subconsciously. We may at least hope that, bearing some resemblance to the ultimate though unconscious Purpose which Hegel conceived to subsist in all human affairs, the aggregated activities of the scientific and learned societies of the present day are tending harmoniously to the working-out of an orderly development of science and learning—that "one increasing purpose runs, and the thoughts of men are ripening with the process of the suns."

The grounds upon which a scientific society may base its separate existence are many and varied. Among the institutions formed in the interests of pure science there are those which, like the Physical and Chemical Societies, depend upon a more or less natural partitioning of science into fragmentary portions; while others owe their origin to quite different considerations, and though composite from a

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purely scientific point of view, are conveniently allowed a separate existence. Astronomy, for example, is a compound of mathematics, physics and chemistry, and is in no respect a natural *branch* of science; but inasmuch as it deals with a special group of phenomena, viz., those of the heavenly bodies, the existence of a Royal Astronomical Society, or a British Astronomical Association, is perfectly reasonable and useful. But while it is often logical to take a special class of phenomena and make it the basis of a scientific society, it is sometimes inconvenient to do so. Thus, to establish an Electrical Society would enlist such widespread and far-reaching interests as would defeat the object in view; for the new Society would find itself without any natural boundary to its activities, and would ever be roaming over the fields of its neighbours and far beyond. Turning from societies formed for the study of pure science to those which devote themselves to the applications of science, we may also distinguish the operation of a very natural selection in the partitioning of the whole domain of applied science into the various sections. It is unnecesary to labour the point by the citation of instances that will readily occur to the minds of our readers. Suffice it to say, that in the whole range of societies having a legitimate existence, whether in the interests of pure or applied science, there is evidence of harmonious inter-relationship combined with judicious confinement within limits. Each such society has its appointed definite *locus standi*, and is careful not to tread on the toes of its neighbours.

To-night a new scientific society will commence its public career. Among the numerous institutions formed in the interests of various branches of pure and applied science that seemed to have left little, if any, ground uncovered, a place has been found for one that is to be devoted to matters relating to Röntgen radiation, which has been styled the Röntgen Society. The honour of being the first president of this new fraternity worthily devolves upon Prof. Silvanus P. Thompson, whose important share in past researches on Röntgen rays is thus fitly recognised by his colleagues. Dr. Thompson will deliver his inaugural address to-night at the opening meeting, which will be held at St. Martin's Town Hall, and the address is to be followed by a conversazione. We are not yet sure that the particular class of phenomena in which this new association is interested really constitutes a natural and separate branch of science. In a review which immediately follows our leading article, it will be seen that Dr. Thompson himself inclines to the view that Röntgen rays are a species of light, and that their study belongs to Optics. There is great uncertainty about the matter. Nor does it seem that any of the known practical uses of Röntgen rays lie beyond the ground already covered by existing societies. The study of the nature and cause of these rays belongs properly to the Physical Society, which unfortunately is not so overburdened with Papers that it can afford lightly to esteem, or reluctantly to be deprived of, those relating to Röntgen radiation. And systematic investigation of the practical uses to which the phenomena may be put may justly be claimed for the existing institutions, devoted severally to photographic, medical, surgical, chemical, and other branches of applied science. On the one hand, the new society attaches itself to what has not yet been proved to be intrinsically and essentially new and distinct as a class of physical phenomena; on the other hand, it enters into competition with numerous well-established associations We trust, however, that youthful vigour and a robust constitution will enable it to make a good start and to live to ripe old age. The Röntgen Society has our best wishes for its success.

REVIEWS.

Light, Visible and Invisible. By Prof. Silvanus P. Thompson, D.Sc., F.R.S. (London: Macmillan and Co. 1897.)

What is light? Upon the answer to this question must depend whether or no light may be distinguished as visible or invisible. The popular association of the term "light" with that which gives rise to visual perception may prompt the question, When is light invisible? But then the remembrance of an ancient experiment, in which a ray of light was passed transversely across a dark, dustless tube, and was shown to be invisible in itself, might suggest the alternative question, When is light itself ever visible? We may safely ignore the popular idea of light, and, with Dr. Thompson, may apply the term to all rays kindred to those which excite perception; but we meet a more serious obstacle in the objection that light rays of any kind are never visible. It would seem that the common distinction between visible and invisible light arises from the perfectly correct distinction between the visible and the invisible part of the spectrum—a very different matter; and, judging by the chapter headings, this has been the basis of classification adopted by the author of the book before us.

This little volume is something more than a reprint of the series of lectures delivered by Dr. Thompson at the Royal Institution, at Christmas, 1896. To each reprinted lecture there is appended a useful series of notes and comments that serve to lift the book out of the purely elementary and popular, and to enhance its value as a students' introduction to the study of optics. Lecture I. is on "Lights and Shadows," and is treated in a modified system of geometrical optics which has been extensively developed by the author. The essential feature of the new method is to direct attention to the wave front rather than to the source of light. It is worthy only of an obsolete school of action-at-a-distance physicists to attach importance to the distance between a wave front and the light source from which it started some time before. The moment a wave is sent out from a light source it ceases to have any physical connection with that source, and its future career depends only on the reaction between the wave and its immediate environment. Dr. Thompson gives the following explanation of his method:

> In treating optics from the new standpoint, we have to think about surfaces instead of thinking about mere lines. Waves march always at right angles to their surfaces; a change in the form of the surface alters the direction of march. The wave surface is to be considered instead of the "ray." The curvature of the surface therefore becomes the all-important consideration. *All that any lens or mirror or any system of lenses or mirrors can do to a wave of light is to imprint a curvature upon the surface of the wave.* If the wave is initially a plane wave, then the curvature imprinted upon it by the lens or mirror will result in making it either march towards a point (a real focus) or march as from a point (a virtual focus). If the wave possesses an initial curvature, then all that the lens and mirror can do is to imprint another curvature upon its surface, the resultant curvature being simply the algebraic sum of the initial and impressed curvatures. As will be seen, in the new method the essential thing to know about a lens or mirror is the curvature which it can imprint on a plane wave; that is, indeed, nothing else than what the opticians call its "power," the focal power being inversely proportional to the so-called focal length.

Passing over Lecture II., entitled "The Visible Spectrum and the Eye," in which are dealt with in an admirably lucid and comprehensive manner the essential principles of colour perception and refraction, and the succeeding lecture on "Polarisation of Light," which is equally praiseworthy in regard to the wonderful way in which its subject is made so clear that babes and sucklings can comprehend it, we come to the first indication of invisible light in Lecture IV., which, together with Lecture V., treat of "The Invisible Spectrum." The author quite early defends the use of the term "invisible":—

> Perhaps you raise the objection that if such waves are invisible they cannot be waves of light. Well, if you were to lay down as a definition beforehand that the term "light" must be applied only to the waves that are visible to the human eye, there is nothing more to be said. But what if there are other eyes, or other processes that will enable these waves to be observed? Further, if it is found that these invisible waves agree with the visible waves in other important respects; if, in fact, it is found that

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they can be reflected, refracted, polarised and diffracted, then we are bound to regard them as *light*. They may have wave lengths that are larger than that of the red waves, or smaller than that of the violet waves, and so our eyes, with their limited range of perception, may fail to be sensitive to them. Nevertheless, if in their physical properties they agree with the visible kinds, then the fact that to us they are invisible simply demonstrates the imperfection of our eyes.

The contention is in strict accord with the modern views of optical phenomena; and, the matter thus settled, the author passes on to discuss the properties of the spectrum, and, by easy transitions, the phenomena of luminescence, fluorescence and similar effects of rays that fall beyond the visible spectrum. Passing from the ultra-violet to the infra-red region, in Lecture V., we are taken down the scale of ether waves until we finally come to the region explored by Hertz, and the latter part of the lecture is an interesting summary of the work done by Hertz in this branch of electro-optics.

In the "Introduction" to the little work before us Dr. Thompson says that "two things are expected of a lecturer who undertakes a course of Christmas lectures at the Royal Institution. In the first place his discourses must be illustrated to the utmost extent by experiments. In the second, however simple the language in which scientific facts and principles are described, every discourse must sound at least some note of modernity, must reflect some wave of recent progress in science." We wonder how many physicists, if asked before the lectures were delivered, would have guessed that the "note of modernity" selected for a course of lectures on Light would deal with Röntgen rays? Dr. Thompson's last lecture bears the sufficiently startling title, "Röntgen Light," which would seem to indicate that he, at any rate, had no doubt of the appropriateness of the selection—a certitude, however, which is not so evident in the text:—

You will have noticed that I have spoken of these rays as "Röntgen light." But are we really justified in calling it light? It is invisible to our eyes; but then so also is ordinary ultra-violet light, and so is infra-red light, and Hertzian light. And there are other kinds of light, too, amongst them one discovered during last year by M. Becquerel and myself, which are invisible. But if the Röntgen light can be neither reflected nor refracted, neither diffracted nor polarised, what reason have we for calling it light at all? In fact, direct proof that it consists of transverse waves is wanting. Many conjectures have been formed respecting its nature. Röntgen himself suggested that it might consist of longitudinal vibrations. Others have suggested ether streams, ether vortices, or even streams of minute corpuscles. At one time the notion that it might be simply an extreme kind of ultra-violet light of excessively minute wave-length was favoured by physicists, who were disposed to explain the absence of refraction and the high penetrative power of the rays upon Von Helmholtz's theory of anomalous dispersion, according to which the ultra-violet spectrum at the extreme end ought to double back on itself. The most probable suggestion yet made, and the only one that seems to account for the strange lateral emission of the rays right up to the plane of the anti-cathode, is that of Sir George Stokes. Stokes's view is that while all ordinary light consists of trains of waves in which each ripple is one of a series that gradually dies away, the Röntgen light consists of solitary ripples, each of not more than one or one and a-half waves.

As a matter of fact, not only is the alleged Röntgen "light" invisible and all the rest of it, but it differs from every other kind of ether wave, if such indeed it really be, in not being capable of physically illuminating any object on which it falls. When invisible light rays fall on an object it is only our visual defects that prevent us from seeing the object illuminated thereby; but when the so-called Röntgen light falls on an object it is not merely visual defect, but the physical conditions of the object that prevent anything corresponding to illumination from taking place. The rays emitted from a fluorescent screen upon which Röntgen rays fall are totally different from the rays exciting them; whereas with every other kind of light the rays emitted are of the same nature as the rays that excite them, and differ only in degree. It requires, therefore, in the present state of development of the subject, considerable stretch of the imagination to regard Röntgen rays as light.

Trasmissioni e Distribuzioni Polifasi. By Prof. RICCARDO ARNÒ. (Turin: Unione Typografico-Editrice, 1897.)

This is a little *brochure* of 54 pages length, containing some notes on the theory and practice of the polyphase system of electrical distribution of power. The opening chapter discusses general considerations in a couple of pages; then comes Chapter I., on the current and potential distributions of polyphase systems, in relation to the several systems of winding and connection adopted in practice. Chapter II. discusses, in order, the star-winding, the delta-winding, various methods of measuring potential, and the calculation of conductors. Chapter III. deals with methods of transforming two-phase into three-phase systems and *vice versâ*, and gives brief accounts of the systems of Scott and S. P. Thompson. The succeeding chapter similarly treats of the transformation from single-phase to polyphase systems, and notices briefly the Ferraris-Arnò system and other methods of converting from simple periodic currents to two-phase or three-phase currents. Some account of the Steinmetz monocyclic system is given in the next section, and is illustrated by some good diagrams. The little volume will be read with profit and interest by those who are desirous of learning the rudiments of this branch of engineering.

Die Galvanischen Batterien, Accumulatoren und Thermosäulen. Eine Beschreibung der Hydro- und Thermo-elektrischen Stromquellen mit besonderer Rücksicht auf die Bedürfnisse der Praxis. By W. PH. HAUCK. (Vienna: Hartleben, 1898.)

We cannot say that we think the promise conveyed in the title of this book has been altogether fulfilled; for instance, concerning the source of E.M.F. in a cell, the author states that "the acid dissolves the zinc, exciting thereby the E.M.F., the latter separates the electricities, driving the negative to the zinc, the positive to the liquid. From the latter it is led away by the cathode to unite in the connecting wire with that coming from the zinc, whereby the magnetic, thermal, physiological and chemical effects already noticed are produced." This explanation is scarcely in accord with modern theories on the subject, nor is it useful in paving the way to the understanding of them: and the ionic hypothesis which has already proved of so much practical value in dealing with the problems presented by electrolysis is not even alluded to throughout the book. If the general chemistry involved in electrolytic processes is thus weak, it is not surprising to find that the theory of the chemical reactions which occur in the working of secondary batteries is very inadequately discussed. In fact, so far as the theoretical part of the book is concerned, it does not seem to have been revised since the first edition appeared some seven years ago. With the portion of the book, however, which deals with cells and thermopiles, the case is different. These are well classified, and the illustrations, which are numerous, are good. The description of the various forms of primary batteries in existence occupies nearly 200 pages, and the contents of these should effectively give pause to the would-be inventor of a new cell. The various types are classified, under convenient headings and sub-headings, which makes reference to any particular form easy. It is surprising to see what a large number of variations have been possible in the arrangement of the few materials suitable for the construction of a cell. But unless some great reduction should take place in the price of zinc, or the difficulties connected with the use of coal or some cheap form of carbon as the soluble electrode are overcome, it does not appear probable that the field of usefulness of the primary battery will be materially extended. In the case of secondary batteries, too, their number is legion, although here the choice of materials is reduced practically to lead, lead peroxide and sulphuric acid. It is noticeable that the marked superiority which the leading modern cells display over the older forms is due principally to numerous small improvements which have been effected from time to time in the method of construction and the arrangement of the parts. The chapter on the employment of secondary batteries suffers from the same defect as that which has already been noticed with reference to the portion of the book dealing with electrolysis; that is, it has not been brought up to date. We are given an account of the classic experiments, which were made in the early eighties, on the application of the cells to driving vehicles and launches; and even with regard to telegraphy, the most recent example given dates from 1889, and yet this book bears on its title-page the date 1898.

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THE FERROMAGNETIC PROPERTIES OF IRON AND STEEL.*

BY PROF. J. A. FLEMING, D.SC., F.R.S.

(*Continued from page 21.*)

It will be noticed that if any number of positively-charged and negatively-charged atoms built up into a molecular structure are revolving round an axis, the system has resultant magnetic moment if the algebraic sum of a series of quantities, each one of which is the product of the electric charge (e) of an atom, and the square of its distance (r) from the axis or centre of revolution, giving to e the *plus* or *minus* sign, according as the charge is positive or negative, has any finite value. It is, therefore, desirable to call this summation quantity $\{\Sigma(er^2)\}$ the *electric moment* of the molecule. It therefore follows that if a molecule consists of a number of positively-charged and negatively-charged atoms revolving round an axis of revolution N times a second, the magnetic moment m^1 of that molecule will be given by the value of the expression

$$m^1 = \Sigma(er^2) \cdot \frac{\omega}{2v},$$

where ω is the angular velocity of the molecule round its axes, and v is the constant 3×10^{10} and $\Sigma(er^2)$ (which may be written I^1) is the electric moment of the molecule. This last quantity is analogous to the moment of inertia $\Sigma(mr^2)$, only in taking the sum constituting the electric moment we have to pay attention to the *sign*, whether *plus* or *minus*, of each atomic charge e.

Hence we have the relation

$$m^1 = I^1\omega \frac{1}{2v},$$

or the magnetic moment of the molecule is proportional to the electric moment. Hence we can state that such a system of electrified atoms or *electrons* in orbital motion has a magnetic moment if it has an electric moment.†

The great difference between ferromagnetism and paramagnetism or diamagnetism seems to indicate that the first is a physical quality of a special kind, and we need not therefore be led aside into a discussion of how far the above hypothesis could be used to account for the small differences in magnetic susceptibility between the two latter classes of bodies.

It is clear that if a molecule, consisting of electrified atoms held together by their electric attractions, is set in revolution, it is possible to give it a speed of revolution so great that the centrifugal action breaks up the molecule, and it is also clear that if a four-atom molecule, as above supposed, breaks up into two two-atom molecules, the magnetic moment of each pair would be zero. Hence the other part of the hypothesis, I suggest, is that rise of temperature in ferromagnetic metals, has, as part of its effect, an increase of the angular energy of rotation of the molecules to such a point, that the molecules, having an electric moment at lower temperatures, break up into molecules having no electric moment. The gradual loss of permeability and other magnetic qualities is therefore a statistical result. It is the expression of the fact that the gradual resolution of the molecules is proceeding as the molecules take up energy of rotation from the surrounding medium. Deferring for one moment a discussion of the causes of the increase of permeability with rise of temperature under low magnetic forces, the suggestion made, therefore, as to the cause of ferromagnetism, is that it lies in the unique structure of the molecule of iron or other ferromagnetic, whereby it has a finite electric moment below a certain temperature; and that rise of temperature ultimately brings about a rupture of the molecule by increasing the angular velocity of rotation beyond the point at which the interatomic electric forces can hold the original structure together.* We may then ask, have we any evidence for changes in iron at the critical temperature which would indicate anything like molecular decomposition?

The observations on the specific heat of iron† have shown that there is a remarkable increase in the specific heat of iron as it is heated up. According to M. Pionchon, the specific heat of iron at any temperature from 0°C to 660°C is given by the formula

$$\gamma_t = 0{\cdot}1012 + 0{\cdot}00005066t + 0{\cdot}000000164t^2.$$

From this formula I calculate the specific heat of iron at various temperatures to be as follows:

Specific Heats of Iron at Various Temperatures.

Temperature.	Specific heat.
0°C.	0·1012
100°C.	0·1079
200°C.	0·1176
300°C.	0·1306
400°C.	0·1468
500°C.	0·1665
600°C.	0·1892

Also, it has also been shown that the average specific heats of iron between 750°C. and 1,000°C. = 0·213
between 954°C. and 1,006°C. = 0·218
and between 1,050°C. and 1,200°C. = 0·1988.

I have set these values out in a curve (*see* Fig. 6), and you will note from it the curious fact that the specific heat of iron

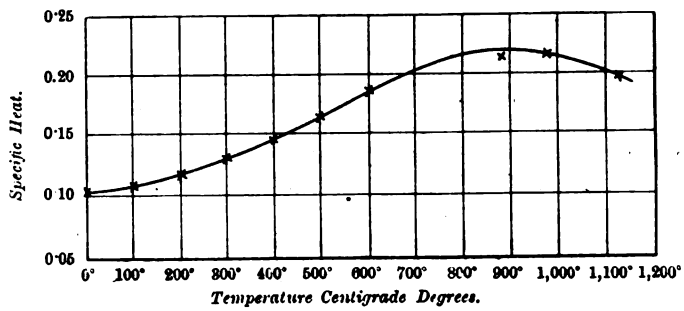

FIG. 6.—Variation of Specific Heat of Iron with Temperature.

appears to come to *a maximum value* at about 850°C., viz., *at or a little above the critical temperature.* This is apart altogether from the small absorption of heat at the critical points.

By Dulong and Petit's law, the product of specific heat and atomic weight should be a constant not far from 6·0. The product of 0·1012 (the specific heat of iron at 0°C.) and 56 (the atomic weight of iron) is 5·6. The product of 0·218 (the specific heat at 850°) and 28 is 6·1. Hence, as M. Pionchon has pointed out, if we take the atomic weight of iron as 56, it approximately obeys Dulong and Petit's law between about 0°C. and 100°C., but to make it obey the law at 850°C. we must take the atomic weight of iron as half of 56, or 28. When we heat a compound gas such as carbonic acid, we find an increase in specific heat with temperature, and such increase is held to be an indication of some internal work being done in the molecule over and above that necessary to raise the temperature. In the case of a compound gas, this work consists in dissociating the molecules. Hence in this rise of specific heat of iron with temperature, we have

* A lecture delivered October 18, 1897, to the Sheffield Society Engineers and Metallurgists. *Copyright.*

† At the time when this lecture was written I had not attempted to study, with any proper care, the elaborate mathematical papers by Dr. J. Larmor, entitled "A Dynamical Theory of the Electric and Luminiferous Medium" (*Phil. Trans.* Roy. Soc., 1894, 1895 and 1897). As far as I have been able to follow his rather difficult analysis and physical discussion, the theory he originates and develops of the construction of a molecule and atom is that it is a collocation of *electrons* or strain-centres in orbital motion. It is highly probable that the somewhat crude theory of the structure of an iron molecule suggested in the text will be found insufficient or defective when judged in the light of Dr. Larmor's analysis. My object has not been so much to attempt to grapple with any details in the supremely difficult problem of molecular structure as to indicate to theorists and experimentalists some of the points which must be met by any adequate and complete theory of ferromagnetism.

* It has been shown by Prof. J. J. Thomson ("Recent Researches in Electricity and Magnetism," p. 21) that an electrified sphere cannot be made to move through a dielectric with a greater velocity than that of light. Hence, if rise of temperature involves increase of speed of the motion of electrified atoms through the ether, that may imply that there is an *upper* limit to temperature just as there is a *lower* limit on absolute zero.

† See *The Electrician*, May 14, 1897, Vol. XXXIX, p. 36. Prof. W. W. Hartley, F.R.S., "On the Specific Heat of Iron at High Temperature." A Note read before the Iron and Steel Institute, May, 1897.

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a suggestion that some internal work analogous to dissociation going on in the molecule.

Again both Dr. J. Hopkinson and Dr. D. K. Morris more recently have shown that a remarkable change takes place in the electrical resistivity of iron at the critical temperature. The curve (*see* Fig. 7) delineating the variation of electrical resistivity of iron in terms of the temperature below about 800°C., is a curve which is concave upwards and which rises very rapidly. The resistivity of iron at 1,000°C. is nearly eight times its resistivity at 100°C., and about twelve times its resistivity at 0°C. But at 800°C. the curve *changes its direction of curvature* and becomes concave downwards and continues to rise at a much less angle than before. The temperature coefficient or the change in resistivity per degree is about 0·5 per cent. per degree at 0°C. The temperature coefficient per degree at 1,000°C. expressed as a percentage of the resistivity at 0°C. is about 0·24 per cent., and as a percentage of the resistivity at 1,000°C. is only 0·02 per cent. There is however no discontinuity between these two different portions of the same curve.

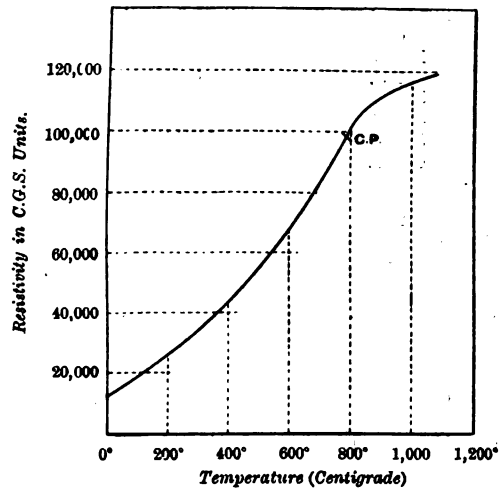

Fig. 7.—Variation of Electrical Resistivity in Iron with Temperature Annealed at 1,050° C. (Dr. D. K. Morris).

If therefore we compare the physical properties of iron at 1,000°C. and at 100°C., we find they are two totally different substances.

In the case of Iron at 100°C.	*In the case of Iron at 1,000°C.*
The magnetic permeability may be as much as 4,000 C.G.S. units.	The magnetic permeability is about unity.
The specific heat is about 0·108.	The specific heat is about 0·218.
The electric resistivity is about 16,000 C.G.S. units, or, say, 16 microhms per cubic centimetre.	The electric resistivity is 120,000 C.G.S. units, or, say, 120 microhms per cubic centimetre.
The temperature coefficient is 0·5 per cent. per degree.	The temperature coefficient is 0·02 per cent. per degree.
The magnetic susceptibility varies greatly with the flux-density or induction.	What little susceptibility remains is independent of the flux-density or induction.
The flux changes involve a magnetic hysteresis.	The flux changes involve no hysteresis.
The iron is a *ferromagnetic* body.	Iron is merely a *paramagnetic* body.

All these physical changes take place at the critical temperature, and if identity of physical properties constitutes identity of substance, we are entitled to say that iron at 1,000°C. is not the same substance as iron at 100°C. This, I think, argues some breaking-up of the molecule of the kind I have indicated, or some change of an equivalent nature.

There are some other magnetic phenomena which require explanation, and concerning which I desire to suggest the outlines of a working hypothesis. We have to explain the remarkable rise in permeability which takes place with rise in temperature at a point a little below 800°C. and under small magnetising forces. We have also to explain how it is that annealing, and the presence of very small quantities of carbon, manganese, and other substances make such a marked difference in the magnetic qualities of iron. It may be remarked, however, in passing, that the presence of carbon in iron is not at all essential for the manifestation of ferromagnetic properties. Perfectly pure iron, like perfectly pure nickel, is highly ferromagnetic.

(To be concluded.)

THE TELESCRIPTOR.

The uncouth word "telescriptor" has been coined for the name of a most ingenious and compact type-printing telegraph instrument, the invention of an Austrian electrical engineer, Herr Bernhard Hoffmann. The machine is not to be regarded as

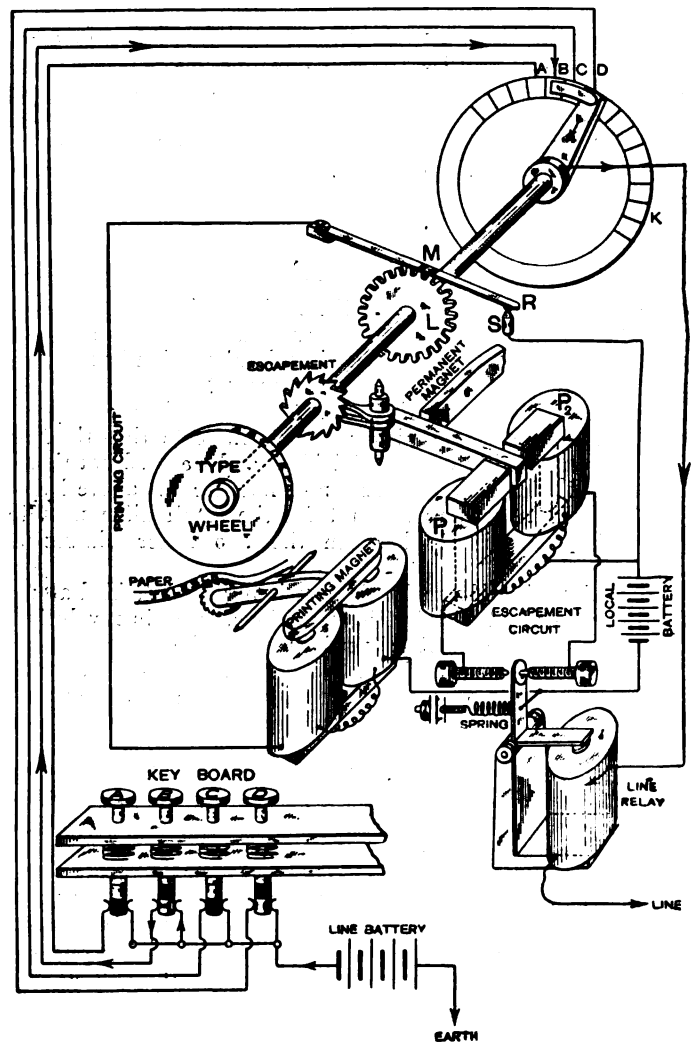

Fig. 1.—Diagram of Connections.

a competitor of the well-known Hughes instrument, as simplicity of operation has been aimed at in the first place, and speed only perhaps as a third *desideratum*, ranking only after compactness. The apparatus seems especially suitable for replacing the old Wheatstone A B C instrument wherever it is still used, and for taking the place of the telephone on private lines when it is desired to keep records of the messages sent and received. Fig. 1 shows the general appearance of the instrument; its overall dimensions are 16in. by 15in. by 12in. high. The keys corresponding to the letters are arranged in alphabetical order,

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and each key also controls a sign or figure. The two extra keys for changing from letters to figures, and *vice versâ*, also serve as spacers, and it is unnecessary to hold these keys down while the other keys are being depressed, as it is in the case of typewriters of the Remington pattern.

The same instrument is used both for sending and receiving, and the instructions for operating are extremely simple. Two levers marked "Receive" and "Transmit" (or, rather, their French equivalents, as the machines are at present made by the Société des Téléphones of Paris) are depressed when it is desired to transmit a message, and this starts the machine running. A key marked "Synchro." is then depressed and held down until the type-wheel comes to rest, and when this key has been pushed down twice the machines at the two ends are in step. A key marked "Lett." is then held down till the wheel stops, and the machine will write letters until the key "Fig." is depressed. When writing, each letter-key used is to be held down until the machine stops, when it can be released, and the next letter required can be depressed. After the message is ended the "Synchro." key should be depressed and held down until the machine stops before the transmitting lever is released, in order to cut off the line-current. If this is omitted a white disc marked "Please Synchro." appears on the front of the apparatus, to remind the operator of his omission. It is intended to replace this arrangement by a locking mechanism, locking the transmitting lever until the "Synchro." key is depressed.

If an earth-return be used, only one line wire is necessary, and of course the mechanism for the actual printing and for

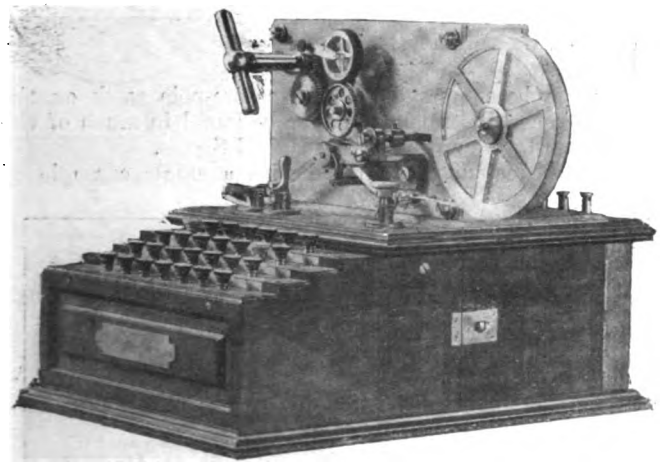


Fig. 2.—The "Telescriptor."

controlling the clockwork is worked through a relay, so that a more powerful local battery can be used. The type-wheel is worked by clockwork, which requires winding periodically, but the escapement of the clock is controlled by an electromagnetic mechanism. The line current is unidirectional, and the relay is brought back to its second contact by a spring when the current stops. Fig. 1, which is a diagrammatic sketch of part of the connections, will help to explain the action of the instrument. The lower ends of the keys are fitted with contact rings and insulating rings (the latter are shown black in the diagram), and it is seen that they are arranged alternately, making and breaking contact with their respective contact springs in their normal positions. One set of these contact springs is connected to the battery, the other spring of each key to one segment of a revolving contact-wheel seen on the top right-hand of the diagram. The current flows from the segment under the brush through the line relay and thence to the line. If all the keys are up, it is seen that, by the alternate arrangement of the key-contacts, the line-current is alternately made and broken; this causes the tongue of the relay to oscillate backwards and forwards, alternately closing the circuit of the local battery through one or other of the pair of magnets P_1, P_2 actuating the escapement. This makes the type-wheel and the contact-wheel revolve continuously until a key is pressed. As soon as a key—say K—is depressed, the proper sequence of make and break is interrupted, when the corresponding segment K comes under the brush, and the relay, and therefore the clockwork, stops. The relative position of the type-wheel and contact-wheel is so arranged that when the shaft stops, the letter corresponding to the section under the brush is just above the paper. There is a ratchet-wheel L on the same shaft, and so long as the shaft is rotating the ratchet M rides on the top of the teeth, but as soon as the wheel stops the ratchet drops between the teeth, making contact between the lever R and the contact spring S. This closes the circuit of the printing magnet, so that the paper is then lifted against the type-wheel, and the letter is printed. There is in addition the usual ratchet arrangement for the feed of the paper, so that as soon as the latter drops again it is moved forward one space.

The relays of the instruments at either end are connected in series through the line, so that the instrument at the receiving end acts in precisely the same way as the one at the sending end. The synchronising device remains to be explained, however. In order not to complicate Fig. 1 it has not been included in that diagram. The key, already mentioned, marked "Synchro." is in reality merely a reversing key, and it is used in connection with a polarised relay in each of the two instruments. The coil of this relay is connected in series with the coil of the line-current relay already mentioned, and when the current is flowing in its normal direction the polarised relay is unaffected. When, however, the current is reversed the tongue of the relay is attracted. The contacts of the relay are so connected to the local circuit and to contact rings on the contact-wheel that, when the tongue of the relay is over, the local circuit is disconnected as soon as the wheel reaches a certain zero or starting postion, which is the same on both machines.

An idea of the speed of working is gathered from the fact that the line-current relay makes a complete oscillation 14 times in a second (*i.e.*, it receives 14 currents per second), and this corresponds to 26 letters, or a complete revolution and two letters. Thus it is seen that the maximum time taken to print a letter is slightly less than one second, and that the average time is, roughly, half-a-second. An exaggerated *legato*—not the *staccato* of the typewriter—touch should be used in playing on the keys. For instance, if the letter E is to succeed the letter D it would be difficult to get the second key down within $\frac{1}{28}$th of a second after the first one had been released, but the second key may be depressed just before the first is released, and so a second is saved.

It is stated that the capacity of the line does not interfere with the working of the apparatus, satisfactory experiments having been made on a 13 m.f. line at the Post Office, with 100 volts line-voltage. The line-current required is from 25 to 30 milliamperes. For short lines 6 to 12 dry cells are used according to the resistance of the line, for long lines considerably more. A battery of 9 larger-sized dry cells is used for the local circuit, unless current is tapped off the supply mains.

SOME EXAMPLES OF OVERHEAD TROLLEY CONSTRUCTION.

Apropos of our remark in last week's issue, that in the United States at the present time the pole-and-bracket method of trolley-wire suspension is being adopted in preference to span-wire suspension in the best and most substantial work, the accompanying illustrations of the latest foreign practice in trolley road construction are of special interest. Figs. 1 and 2 are views of a portion of the high-speed electric railroad between Washington, D.C., and Baltimore, Md., which is now nearing completion. This is a double track railroad of exceptionally solid construction, and it is principally laid on a private right-of-way. It is intended to compete with the fast-speed steam service of the B. and O. and other railroads, which it parallels throughout its entire length of 40 miles. The poles and brackets are of hollow steel, and the poles are set midway between the tracks, giving the overhead equipment

a light and well-balanced appearance. In Fig. 2 is shown very clearly the method of attaching the trolley wire to the bracket, by means of which the rigidity inherent in the older forms of hanger is obviated, and flexibility of suspension, which is the only real merit in the span in Fig. 8 would have been more elegant and light in appearance had it been constructed in steel. The centring of the trolley wires over the tracks, rendered necessary by the use of a rigid trolley arm, involves a length of bracket that is also inartistic. Nevertheless, side-bracket construction, which for

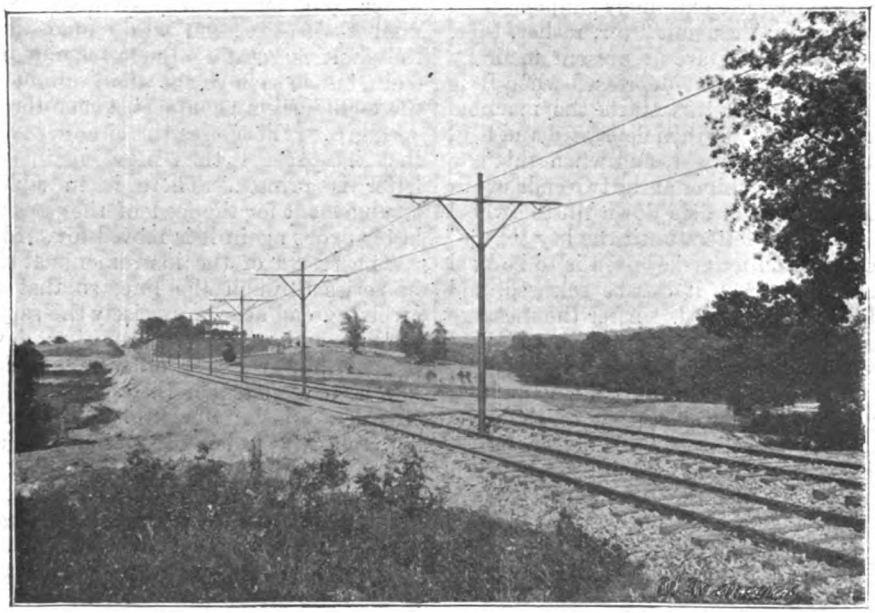


FIG. 1.—View of the High-Speed Electric Railroad between Washington and Baltimore.

wire, has been obtained. Another form of bracket suspension is shown in Fig. 8, which gives a view of a 1-mile straight drive along the new Suburban Railroad at West Chicago, this length having been equipped last August with overhead work elegance may be compared with the centre-pole work on the Washington and Baltimore line is to be found in much of the later overhead trolley work in the United States.

We may conclude this article with a single example of

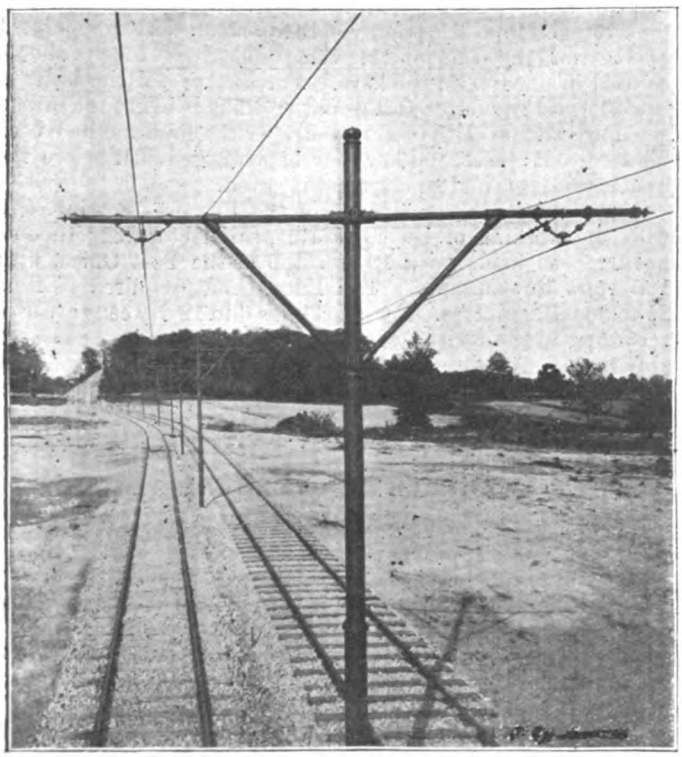


FIG. 2.—Double-Bracket Trolley Suspension on the Washington and Baltimore Electric Railroad.

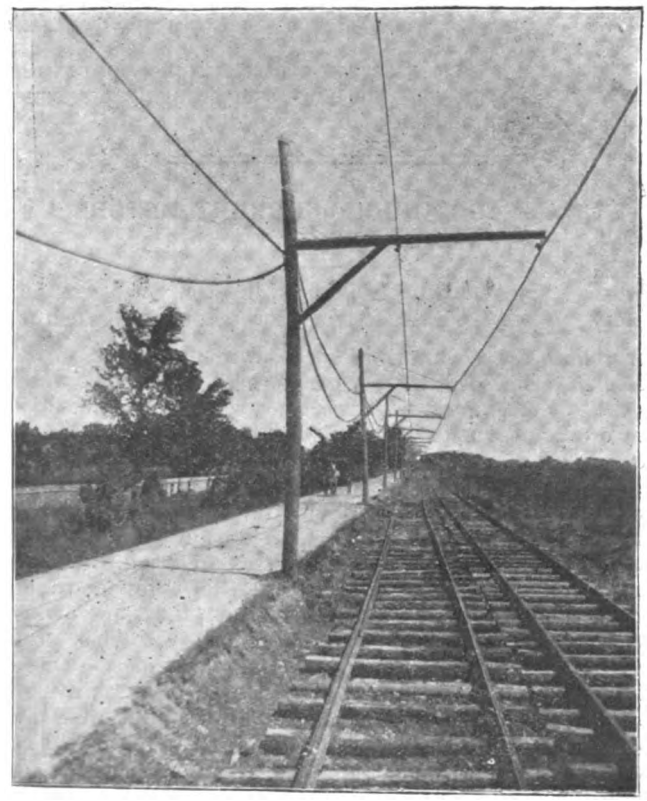


FIG. 3.—Single-Bracket Trolley Suspension on the Chicago Suburban Railroad.

in the remarkably short space of 12 hours 53 min. Owing to the cheapness of timber in America this material, unfortunately for their artistic possibilities, is extensively used for trolley poles and brackets; and the particular example shown artistic pole-and-bracket construction on the Continent, and we have selected the Siemens and Halske trolley pole used on the suburban tramways of Budapest. This is illustrated in Fig. 4. In this pattern of pole the brackets are provided with

the fiddle-bow suspender for the span-wire support, a method of suspension now largely used in America, and a modification of which is seen in Fig. 2. Messrs. Siemens and Halske have adopted a length of span somewhat larger than usual for the bow-string, but this probably was rendered necessary by the

FIG. 4.—Double-Bracket Trolley Suspension on the Suburban Tramways of Budapest.

fact that the cars carry slider bar contacts in place of ordinary trolley arms and wheels. The bow-string is of galvanised steel, 0·24in. (6mm.) in diameter.

TESTS OF CONTINUOUS-CURRENT MOTORS AT ERITH.

Through the courtesy of Messrs. Easton, Anderson and Goolden we were enabled during the past week to witness

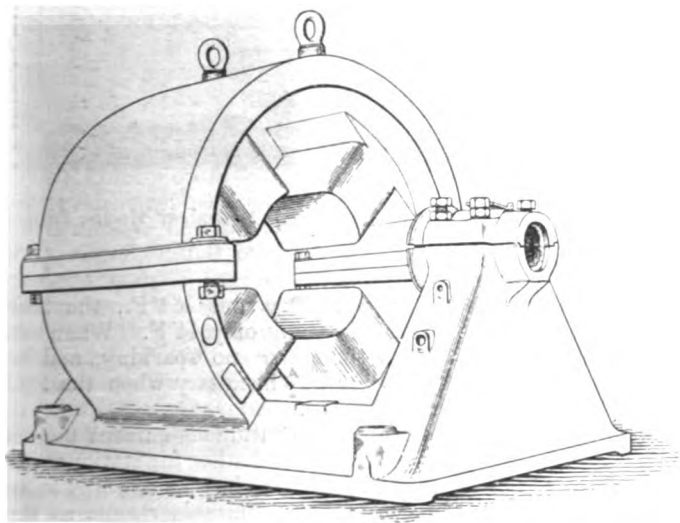


FIG. 1.—Cast Iron Carcase of a Continuous-current Fynn Motor.

some tests of two electric motors, recently built by that firm of engineers for driving a machine shop at Johannesburg, and are now enabled to present our readers with some illustrations and particulars of the motors, and of the tests to which they were subjected.

The motors are continuous-current machines, built according to the designs and under the patents of Mr. V. A. Fynn, to whom we are indebted for much assistance in the preparation of data and illustrations for this article. Each motor is an exact duplicate of the other, and is constructed to absorb 20 kilowatts. We may here remark that the motor resembles in all respects the continuous-current generator built by this firm, the same plans and specifications being used in the construction of either motor or generator. The construction is

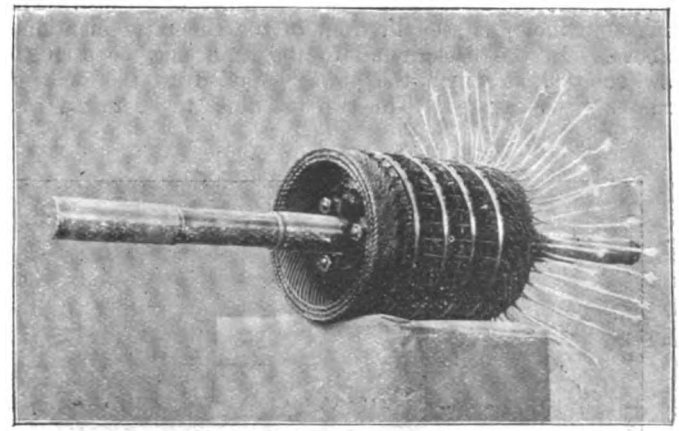
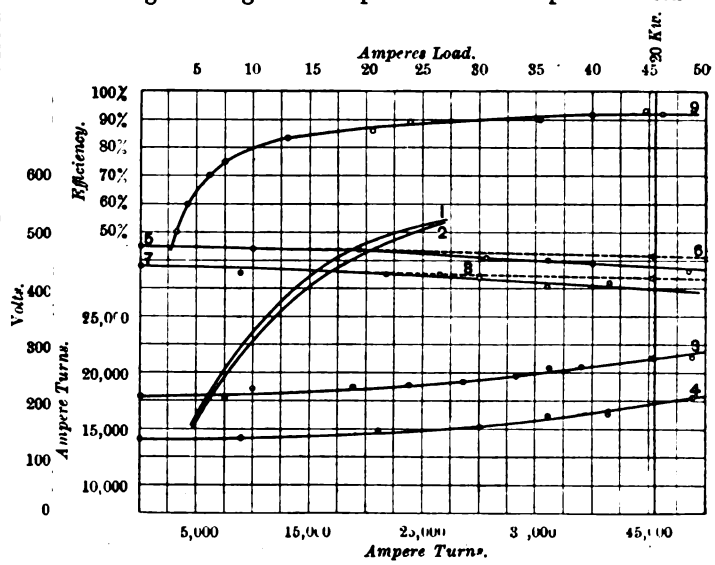


FIG. 2.—Armature of Fynn Motor in Process of Construction.

simple, strong and effective in character, and is such as to adapt the machines to the rough usage to which their every-day work often exposes them. In Fig. 1 is shown the carcase of one of the actual motors tested. It will be seen that it consists of no more than two castings bolted together, the lower casting forming the bed-plate and lower pair of field



Shunt winding. 440 volts 45·5 amperes 800 revolutions, armature resistance 4ω.

1. Saturation curve 800 R (falling).
2. Saturation curve 800 R (rising)
3. Load curve, 440 volts const. speed const. 800 R (varying excitation).
4. Load curve. 440 volts const. speed const. 950 R (varying excitation).
5. Load curve, speed const. full load excitation const. (varying volts).
6. Calculated ohmic drop.
7. Load curve, speed const. no load excitation const. (varying volts).
8. Calculated ohmic drop.
9. Efficiency curve by Hopkinson's method after three hours' run at full load.

FIG. 4.—Test of a Standard 20-unit 4-pole Dynamo, by Messrs. Easton, Anderson and Goolden, Ltd., with Fynn's Winding.

magnets, while the upper casting forms the two upper pole-pieces and yoke. By removing this upper casting the armature and coils are well exposed, and may readily be removed. Fig. 2 shows a photographic view of an armature in process of construction. The armature is drum-wound for a four-pole field, and the conductors are carried in slots, there being 12 conductors in each slot. All the conductors are

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connected in series, and develop 440 volts when the speed is 800 revolutions per minute. The field coils are shunt-wound, and are carried on bobbins secured at the back to the cast-iron frame. The air-gap of these machines is $\frac{1}{8}$in. each side, or a total of $\frac{1}{4}$in.

For the test, which was made with a view to determine the commercial efficiency of the motors, the Hopkinson two-dynamo method was used, the actual arrangement of the testing set being as shown in Fig. 8. A countershaft (not shown) drove a generator, shown in the background, which supplied a measured amount of electrical power to a small make-up motor, the duty of which was to supply energy to compensate the losses in the two machines under test. This make-up motor is seen in front of the generator mentioned above. In the background to the right may be seen the switchboard at which the power supplied to the make-up motor was measured. The two machines to be tested were mechanically and electrically connected in the usual manner, one running the other directly as a generator, and taking electrical power from it. The voltages and currents between the two machines were also measured at the switchboard. The method of testing consisted in running the entire set in such a way as that the power supplied to the make-up motor should be measured when the two machines were running at normal speed and full load. The electrical power required to run the make-up motor idle was then measured, this having to be deducted from the in-put power on the principal test. Besides these measurements it was necessary to ascertain the resistances of the make-up motor winding, in order to determine the excitation loss.

As a result of this test it was ascertained that the combined efficiency of the two machines was 86 per cent., showing a separate efficiency of 92·5 per cent. The copper loss at full load was 1·8 per cent. The make-up motor running alone took 2·5 amperes at 205 volts, or 513 watts. Subtracting this from the in-put into the motor we get approximately the actual work done by that motor. When driving the set not excited the motor took 11·4 amperes at 202 volts, or 2,100 watts, whence the ventilation and friction losses equalled 1,587 watts, or 1·8 per cent. per machine. The motor driving the set fully excited took 28 amperes at 204·6 volts, or 5,740 watts. Since the resistance of the armature of the make-up motor was found to be 0·5 ohm, the excitation and iron losses of the set when driven excited amounted to an aggregate of 3·9 per cent. The accompanying set of curves (Fig. 4) give in further detail the particulars of the efficiency and other tests.

As regards satisfactory running, the motors showed the following results: After a three-hours' run at full load the rise in temperature of the armature was only 54°F., the temperature rise in the field coils being only 44°F. When run with copper-gauze brushes there was no sparking, and no movement of the brush rocker was necessary when the load varied between zero and full value.

At a time when the demand for continuous-current motors is rapidly increasing in this country, whether for stationary or locomotive purposes, it is gratifying to be able to point to an English-built motor showing such admirable results as the Fynn motor, built by Messrs. Easton, Anderson and Goolden. Indeed, we may safely say that if equipped with series-winding in place of the shunt coils, and suitably encased in an ironclad casing, this motor would form an excellent pattern of tramway motor.

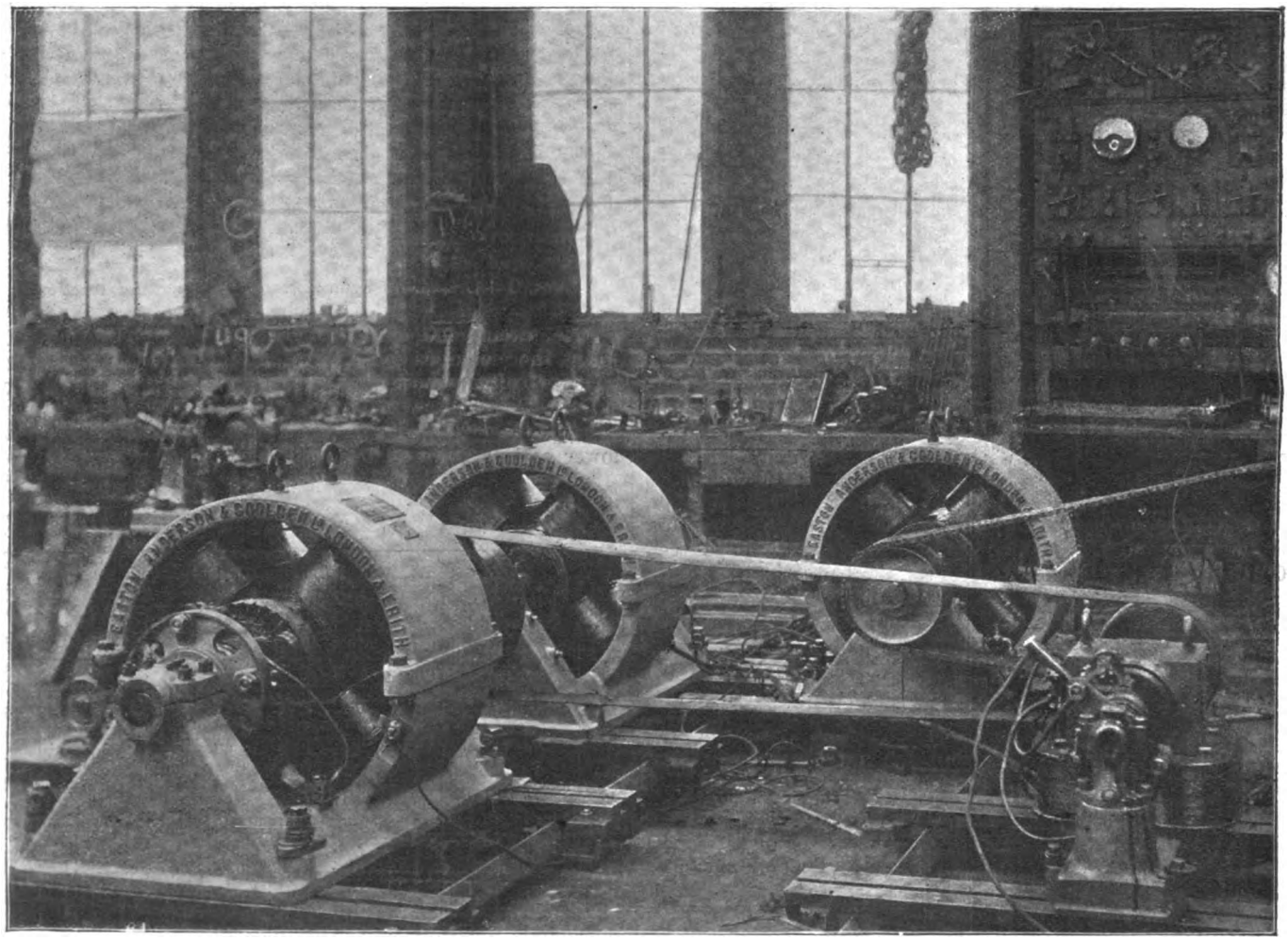

Fig. 3.—Arrangement of Two Continous-Current Fynn Motors and Testing Set for an Efficiency Test by Hopkinson's Method, at Messrs. Easton Anderson and Goolden's Works, Erith.

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CORRESPONDENCE.

THEORIES OF ELECTRICITY AND MAGNETISM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I flatter myself that I understood the scientific writings of the English before I had learned their language proper.* In order, however, not to be reckoned among those Germans (if there be indeed any such) who might for a moment doubt either the excellency of the methods employed by the English in theoretical physics,† or, above all, the greatness of such a theory as Maxwell's, I have taken the liberty of inserting here the motto used in one of my books‡; it is taken from Goethe's "Faust," and was applied to Maxwell's formulæ; it is:—

"War es ein Gott, der diese Zeichen schrieb,
Die mit geheimnissvoll verborg'nem Trieb
Die Kräfte der Natur um mich enthüllen
Und mir das Herz mit stiller Freude füllen."

The excellent scientific work by the worthy critic of Dr. Curry's book§ in *The Electrician*, Vol. XXXIX., p. 643, has always been accorded my highest appreciation, and especially since he has *further developed* Maxwell's theory exactly in the spirit of the originator; I therefore hope that he may detect no depreciation of the high esteem and admiration I have always had for his work when I defend myself and Curry's book against his criticism.

Our critic not only condemns Helmholtz's method of treating the given subject and all other such, but depreciates Hertz's method of treatment, which is materially different from that of the former scientist. It seems to me, however, and history surely confirms such a view, that the progress of science is only greatly retarded by accepting prematurely any one method or theory to the exclusion of all others. The writings of Heaviside, Lodge, Poynting, Föppl, &c., excellent and instructive as they are, all cultivate only a given definite direction in the inexhaustible field of Maxwellian ideas, and it must thus be regarded as a certain relapse into the old dogmatic method if we refuse to recognise the importance of the cultivation of all other methods, many of which even revert to Maxwell's. I am willing to go even further, for, however strongly I should always condemn the metaphysical doctrine of the *existence* of one or two fluids, there are, nevertheless, many representations taken from such old doctrines that are extremely illustrative. For that reason it seems to me there will be room for them in science for a long time to come, perhaps always, alongside the Heaviside-Lodge-Poynting method and such others, in the same manner as, for example, many representations from Newton's emission theory of light still play an important *rôle* in dioptrics. I myself consider it a special merit of Dr. Curry's book that the *rôle*, which these illustrations (concrete representations) play in the frame of Maxwell's theory, however indispensable they may seem at present, is so sharply set forth. Maxwell also operates continually with fluids, &c.; some of his articles even carry the headings "one fluid," "two fluids," &c.

How greatly disturbed our worthy critic would have been if he could only have found the following paragraph in Dr. Curry's book: "Varley's discovery seems to me to necessitate the conclusion that resinous electricity, not vitreous, is the electric fluid, if we are to have a one fluid theory of electricity. Mathematical reasons prove that, if resinous electricity is a continuous liquid, it must be endowed with a cohesional quality, such as water on a red-hot metal, &c." But Lord Kelvin said this word for word in the year 1897.‖

As a proof that the work of the German scientists in the electromagnetic theory of light has by no means been always purely academic, I may observe that Wilhelm Weber laid its first foundation stone, when he determined the relation between the electrostatic and the electromagnetic units of current. This determination came before the appearance of Maxwell's chief works, for which the latter with the magnaminity peculiar to all men of such greatness paid Weber due tribute. I may also be allowed to mention my own work* on the specific inductive capacity of many solid substances and several gases, and its different values according to the direction taken in crystallised sulphur; these together with a short Paper by Gibson and Barclay, on the specific inductive capacity of paraffin, offered the first confirmations of the electromagnetic theory of light, as mathematically formulated by Maxwell. Hertz was inspired to his much more ingenious experiments by Helmholtz's theory, and learned still later Maxwell's theory in the original form.

Whether the longitudinal oscillations and the other generalisations, which Helmholtz has added to Maxwell's theory, are of great importance or not, is a question that the present stage of science is unable to decide. It is surely not very difficult to comprehend why I should have treated a subject in my lectures at Munich, with which my hearers were more or less familiar and in which they were especially interested, and that thereby Helmholtz's theory was forced into the foreground; and that I had, moreover, no scruples in recommending a book to the English, which followed essentially my own lectures, may be sufficiently justified from what I have said above.

Although I cannot, of course, take the responsibility for the validity of all small details in Curry's book, I may observe, however, that none of the places mentioned in the given criticism seem to me to be faulty, they differ only from our critic's representation either in form or in contestable points that have not yet been decided by empirical facts. Strange as it may seem, there is indeed one place in which it is not Curry's but our critic's representation that differs from Maxwell's. He who is not prejudiced beforehand towards the form of representation chosen by Curry, and takes the trouble to familiarise himself with his notation and definitions, should find that his book offers a consistent theory of the phenomena, which differs from others only in unessential points or such as have not yet been decided by experiment; moreover, that in many respects —due chiefly to following Helmholtz's theory—empirical facts are left much more freedom than the specifically English theories allow them, which in consideration of future *experimenta crucis* should hardly be unwelcome.—Yours, &c.,

Vienna, Oct. 13, 1897. LUDWIG BOLTZMANN.

THE ELECTROSTATIC CAPACITY OF LONG CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Perhaps as good a reason as can be given for doubting the reliability of the Muirhead-Gott method is the fact that in the hands of its exponents it invariably reproduces very closely the sum of the results obtained when the cable was in short coil sections. If, as we are told by Dr. Muirhead and others, there is an appreciable variation of capacity with temperature and, perhaps, pressure, one would expect that the capacity of a cable laid in deep water would differ materially from the value estimated from the shore tests.

As a matter of fact the results obtained by any of the Gott methods depend upon the manner in which the tests are "timed"; and it is only by selecting suitable periods of "charge" and "mix" for the particular cable under test that the result desired can be obtained. It is certain that, given a long cable of unknown capacity, an *estimate* and not a *measurement* of its capacity is all that it is really possible to obtain.

Too little attention, it seems to me, has been given to the problem of devising a really good capacity test. It is questionable if we shall ever be able to hit upon a fairly exact method for long cables, but in the meantime some improvement may possibly be made to existing ones. The principal defect of the Gott method results from charging in cascade, because the

* *See* "The Electrician" Electrical Trades Directory and Handbook, Art. "Boltzmann."

† *See* also Boltzmann "On the Methods of Theoretical Physics," London Physical Society, *Proc.* XII., III., p. 336, December, 1893.

‡ "Vorlesungen über Maxwell's Theorie der Electricität und des Licht," Part II., 1893, Barth, Leipzig.

§ "Theory of Electricity and Magnetism," Macmillan and Co., London, 1897.

‖ *Nature*, 56, p. 84, May 22, 1897.

* *Wiener Sitzungsberichte*, Vol. 65, 1872; Vol. 67, 1873; Vol. 68, 1873; Vol. 69, 1874; and Vol. 70, 1874.

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battery is separated from the cable by the condenser and is thus unable, after the first charge, to replace the more or less rapid leakage which takes place through the dielectric. The first stage of the test may be represented by Fig. 1. It is evident that during the "charge" period c is gradually raised in potential by the battery acting through r, while C is at the same time slowly discharged. The result is that the "balance" reading alters towards the earth end of the slides as time passes after the battery has been applied. This action may take place rapidly with a long cable of low dielectric resistance, especially if the condenser c is well insulated; and one of the difficulties of the Gott test is that

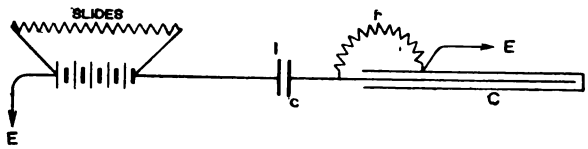

Fig. 1.

of accurately hitting on the slide reading at which a balance will be obtained at any given small interval of time after "battery on." Unless perfectly accurate time is kept a different result will be obtained at each attempt, and matters are apt to be further complicated in this respect when, as is generally the case, variable earth currents exist.

The variations in the "discharge" and "reproduction" deflections are even more serious, and it is only by taking a mean of a large number of readings that anything can be obtained upon which it is safe to base the correction. It is

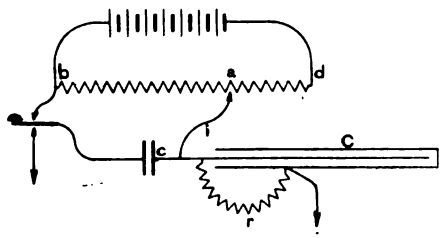

Fig. 2.

for these reasons, I should say, that Mr. Elton Young prefers to calculate, from the approximate inductive capacity and dielectric resistance, what the fall of the cable's potential must be during the time of "charge";* and, granting reliable data, I think his method gives greater promise of accuracy than that based on the actual observation of very variable quantities.

But it must be borne in mind that Mr. Young's formula only applies when the D.R. of the condenser is practically infinite. It may be very high and yet not high enough to be entirely left out of account. As an example: If a 500 m.f.

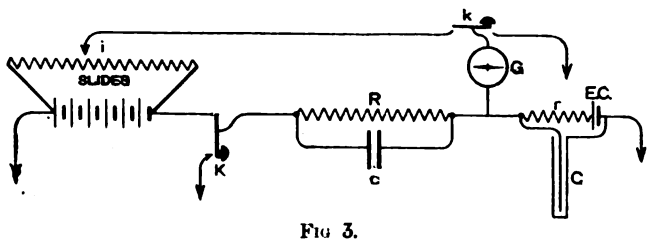

Fig 3.

cable with a D.R. of 1 megohm were tested with a 50 m.f condenser, the D.R. of the latter would have to be many times higher than 10 megohms to be taken as perfect, for at that value the leakages would balance and no correction would be required at all.

Another way of counteracting the leakage effect is to charge the cable viâ the index circuit i as well as viâ b (Fig. 2). Any leakage or absorption in either c or C is then continuously replaced by the battery, and if the keys are moved quickly to "mix" it does not matter if the leakages are balanced or not, or how long the "charge" is made.

* See *The Electrician*, Aug. 20, 1897, p. 536 *et seq.*

I prefer, however, to combine these devices, and take the test as follows (Fig. 3): After observing the E.C. deflection, R is adjusted to be a little higher in proportion to c and C than r, so that as the dielectric of the cable r rises in resistance under electrification the "spot" of the galvanometer G gradually crosses scale zero (i being properly placed at the estimated point of "balance"). When R thus balances r, K and k are depressed to mix and discharge, and the position of i corrected until a slight "kick" is obtained in the opposite direction to the E.C. deflection. I believe the use of R allows the E.C. to act proportionally on both capacities and thus prevents it vitiating the results.

I should like to draw attention to the fact that the diagram for Gott's test may be drawn in either of the two ways, shown in Fig. 4, and suggest that both Muirhead and Young's formulæ require modification accordingly, unless R and r are properly proportioned. In selecting a cable with 22 megohms D.R., Mr. Dearlove * chose rather an easy case. From the fact

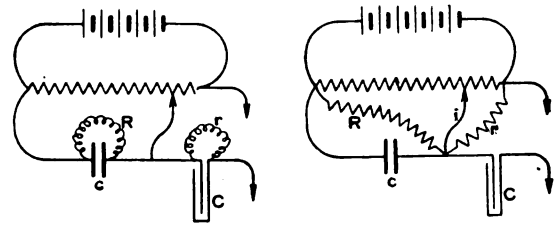

Fig. 4.

that he obtained practically the same reading at 10″ as at 60″ charge I should say the leakages must have been practically balanced, so that if he applied Young's correction to the cable side only he would vitiate rather than correct the tests.

I must add that the results I obtain by the method described are usually slightly lower than the reputed inductive capacity of the cable. WALTER J. MURPHY.

c.s. "Amber," Perim, Oct. 16, 1897.

ENCLOSED ARC LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the advertisement p. vii. of your last issue a notice is given that users of lamps the inner globe of which is surrounded by an atmosphere of inert gas, render themselves liable to action for infringement of the Company's patents. Does this notice refer to Staites' patent 11,449/46, in which an arc lamp is inclosed in an air-tight glass globe to prevent the action of the air on the carbons, and does not the threat come a little late in the century? Probably some one who has no direct interest in the Jandus arc lamp may be able to propose a solution to my question.—Yours, &c., F. J. S.

Oxford, Oct. 29th.

[We do not think that the Jandus patents claim the general means of inclosing the arc from a combustion-supporting atmosphere, as suggested by our correspondent. The practical difficulties involved in the perfect inclosure of the arc, intensified as they are by the necessity for keeping down the cubic contents of the inside cylinder into which the carbon has to freely feed, is probably the cause of the adoption of an outer globe—also air-tight, and which ultimately secures the effect of "surrounding the inner globe (or cylinder) by an atmosphere of inert gas." As our correspondent remarks, the idea of inclosing the arc itself in an air-tight or practically air-tight vessel, whereby its consumption is retarded, is, we also believe, quite old and venerable. The U.S.A. patents of Beardslee and Baxter in this field may be cited as showing how the problem of practically carrying out this idea had early engaged the skill of inventors.—Ed. *E.*]

FEEDER CUT-OUTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As a general rule, I carefully read your issues; but in this particular instance I have overlooked an article which has a personal interest for me, and to which my attention has

* See *The Electrician*, Sept. 3, 1897, p. 601.

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now been called. I refer to your notice of the "Andrews' System of High-Tension Feeders and Cut-Outs" on Oct. 22.

Excepting for the use of the Andrews' cut-out, it is identically the system which has been in use here for at least the last nine months. A short description of it was included in my much-debated report of Aug., 1896, extracts from which were given in your issue of Sept. 4, 1896. I also described the system when discussing the Paper on "Distributing Systems" at the Manchester Convention of the Municipal Electrical Association. At the same time it does not appear to me to be original; rather is it an adaptation of the network principles of low-tension main to high-tension purposes. At Blackpool we have not only "netted" the high tension but also the low tension. The reliability of the system has only been tested on one occasion as yet, and that was the result of the all-too-vigorous action on the part of a British workman, who managed to drive his pick into a high-tension feeder. The fuses at both ends immediately blew, the only effect on the lighting being a momentary flicker.—Yours, &c.,

ROBT. C. QUIN.

Corporation Electricity Works, Blackpool, Oct. 29, 1897.

LEGAL INTELLIGENCE.

New and Mayne (Limited).

A petition by Messrs. J. K. and R. Lord for an order for the compulsory winding up of New and Mayne (Limited), electrical engineers, came before Mr. Justice Vaughan-Williams (now Lord Justice Vaughan-Williams) on the 29th ult.

Mr. BAKER, who supported the petition, stated that his clients were judgment creditors for £159. 11s., and that he received support for the petition from eight other creditors, but no notice of opposition, except from the liquidator and debenture-holders.

Mr. HAMILTON, who appeared for the liquidator, asked that the petition should stand over until there was a meeting of the creditors to consider a scheme of arrangement.

Mr. BAKER said that the scheme had already been before the creditors, and had not been approved of.

Mr. HAMILTON stated that the liquidator would show that if there was a forced sale of the property, the unsecured creditors and the shareholders would receive nothing, whereas if the scheme of reconstruction were entered upon not only the creditors would be paid, but the shareholders would also benefit.

Mr. BAKER thought that in these circumstances it might be well if the petition should stand over; but it was a fact that some of the unsecured creditors had not been invited to the meeting which had been already held.

Mr. HAMILTON said he was not aware that that was so, but if on inquiry it were found to be so, invitations and copies of the scheme of reconstruction would be issued for those creditors.

The further hearing of the petition was then adjourned until the first petition day after Nov. 10.

Holophone Company (Limited) v. O. Berend and Co. (Limited).

This case, which was for an *interim* injunction to restrain the alleged infringement of a patent in glass globes, was to have come on on Thursday before Mr. Justice Stirling.

Mr. WARRINGTON, Q.C., for the plaintiffs, in support of the motion, said that an affidavit had been lately filed which would necessitate an adjournment, and he therefore asked that his lordship should allow the motion to stand over till the 19th inst., when the matter would come before Mr. Justice Kekewich.

Mr. H. TERRELL, on behalf of the defendants, said that Mr. Justice Kekewich had expressed an opinion that the motion ought to stand till the trial. It seemed to him (Mr. Terrell) useless to come there. The patent was a new one, which had never been upheld.

Mr. WARRINGTON said that he should have something to say about that, but he would consider whether the motion might not stand over till the trial. It was not, however, a matter they could possibly trouble his lordship with then.

His LORDSHIP: Very well, let it stand till to-morrow (Friday) fortnight.

Mr. WARRINGTON said that he supposed the defendants would continue the undertaking they had given on a former occasion when the case was before the court.

Mr. TERRELL said that that would be done.

Fires on Tramcars.—It is stated in the *Elektrotechnische Anzeiger* that no fewer than 70 motor cars on the Munich electric tramway have caught fire when in use during the last nine months. The municipal authorities are consulting Dr. Oskar von Miller as to the cause of these mishaps.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

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"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book for the electrical trades desires to contradict a rumour which he learns is in circulation that the issue of this work is to be discontinued. The Directory and Handbook for 1898 is already in course of preparation, and the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced.

Tenders Invited.—Tenders are invited for plant and works in connection with the scheme for the conversion of the Blackpool Corporation electric tramways to the overhead trolley system. Tenders, addressed to the Chairman of the Electric Lighting and Tramways Committee, must be delivered to Mr. Robert C. Quin by 10 a.m. of Monday, the 22nd inst.

——— The Postmaster-General invites tenders for the purchase of old telegraph stores, including about 26 tons of gutta-percha, 40 tons copper (wire, plates, &c.), and a quantity of other metals, india-rubber-covered wire, &c. Some further particulars are given in an advertisement elsewhere, and forms of tender can be obtained from the controller of stores (Mr. Charles E. Stuart), General Post Office, London, E.C. Tenders will be received until 10 a.m. on Tuesday, the 23rd inst.

——— As will be seen from our advertisement columns, the Corporation of Ayr are inviting tenders from firms willing to undertake the "free wiring" of premises in the streets of the burgh. Particulars as to districts in which the mains are laid can be obtained from the burgh electrical engineer (Mr. Arthur J. Fuller), and tenders must be sent in to the town clerk (Mr. A. G. Young), Municipal Offices, Ayr, by Thursday, the 11th inst.

——— The Agent-General for Victoria invites tenders for the supply of electric light cables and fittings for the railway department of the Colony. Specifications and conditions of contract can be had at the Agent-General's office, 15, Victoria-street, Westminster, London, S.W., and tenders must be delivered by Nov. 10, to be opened at Melbourne on Dec. 20.

——— The Corporation of Burnley require tenders for the supply and delivery of lead sheathed, armoured underground cables. Tenders to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, by the 17th inst.

——— With respect to the tenders which were recently invited for electric lighting for Belize (British Honduras), we are informed that the whole matter is in abeyance, and that the tenders will not be considered.

——— The Hamburg Finance Deputation require tenders for an electric light installation in the Kalberställe at the Sternschanze cattle yard. Tenders to the Finanz Deputation, Hamburg, by the 8th inst.

Tenders Received.—Seven tenders were received by the Glasgow Corporation for the electrical equipment of the Springburn-Mitchell-street tramways route on the overhead trolley system. All tenders were from American firms or their representatives in this country, and, after consideration of the offers submitted, the Tramways Sub-Committee recommend the acceptance of the lowest tender (that of the Westinghouse Electric Company) for the whole of the work at £19,657.

Appointments.—Mr. W. R. Culley, submarine telegraph superintendent at Dover, has been appointed to a similar post at Woolwich.

——— The Torquay Town Council on Saturday appointed Mr. P. Storey, of Torquay, engineer in charge of the Corporation electricity works, at a salary of £200 per annum. It will be remembered that Mr. Storey was originally recommended for the appointment by the Council's consulting engineer (Mr. W. H. Trentham) and Prof. Ayrton, who was called in to assist in the selection of a suitable man, endorsed Mr. Trentham's choice.

——— Mr. T. M. Priestley, for over 17 years postmaster of Lancaster, and formerly telegraph superintendent at Huddersfield, has been appointed Postmaster of Peterborough.

Appointments Vacant.—An assistant electrical engineer is required to take charge of a shift in low-tension three-wire station. Salary £90 per annum. Applications to "W. E. B.," *The Electrician* office, Salisbury-court, Fleet-street, London.

——— The Urban District Council of Morecambe require a clerk for their electrical department. Applications to the electrical engineer (Mr. C. F. Parkinson), Council Offices, Morecambe, by the 15th inst. See advertisement elsewhere.

Bankruptcies.—At the London Bankruptcy Court last week, before Mr. Registrar Giffard, Samuel Elliott, of Newbury (Berks) and London, applied for his discharge. Bankrupt failed in March, 1895, with liabilities returned at £65,241, but proofs amounting to £117,531 had been made by creditors, and the assets, which were valued at £8,553, only realised £3,788. Debtor was a joinery and moulding manufacturer, but during the six years preceding the receiving order he was mainly engaged in developing and exploiting certain patented inventions for the annihilation of smoke and fumes. He ascribed his failure to losses in respect of his patented inventions. Discharge suspended for four years.

Bankruptcies.—At the Bankruptcy Court, Carey-street, W.C., on Thursday last, on the petition of W. T. Henley's Telegraph Works Company (Limited), a receiving order was made against the estate of S. Bousfield Tatham, electrical engineer, 26, Thurloe-place, South Kensington. No information transpired with regard to assets or liabilities, but the act of bankruptcy alleged in the petition was a recent seizure and sale of the debtor's goods under an execution.

——— At the London Bankruptcy Court on Tuesday Sir W. E. J. Vavasour, Bart., whose bankruptcy was recently announced, was publicly examined. Gross liabilities £70,586, with assets estimated by the debtor in excess of liabilities. The bankrupt has been associated for some years past with electrical inventions, several of which he has patented. In 1891 a company was formed to acquire these patents, but was not a success. Examination concluded.

——— William Marshall, director of the London Electric Omnibus Company, of 16, Tokenhouse-yard, E.C., against whom a receiving order was made in July last, has submitted an amended statement of affairs. He returns his liabilities at £15,390, of which £6,701 is unsecured, with an estimated surplus in assets of £54,560, subject to realisation. An adjudication of bankruptcy has been made, and Mr. Flaxman Haydon has been appointed trustee.

Liquidations.—It has been decided to wind up the Standard Dynamo and Motor Manufacturing Company (Limited) voluntarily. Mr. Wm. Beanland, 35, Hustlergate, Bradford, is liquidator.

——— An order has been made by the High Court of Justice for the compulsory winding-up of Conrad Dewey and Co. (Limited), manufacturers of electric light fittings, &c., 24, Farringdon-avenue, London, E.C.

——— A petition has been presented for the compulsory winding-up of the Ward Electrical Car Company, Limited. This petition will be heard on the 10th inst. Messrs. W. and W. Stocken, 48, Lime-street, E.C., are solicitors for the petitioner, Mr. E. R. Evans.

Business Notices.—It is announced that the Edison Swan Company are renovating their old factory at Benwell, near Newcastle, which is, it is stated, to be re-opened early next year.

——— Messrs. D. H. Bonnella and Son, 58 and 60, Mortimer-street, Cavendish-square, W., and 42 and 43, Kirby-street, Hatton-garden, E.C., have been appointed by Messrs. W. B. Haigh and Co. (Limited), manufacturing electrical and general engineers, Oldham, sole representatives and agents for London and district for their dynamos, motors, switchboards, &c.

——— The Tudor Accumulator Company (Limited) notify the removal of their offices from 5, Cross-street, Manchester, to 16, Victoria-street, Westminster, London, S.W. The Company's works remain at Dukinfield, near Manchester.

——— The British Thomson-Houston Company (Limited) have opened a branch office in Glasgow, at 63, St. Vincent-street. This office is in charge of Mr. M. H. Bennett.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 27 to Nov. 2, with the ports of destination :—

Argentina—Buenos Ayres, £313 (including £193 telegraph material). *Australasia*—Adelaide, £10 ; Albany, £86 ; Auckland, £230 ; Fremantle, £382 ; Launceston, £120 ; Melbourne, £15 ; Sydney, £471 (including £203 telegraph material). *Belgium*—Brussels, £47 ; Ostend, £50. *Brazil*—Rio Janeiro, £77. *Burma*—Rangoon, £45. *Ceylon*—Colombo, £49. *Columbia*—Santos, £6. *Gibraltar*, £2,288. *Holland*—Amsterdam, £140 ; Harlingen, £10 ; Rotterdam, £118 (including £46 telegraph wire). *India*—Bombay, £47 ; Calcutta, £61 ; Kurrachee, £43. *Italy*—Spezzia, £1,041. *Japan*—Yokohama, £814 (including £42 telegraph material). *Madeira*, £170. *Malta*, £98 (including £85 telegraph material). *Russia*—St. Petersburg, £298 (including £121 telegraph material). *South Africa*—Cape Town, £766 ; Durban, £445 (including £131 telegraph material) ; Port Elizabeth, £900. *Spain*—Malaga, £20. *Sweden*—Gothenburg, £696 ; Stockholm, £234 (including £94 telegraph wire). *United States*—New York, £130. *Zanzibar*, £134 (including £85 telegraph material). Total, £10,354 against £5,650 in the corresponding week last year (Oct. 28 to Nov. 3).

Annuaire de l'Association Suisse des Electriciens.—The 1897 edition of this Annuaire gives, in addition to lists of the members of the Association and of Swiss firms engaged in electrical work, statistical information relating to telegraphs, telephones, &c., in Switzerland

Awards.—Messrs. Robey and Co. (Limited), Globe Works, Lincoln, obtained a gold medal, the highest award of merit, for their gas engine exhibited at the Brussels International Exhibition. This was the firm's only exhibit.

The Horsfall Furnace Syndicate were also awarded a gold medal for their patent refuse destructors, and a bronze medal for their patent smoke-consuming boiler furnace at Brussels.

Aberdeen.—A report on the electric lighting of the quays has just been presented to the Harbour Board by the Docks and Pilotage Sub-Committee. The Committee state that the quays surrounding the Victoria and Upper Docks are at present insufficiently lighted, and existing gaslights must be increased in number and illuminating power, or some more improved method of lighting adopted. Information as to the practice elsewhere had been received from the authorities of 99 British and Continental harbours, and visits were paid to Leith, Liverpool and Manchester. At a number of these ports electric lighting had been adopted with excellent results; and in view of the information received, and the requirements of Aberdeen, the Committee recommend that the quays and public sheds at Victoria and Upper Docks and the graving dock be lighted electrically, and that electric beacons be provided at the dock entrances for the better navigation of vessels at night. For the lighting of the quays it was proposed that one row of arc lamps, of 2,000 c.p. each, be erected along the middle of the quays at a height of 25ft. and 40 yards apart. The electric beacons would be of 6,000 c.p. each, and would be placed on standards 80ft. high, one at the entrance to Victoria Dock, one at Regent Bridge, and one at the entrance to the Albert Basin. The Town Council had offered to supply current at a reduced rate from the municipal electricity works, and the cost of lighting would be £1,700, which, it was anticipated, would be very considerably reduced in the near future. The Sub-Committee had also obtained tenders for a complete independent installation of generating machinery, mains, lamps, &c., and from an examination of these, and an estimate of the probable working expenses of the installation, it was found that the annual cost would not be less than £1,391. The tenders did not, however, allow for the provision of duplicate plant, for the cost of erecting station buildings, or for general superintendence. After full consideration of the whole question the Committee estimated the total annual expenditure of an independent plant at £1,570. The report, therefore, recommends that the supply of current be taken from the corporation mains. The cost of lighting the quays by electricity would be greater in the meantime than that of the existing gaslight, but the Committee were of opinion that the Commissioners must in any case be prepared to face a much larger expenditure in future to render the lighting of the quays satisfactory.

Aston (Birmingham).—The District Council have appointed Mr. J. C. Vaudrey consulting electrical engineer.

Asylum Lighting.—At the last meeting of the Staffs. County Council the Lunacy Committee recommended the acceptance of tenders, amounting to £9,500, for the installation of the electric light at Cheddleton Asylum. It transpired that tenders were not publicly advertised, and consequently the matter was sent back to the Committee in order that tenders should be publicly invited.

Banagher (Ireland).—The premises of the West of Ireland Distillery Company are being fitted up for the electric light by Messrs. Tuck and Co. (Limited), of Dublin.

Blackburn.—The Town Council have approved the scheme of the borough electrical engineer (Mr. A. S. Giles) for the electric lighting of the Preston New-road and Witton tramway routes.

Brierley Hill (Staffs.).—The District Council have rescinded their resolution insisting upon the British Electric Traction Company taking electric current for working the local tramways from the Council. The Company, however, undertake to erect a power-house in the district.

Buenos Ayres.—The Buenos Ayres and Belgrano Tramways Company have now obtained the sanction of the municipal authorities to substitute electric for horse traction over their entire system, which extends from Plaza Victoria, in the centre of the city, to the suburb of Belgrano. The period of the concession is 99 years.

Cathedral Lighting.—In the current month's issue of the Newcastle *Diocesan Gazette* it is stated that the arches and woodwork in the choir are suffering so from the effects of the gas that the vicar and churchwardens are seriously contemplating the introduction of the electric light, at any rate into that portion of the Newcastle Cathedral. The cost of this partial installation is estimated at £100.

Chapel Lighting.—The Portman Chapel (London), which has recently undergone considerable alterations and improvements, is now lighted electrically.

Chelsea (London).—The Vestry have appointed an Electric Lighting Committee, to deal with the question of the establishment of municipal electricity works in this district. A similar committee was appointed in 1882. Meantime, the Chelsea Company are in possession.

Commission of Sewers (London).—At the meeting of the Commission, on Tuesday, the solicitor brought up a report on the subject of the refusal of the City of London Electric Lighting Company to pay the expenses of the electrical inspector (Mr. A. A. Voysey), and reported that the Company had issued a writ for the recovery of £6,473. 11s. 8d. from the Commission. After some discussion the matter was left in the hands of the solicitor.

The question of granting the Post Office wayleaves for telegraph wires was also discussed, and Mr. Morton expressed regret at the action of the London County Council in giving away their rights over the streets under their control, and said it would be necessary for them to let the municipalities of the kingdom know of the stand the Commission was making against the action of the Post Office authorities. A motion that this communication be now forwarded to the municipalities and the local authorities of the metropolis, enclosing the correspondence which had passed between the Postmaster-General and the Commission on the subject was unanimously carried.

The Markets Committee submitted a report on the proposed light railway from Deptford Market to the station of the London, Brighton and South Coast Railway. The Light Railway Commissioners were of opinion that the scheme could not be entertained under the Light Railways Act, and therefore the Committee recommended that notice be given for promoting a Bill in the forthcoming session for powers to construct the line.

Cork.—The City Council had before them on Tuesday reports by the Electric Lighting Committee and the city engineer (Mr. H. A. Cutler) relative to the proposed agreement with the Cork Electric Tramways and Lighting Company for the electric lighting of the principal streets of the City. The scheme provides for the erection of 94 arc lamps and 220 incandescents (giving a total candle-power of 76,694) which would displace 276 gas lamps of 3,259 c.p. The present cost of gas lighting is £694. 2s., and the estimated cost of the electric lighting is put at £1,186. 2s. 11d. Under the terms of agreement, current for public lighting is to be supplied at 2½d. per unit, and after 12 o'clock two 32-c.p. incandescents will be substituted for each arc.

Crewe.—The draft of the order proposed to be made by the Light Railways Commissioners authorising the construction of light railways in Crewe was discussed at the last Council meeting. It was resolved to insist upon the insertion of a clause binding the promoters to construct the whole of the proposed railways in the borough, and to exact a bond of £200 per mile as a guarantee for the due construction of the lines. Various other amendments were proposed, and the Order was passed and directed to be sent to the Light Railway Commissioners for their approval.

Electricity in Quarrying.—At the recent meeting of the New Welsh Slate Company the Chairman said that he thought a large saving in their expenses might be made by the use of electric power, but, owing to want of funds, so far they had been unable to adopt it.

Florence.—A German Company (the Kontinentale Gesellschaft für Elektrische Unternehmungen) has commenced the erection of electricity supply works in this town.

Fraud.—Louis Héndlé, described as an electrical engineer, was this week sentenced at the Central Criminal Court to three years' penal servitude for obtaining money under false pretences from a number of persons. Prisoner had an office in Broad-street House, E.C., and obtained money for the supposed purpose of patenting and exploiting certain inventions relating to electrical appliances.

French Inland Telegraph Charges.—M. Deloncle has given notice of an amendment to the forthcoming Budget in favour of reducing the minimum charge for an inland telegram to 25 centimes (2½d.) for 10 words or under. The present minimum charge is 50 centimes.

Glasgow.—The joint sub-committee recently appointed to consider the lighting of the Springburn tramway road recommend that the whole of the route from Mitchell-street terminus to Springburn should be lighted electrically. It is proposed to light Mitchell street by fixing cross wires to the buildings by means of rosettes; to light Parliamentary-road and Castle-street by erecting poles on both sides of the street, and to light a portion of the route at Sighthill by fixing single poles, with overhanging arms, in the centre of the thoroughfare. This experiment is intended to assist the committee in a selection of the system best adapted for the different thoroughfares when the greater extension of street electric lighting comes to be considered, which it must shortly be.

Greenwich (London).—The District Board of Works have received a report from Mr. A. H. Preece relative to the question of establishing electricity supply works. The District Committee have been instructed to consider and advise upon the recommendations in the report.

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Hackney (London).—A special meeting of the Vestry was held on Wednesday evening, for the purpose of considering a proposal to transfer the Provisional Order to a company. At the last meeting of the Vestry a joint report was presented by the Public Health and Electric Lighting Committees on certain prosposals for the erection of electric lighting and refuse destructor works. They had fully considered these proposals for the transfer of the Order. In each scheme the destruction of dust was to be carried out at prices varying from 1s. 1d. to 1s. 3d. per ton, and electric current would be supplied at from 5d. per unit for private lighting. The Vestry would also have the right to purchase the undertaking on certain terms. The Committee, therefore, recommended that they be empowered to submit a proposal for the transfer of the Order, but it was pointed out that as the Vestry had decided to itself undertake the erection of electricity supply works, the report could not be received. Thereupon the chairman ruled the report out of order. The Vestry will, therefore, have to rescind this resolution before any proposal for the transfer can be discussed. It will be seen that electric lighting matters in Hackney continue to be somewhat involved.

Hammersmith (London).—On the recommendation of the Electric Lighting Committee the Vestry have decided to transfer the arc lamps in Shepherd's Bush-road and the Lawn from the sides to the centre of the road.

Heligoland.—Herren Oscar Baensch and Co., of Berlin, agents for Messrs. Brown, Boveri and Co., have obtained a concession from the municipal authorities for the erection of electricity supply works in this island for public and private lighting. The Council undertake to take electric current for lighting the streets and public places.

Jassy (Roumania).—The concession for the erection of electricity supply works for the public lighting of the streets of this town has been given to the Kontinentale Gesellschaft für Elektrische Unternehmungen, of Halle.

Lambeth (London).—The Vestry have granted permission to the South London Electric Supply Corporation to lay electric light mains in certain thoroughfares in Brixton, Clapham, Stockwell, Herne Hill and Norwood.

Light Railway Notices.—During the week the following further notices to the Light Railway Commissioners, relating to schemes for the construction of light railways, have appeared :—The Folkestone District Electric Railways Company (Limited) intimate their intention to apply for powers to construct a system of light railways and tramways in *Folkestone* and district. The gauge is to be 4ft. 8½in., and the motive power electricity. The Bournemouth, Poole and District Light Railways (Electric) Company (Limited) have notified their intention to apply for powers to construct light railways from *Poole* through *Parkstone*, *Bournemouth*, *Boscombe*, *Pokesdown* and *Southbourne-on-Sea*, with branch lines to *Seaview-road*, *Winton* and *Springbourne*. The gauge in this case is to be 3ft. 6in., and the lines are to be worked by electricity or other mechanical power. The British Electric Traction Company also propose to apply for an Order authorising the construction of a system of light railways in the borough of *Poole*, the urban district of *Boscombe*, the municipal boroughs of *Bournemouth* and *Christchurch*, the urban district of *Pokesdown*, and the rural district of *Christchurch*. A gauge of 3ft. 6in. is proposed, and power is sought to employ electric or other mechanical power on the lines. The same Company have also notified their intention of applying for powers to construct electric tramways from *Castleton* to *Middleton* and *Rhodes*, and from *Middleton* to *Oldham*, *Lancs*. The overhead trolley system will here be adopted.

Limehouse (London).—As the result of a visit to the Shoreditch electric supply station by a deputation from the Limehouse Board of Works, the question of the erection of joint electricty supply and refuse destructor works has been referred to the Works Committee for consideration and report.

Lincoln.—The alternative schemes for street lighting prepared by the borough electrical engineer (Mr. C. S. Vesey Brown) were considered at the meeting of the Council on Tuesday. The scheme finally adopted provides for the erection of 27 arc lamps in main thoroughfares.

Middleton.—The minutes of the Gas and Electric Lighting Committee of the Town Council state that many promises of support have been received for the proposed electric lighting project. A communication has been received from the British Electric Traction Company relative to the construction of an electric tramway from Castleton to Middleton and Rhodes, and from Middleton to Oldham. A committee was appointed to consider this matter.

Naval Dockyard Lighting.—In a recent issue we announced that the Admiralty proposed to make considerable extensions of the electric lighting installations at the various dockyards. In regard to Portsmouth it is proposed to erect a station between the new electric shop and the wing of the old convict prison, which has been converted into an electric store, and current will be supplied not only for lighting the entire dockyard, but also for electric motors, a plan which will, it is claimed, ensure economy and concentration. The present cost of the gas lighting is about £3,000 a year, and it is estimated that the new scheme will entail an immediate outlay of £30,000 and an ultimate expenditure of £100,000.

Newspaper Enterprise in India.—There is usually little to be said in favour of such specimens of the Indian newspapers as reach us from time to time, but we have just received a set of artistic supplements issued by the *Statesman*, an old-established daily paper published at Calcutta, and those who take an interest in really artistic groupings of scenery, traders' announcements, types of native men and women, views of some of the temples and other show places of India, &c., have in these supplements an opportunity of gratifying their tastes in this direction.

Paddington (London).—The Vestry recently decided to make an experiment in street lighting by arc lamps, and Westbourne-terrace has been selected as the most suitable thoroughfare for carrying out the experiment.

Presentation.—Mr. W. A. Valentine, the Manchester District Manager of the National Telephone Company, was recently presented with a handsome time-piece and ornaments by the members of the Company's staff on the occasion of his marriage. The presentation was made by Mr. William Taylor.

Provisional Order Notices.—The usual official notices of intention to apply for Provisional Electric Lighting Orders have been given in the following cases :—For the district of *Nuneaton*, the Nuneaton Electric Company (Limited); for the parish of *Aldrington* (*Hove*), the Urban District Council of Hove; and for the district of *Partick* (*Glasgow*), the Kelvinside Electricity Company (Limited).

Provisional Orders.—The following additional Local Authorities have passed formal resolutions in favour of applying to the Board of Trade for Provisional Orders : The *Crewe*, *Perth*, *Weymouth* and *Wigan* Town Councils and the *Rawmarsh* (Sheffield) Urban District Council. At the last meeting of the *Marylebone* (London) Vestry it was unanimously resolved to notify the Metropolitan Electric Supply Company (who already supply current in the district) of its intention to apply for an Order, and the County of London and Brush Provincial Company and the Marylebone Electric Supply Company also propose to seek powers for this district.

Railway Train Lighting.—At the recent meeting of the shareholders of the Glasgow District Subway Railway Company, the Chairman stated that considerable difficulty had been experienced in establishing an effective electric light installation in the cars. This difficulty, had, however, been overcome, and the cars were now provided with the electric light; and the result had, no doubt, added greatly to the comfort of the passengers.

Taunton.—We are pleased to announce that Alderman W. Potter, who has done good service as Chairman of the Electric Lighting Committee, has been unanimously invited to accept the Mayoralty for the ensuing year.

Telegraph Extension in South Africa.—In the course of his address on "The Railway System of South Africa," before the meeting of the members of the Colonial Institute, on Tuesday, Sir David Tennant, K.C.M.G., Agent-General for the Cape of Good Hope, stated that the telegraph system, being necessarily connected with railway expansion, communication in the colony by means of the electric telegraph had considerably increased during the last few years. The number of miles of wire erected in 1896 was 16,326, and the number of miles of line 6,464. The revenue last year amounted to £252,910, and the total number of messages forwarded was 2,229,663. These lines had cost a little over half-a-million, which had been raised on loan, and the surplus interest on this investment was considerable. The colony of the Cape of Good Hope was drawing the different portions of the vast South African country closer to each other by further railway and telegraph extensions, and was seeking to secure closer and more friendly commercial relations with adjoining states and colonies.

The Strike.—No progress towards conciliation is to be recorded in connection with the strike and lock-out of the engineers. Both masters and men have sent in replies to the Board of Trade in response to Mr. Ritchie's invitation to attend a conference. The masters' view of the proposal is that if the basis suggested by the Board of Trade is accepted the conference would result in no practical arrangement being arrived at, as it would leave the question of the relations between the employers and workmen the same as before the stoppage of work took place, with all the consequent liability of further industrial disturbances in the near future. The reply from the men's representatives is in the form of acceptance of the draft proposals "with certain amendments." It is clear from both replies that the suggested conference does not meet with enthusiastic acceptance from either party, and the dispute seems as far from settlement as ever. The result of the second attempt of the Board of Trade to bring the parties together seems, therefore, likely to fail. It is thought, however, that the replies contain

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declarations which may afford another opportunity for intervention by the Department. Early in the week it was stated that the masters had come forward with a benefit scheme, which was calculated to seriously affect the position of affairs, as being likely to influence the Society men and to induce the faint-hearted among them to return to work. This is described by the men's representatives as another direct attack on trades' unionism, but whether this be the case or not, there can be no doubt that if the Federation of Employers is prepared with a workable scheme, whether on profit-sharing, endowment assurance, or other lines offering permanent benefit to qualified workmen, a large number of the engineers would be likely to accept such a scheme as a sufficient inducement for giving up the benefits offered by the trades' unions in the shape of out-of-work and "strike" pay. The masters will certainly be well advised to centre their attention on some attractive benefit scheme. On Wednesday a manifesto was issued on behalf of the men asking the support of the trades unionists and workers throughout the country. £10,000 per week, it is stated, will place the Amalgamated Society in a position to stand out for their terms. It is noticeable that particular attention is given in this manifesto to the reported benefit scheme of the employers. Whether the charge against the men's leaders of a desire for the dispute to continue be true or not, these persons do not appear to take at all kindly to the suggested benefit scheme. On Wednesday also an ultimatum was issued to the London members of the Boilermakers' Society who have come out on strike from the London ship-repairing yards. This ultimatum was to the effect that, unless the men return to work forthwith, they will be declared out of benefit. The shops from which the men have come out are declared open to the members of the Society. The engineers are receiving large contributions from abroad, more particularly from Germany, and even from Russian sympathisers (*vid* Switzerland). It is stated that the Employers' Federation now consists of 635 adhering firms.

The Telephone at Huddersfield.—When Mr. A. B. Mountain, borough electrical engineer of Huddersfield, gave his evidence at the Government Inquiry held at Glasgow recently, he informed the Commissioners that application had been made by the National Company for leave to place their wires underground, but that at present he could not advise the Corporation to give its sanction to this application. We now learn that the National Company are not only proposing to place their wires underground, but also to abolish the district exchanges so as to concentrate their subscribers in the central office. Altogether, it is stated, a total expenditure is involved of between £30,000 and £40,000. It will be remembered that the Huddersfield Corporation have themselves erected an exchange with a twin-wire circuit.

Thorpe.—Messrs. Laurence, Scott and Co., of Norwich, have just completed the contract for an installation of the electric light at the new laundry at the Norfolk County Asylum, Thorpe. The plant, consisting of dynamos, accumulators, &c., has now been placed under the charge of the resident engineer, Mr. Chas. Cannell.

Vera Cruz (Mexico).—The Compañia Industrial de Orizaba is engaged in constructing an extensive water-power electric transmission plant which, it is calculated, will add about 2,500 H.P. to that already available for use in this Company's factory at Rio Blanco. The Custom House and the Arsenal at San Juan de Ulna have been fitted up for a complete installation of the electric light, and at the Custom House there is an electric search light of 12,000 c.p.

Waterloo and City Railway.—According to the *Street Railway Review* the cars, both motor and trail, of the Waterloo and City Underground Railway are being equipped with automatic couplings of American design, known as the "Van Dorn" coupling, supplied by the W. T. van Dorn Company.

Waterloo (Liverpool).—At the last meeting of the District Council it was decided to light some of the principal streets of the district electrically.

Westgate (Kent).—At a recent meeting of the Parochial Committee a report on the electric lighting of the district, which had been prepared by Mr. W. C. C. Hawtayne, was considered, and after discussion it was decided to apply for a Provisional Order. This decision has been confirmed by the Rural District Council.

West Ham.—The Mayor (Alderman A. Govier) laid the foundation-stone of the electricity supply station and sewage pumping buildings yesterday (Thursday).

Workhouse Lighting.—The West Derby Guardians have appointed a sub-committee to report upon the question of lighting the workhouse and offices electrically. The Shoreditch (London) Guardians considered at their last meeting a report on the electric lighting of the workhouse, offices, &c. The total capital expenditure involved was put at about £1,100, and the annual cost reckoned at about 10 per cent. more than gas. It was decided to defer the matter for the present.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

October 4, 1897.

2,657. H. J. ECK and H. KING-SMITH. London. An improved switch for large numbers of electric circuits.

22,693. W. G. POTTER. London. Improvements in oval incandescent filament lamps.

22,717. C. E. S. PHILLIPS. London. Improvement in interrupters for electrical circuits, more particularly applicable to induction coils.

22,728. C. S. SNELL. Cornwall. Improvements in connection with stowing and handling submarine cables on board ship.

22,729. C. S. SNELL. Cornwall. Improvements in connection with submarine cable-laying appliances.

22,738. G. THOMAS-DAVIES. London. Improvements in or connected with telephonic apparatus.

October 5, 1897.

22,772. M. E. THOMPSON. London. Improvements in dynamo electric machines.*

22,796. J. PESCHEK. London. Improved wall connection for electric lighting.

22,800. W. E. DOW. London. Improvements in electrical apparatus for use in dental surgery and other electro-surgical treatments.*

22,806. C. S. BRADLEY. Manchester. Improvements in and relating to alternating-current dynamo-electric generators.*

22,807. C. S. BRADLEY. Manchester. Improvements in and relating to alternating-current electro-motors.*

22,844. H. H. LAKE. London. Improvement in switches for electric railways. (Detroit Automatic Switch Company, Limited, United States.)*

22,845. J. CLOOS. London. Improvements in and relating to junction boxes for use in electric distribution systems. (Date applied for under Patents, &c., Act, 1883, Sec. 103, March 6, 1897, being date of application in United States.)*

22,849. S. SZUBERT. London. Electric signalling apparatus.*

22,851. W. P. THOMPSON. London. Improvements in electrical measuring instruments. (O. Blackburn, Shallenberger, United States.)

22,852. R. BELFIELD. London. Improvements in phase-adjusting and regulating methods and means for alternating current apparatus. (E. M. Tingley and O. B. Shallenberger, United States.)

October 6, 1897.

22,895. A. WATSON. Birmingham. Improvements in cord-grips for electric lampholders.

22,897. T. TAYLOR. Birmingham. Improvements in cut-outs for electric lighting and other purposes.

22,939. C. E. KELWAY. London. Improvements in connection with electric lamps and apparatus for signalling and advertising purposes.

October 7, 1897.

23,033. H. C. GOVER, M. S. BLAIR and C. F. PROCTOR. London. An improvement in electric plug contacts.*

23,057. E. C. CROCKER and E. C. HOWE. London. Improvements in and relating to electric railways.*

October 8, 1897.

23,097. G. H. NISBETT. Liverpool. Electrical conductor or cable.

23,098. G. H. NISBETT. Liverpool. Conduits for underground electrical conductors.

23,099. J. SWINBURNE. London. Improvements in or connected with arc light electrical generators.

23,123. J. S. JOHANSEN. London. An electrolyte for carbon and zinc elements suitable for lighting and other purposes.*

October 9, 1897.

23,192. R. H. FINLAY. Belfast. A dynamo-electric machine and motor.

23,239. W. P. THOMPSON. Liverpool. Improvements in automatic telephone exchanges. (The Strowger Automatic Telephone Exchange, United States.)*

23,260. W. M. SCOTT. London. Improvements in automatic magnetic circuit breakers. (Date applied for under Patents, &c., Act, 1883, Section 103, March 17, 1897, being date of application in United States.)*

October 11, 1897.

23,267. J. E. BRYANT. Redditch. Improvements in apparatus for the electro-deposition of one metal on another.

23,296. W. FAIRWEATHER. Glasgow. Improvements in indirect regulation of dynamo-electric machinery. (The Crocker-Wheeler Electric Company, United States.)

23,304. R. WOOD. London. Improvements in magnetic circuit and its use.

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23,329. G. PLATNER. London. Improvements in and connected with substances to prevent polarisation in electric batteries.*

23,332, E. A. PARIS. London. Improvements in secondary battery plates or electrodes.

23,342. F. C. BOURNE and J. G. STIDDER. London. A combined electrical alarm and automatic switch.

23,352. A. ZIMMERMANN. London. Improvements in the manufacture of electrodes for electrolytic processes. (The Chemische Fabrik auf Actien vormals, E. Schering, Germany.)

28,369. H. C. GOVER and C. F. PROCTOR. London. An improvement in electric safety fuses.*

October 12, 1897.

23,418. T. B. MURRAY and G. JOHNSTON. Glasgow. Improvements in electro-motors and dynamos.*

23,422. W. G. HEYS. Manchester. Improvements in electromagnetic clutches. (The Singer Industrial Company, United States.)*

23,442. J. Y. JOHNSON. London. Improvements in electrolytical current-directing devices and transformers. (C. Pollak, Germany.)

23,470. W. NERNST. London. Improvements in electric incandescent lamps and apparatus, or appliances in connection therewith.

23,489. C. P. ELIESON. London. Improvements in electric storage cells.

October 13, 1897.

23,513. G. A. NUSSBAUM. London. Improvements in telephone receivers and the like. (La Société Industrielle des Téléphones, France.)

23,514. J. MCKENNY and A. E. PORTE. Dublin. Improvements in or relating to electric tramways or railways.

23,530. F. E. STUART and A. P. FORD-MOORE. London. Improvements in bicycle holders and their combination with electric contact makers.

23,602. E. J. J. B. BENOIT. London. Improvements in anodes of electro-decomposing apparatus.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

21,273. LIARDET. Electric storage batteries.

23,698. NORTHEY. Electrical governors.

23,706. HEATON and SMITH. High insulation tumbler switch.

25,242. BELFIELD (Wurts and Skinner). Electrical discharge apparatus.

25,500. VERITY. Electric lamp holders, sockets, and the like.

25,600. SMITH. Electric arc lamps or lighting apparatus.

25,943. MAYER. Portable electrical batteries.

1897.

8,280. KLEIN. Electro-medical apparatus and brushes for use therewith.

13,977. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) (Steinmetz). Three-phase alternating current induction meters.

17,691. DOULTON AND MORRIS. Electrical conduits.

18,556. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED (Hewlett). Lightning arresters.

18,628. COLE. Portable electric primary batteries.

19,118. GOLDSCHMIDT. Dynamo-electric driving apparatus especially suitable for propelling vehicles.

COMPANIES' MEETINGS AND REPORTS.

West India and Panama Telegraph Company (Limited).

The report of the Directors of this Company for the half-year to June 30th last refers to the lamented death of Mr. C. W. Earle, who had been Chairman of the Board since 1874. He is succeeded in the chair by Mr. Andrews.

The accounts for the six months show a credit to revenue of £38,209. 14s. 4d. against £42,317. 13s. 10d. for the corresponding half-year of 1896, and the expenses have been £21,426. 17s. 10d. against £22,280. 14s. 7d., leaving a balance of £16,782. 16s. 6d., which, with £646. 3s. 2d. brought from last account, makes a total of £17,428. 19s. 8d., with which it is proposed to deal as follows:—

Dividend on First Preference Shares (6s. per share)	£10,360	18	0
Dividend on Second Preference Shares (6s. per share)	1,400	14	0
Dividend on Ordinary shares (1s. per share) (free of income tax)	4,416	1	0
Balance forward	1,243	6	8
	£17,428	19	8

The traffic receipts show a decrease of £3,124. 9s. 1d., compared with the corresponding period, which is due chiefly to the tariff reductions the Directors were compelled to make, as explained in the last report. This renewed experience of reductions of rate again proves that they do not stimulate West Indian traffic, and invariably result in a loss of revenue.

The expenses of repairing cables during the half-year amounted to £8,763. 19s. 7d., about the same as those for the corresponding period.

In the last report reference was made to the partial competition of the French Company and the probability of fuller competition when that Company repaired its Hayti-Martinique cable. That repair was effected in July last, when the greater part of the traffic of the French colonies of Martinique and Guadeloupe was diverted from this Company's lines to those of its subsidised competitor. The tariff reductions, combined with the loss of the above traffic, are adversely affecting the receipts for the current half-year.

The shareholders have previously been informed of the intention of Her Majesty's Government to establish a cable between Bermuda and Jamaica. With the view of meeting, if possible, the wishes of the Government, and at the same time of preserving and protecting the already inadequate traffic of the Company, the Directors, in concert with the Cuba Submarine Company, and subject to the confirmation of the shareholders, submitted proposals to the Colonial Office for the establishment of the line. The conditions offered were very onerous upon the Companies, but were not accepted by the Government, which proposed other terms involving lower tariff rates, together with an inadequate subsidy. These terms, with certain other considerations, involved such further large sacrifices of revenue that the Directors could not accept them, and ultimately the contract for the cable was made by the Treasury with the Halifax and Bermudas Cable Company.

Western and Brazilian Telegraph Company (Limited).

The report of the Directors of this Company for the half-year ended June 30 last states that the total earnings amount to £59,754. 17s. 8d., against £71,082. 4s. 9d. (a decrease of £11,327. 7s. 1d.) compared with the half-year to June 30, 1896. The loss of revenue is to a great extent owing to the very low rate of exchange prevailing during the half-year, and also to a falling-off in traffic. This is partially accounted for by the fact that the cables of the River Plate Telegraph Company (Limited) (between Monte Video and Buenos Ayres and with which Company this Company has a working agreement), were closed by order of the Argentine Government from Jan. 30th to Aug. 9th. The working expenses amount to £44,575. 12s. 4d., against £37,428. 9s. 1d., an increase of £7,147. 3s. 3d.; the greater part of which (upwards of £6,000) was caused by the hire and expenses of shipping to replace the "Norseman" during repairs and on account of maintenance. Including the amount brought forward from 1896 (£6,405. 11s. 5d.), the balance to the credit of revenue is £29,084. 16s. 9d., from which has to be deducted £8,983. 10s. 5d. for debenture interest, and £1,625. 13s. 2d. for income tax. For the purpose of equalising dividends the Directors have transferred £7,500 from the reserve fund, and now recommend the payment of a dividend (free of income tax) for the half-year, at the rate of £2 per cent. per annum, against £2 per cent. per annum for the corresponding period of 1896, carrying forward £3,867. 15s. 2d. This dividend will be payable: 3s. per share to the Ordinary shares, and 3s. per share to the Preferred Ordinary shares. The dividend warrants will be issued on the 12th inst.

Since the last report £1,300 "A" and "B" Debentures have been exchanged, making a total of £329,800 Debentures exchanged, leaving only £9,000 "A" and "B" unexchanged. At Dec. 31st last the Debenture redemption fund had a credit balance of £116,135. 10s.; from this has been deducted the cost of the premium and expenses of the issue of the new Debenture Stock, and the sum required to provide for the "A" and "B" Debentures still unexchanged, leaving a balance of £47,414. 10s., which has been placed to the credit of reserve, now standing at £56,181. 7s. 7d. The ninth annual drawing of the "A" and "B" Debentures took place at the Company's Offices on Jan. 18th last, when Debentures amounting to £16,900 were drawn and have since been paid off at par.

There is no change in the position of affairs between the Government of Brazil and the Company as to the purchase of the cables. The report refers to the profound regret of the Directors at the death of Mr. C. W. Earle, and notifies the appointment of Mr. T. W. Andrews to fill the vacancy on the board of directors.

The conversion of Ordinary shares into Preferred Ordinary and Deferred Ordinary shares is suspended until further notice.

NEW COMPANIES, STATUTORY RETURNS, &c.

ACKROYD AND BEST (LIMITED).—This Company was registered on Oct. 27 with a capital of £25,000, in £5 shares (of which 3,200 are Preference) to carry on the business of manufacturers of and dealers in miners' safety lamps and lamp-cleaning machines, and electric lighting and other apparatus, now carried on under the style or firm of "Ackroyd and Best," at Hembrigg Works, High-street, Morley. The first Directors are William Ackroyd and James Inman.

CAPE ELECTRIC TRAMWAYS (LIMITED).—This Company was registered on Oct. 29 with a capital of £400,000, in £1 shares, to enter into an agreement with Messrs. Wernher, Beit and Company, to construct, purchase, lease or acquire any tramways or light railways in Cape Colony, or elsewhere in South Africa, to equip, maintain, and work by electrical or other power any such tramways or light railways, and to carry on the business of carriers of passengers and goods, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The first subscribers, with one share each, are: A. J. Swan, A. Eldridge, P. M. Cullen, W. Harrison, T. H. Riches, E. T. Church, and H. W. Brown.

CRAIGPARK COMPANY (LIMITED).—This Company has been registered in Scotland, with a capital of £30,000, to carry on the business of manufacturers of and dealers in telegraphic and other electrical apparatus, plant and machinery.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half month, ended Oct. 31 is £2,028, against £2,394 in the corresponding period of 1896.

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CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26⅝d. per oz. (Nov. 4). Consols (2¾ per cent.) 112—112⅛ for money, 112⅛—112¼ for account; 2½ per cent. 105—105¼ (Nov. 4). Stock Exchange Settling Days; Stocks and Shares Continuation Days, Nov. 9 and 24; Ticket Days, Nov. 10 and 25; Pay Days, Nov. 11 and 26; Mining Share Carry-over Days, Nov. 8 and 23.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.—This Company have declared a dividend of 15 per cent. for the past year, against 13 per cent. for the year 1895-6.

AUTOMATIC TELEPHONE COMPANY (LIMITED).—The statutory meeting of this Company was held on Friday last, Mr. Max Margowski (Chairman of the Company) presiding. The Chairman referred to an article which had appeared in the *Agence Nationale*, which prevented him giving the shareholders such information as he would otherwise have been able to do. The article in question stated that a certain syndicate was in treaty for the acquisition of one of their patents for 25,000,000fr. Such a premature statement was very injurious to their interests. The article contained many misrepresentations. "Their telephone was of a most simple character. You first of all compose the number of the party to whom you wish to communicate on the telephone; you then push a small bolt, and you are then automatically connected. It can be adapted to any existing system all over the world, either the overhead wire system or the underground system. It can be used with the double-wire system, such as is in use in England and in other countries, or for the single-wire system such as they have in Germany, Switzerland, and, he thought, Denmark." The moment the Directors were in receipt of a telegram which they were expecting to receive they would communicate it to the shareholders, who were spread all over the globe. He must request the shareholders after what had happened to refrain from raising any discussion which was likely to be injurious to the interests of the shareholders at large. Mr. Seligmann-Lui, their consulting engineer, would have been present at this meeting but for the fact that he has been compelled to return to Paris. They had a very valuable invention, and its simplicity might be easily understood when he told them it might be compared to the application of a key to an ordinary door lock.

COMMERCIAL DEVELOPMENT CORPORATION (LIMITED).—An abridged prospectus will be found set out in our advertisement columns of the Commercial Development Corporation (Limited) which has been formed with a capital of £200,000, in £1 shares, amongst other things, "to purchase from Mr. A. R. Harvey Rhodin's Patent Electrolyser, including foreign and colonial patents and protections, and to work, licence, and otherwise fully exploit and commercially develop the same, and to promote and form subsidiary companies for the purchase of the patents or of royalties and rights." Some particulars of the Rhodin system of electrolytic production of alkali and bleaching powder was given in *The Electrician* for Oct. 29. The directorate includes Mr. W. Bannister, a Director, and Mr. George A. Grindle, General Manager of the Chloride Electrical Storage Syndicate, and several of the other Directors of the Company are connected with leading trading concerns. Mr. J. G. A. Rhodin, the inventor, is consulting chemist and electro-metallurgist to the Company, and Mr. S. A. Bartlett, F.I.S., 34, Castle-street, Liverpool, is the Secretary. The present issue is for 90,000 Ordinary shares and 10,000 Deferred shares, of which 70,000 Ordinary are now offered to the public. Every allottee of 100 Ordinary shares is entitled to subscribe for and receive five Deferred shares at £2 per share. 2s. 6d. is payable on application, 7s. 6d. on allotment, and the balance in two instalments of 5s. each, with not less than three months' notice. The purchase price of the patents has been fixed at £90,000, payable as to £60,000 in cash, £20,000 in fully paid shares, and £10,000 in deferred shares, which are not entitled to participate in profit until a dividend at the rate of 10 per cent. for the year has been paid upon the ordinary. This leaves a working capital of £10,000 out of the £100,000 now being subscribed, and there will remain £100,000 for further issue as and when required. Sufficient capital for the present needs of the Company having been subscribed by the Directors and their friends, the Company will at once proceed to allotment on the closing of the lists, which open this day (Friday) at 10 a.m., and close at 4 p.m. on Monday next for both town and country.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for July were £2,926, against £4,766 in the corresponding month of last year.

DIRECT WEST INDIA CABLE COMPANY (LIMITED).—The prospectus of this Company was issued yesterday (Thursday) and, as will be seen from the advertisement, the lists of applications were to have closed on Saturday. The appreciation in which such stock and shares are held is, however, very clearly shown by the fact that the list was closed almost as soon as the prospectus was issued. Subscriptions were invited for 12,000 shares of £5 each (£60,000), and £120,000 in 1,200 Four and a-Half per Cent. Debentures of £100 each. The shares were issued at par and the debentures at £95 per cent. The payments on the shares are £1. 5s. on application and £1. 5s. on allotment. For the debentures £10 is payable on application, £25 on allotment, £25 on Nov. 30, and £35 on Dec. 30. The Company has been established to carry out an agreement entered into between Her Majesty's Government and the Halifax and Bermudas Cable Company (Limited), for the laying and working of a submarine cable from Bermuda to Jamaica *vid* Turk's Island, for which Her Majesty's Government undertake to give a subsidy of £8,000 per annum for 20 years, upon the terms and subject to the conditions of the said agreement. The new cable will bring Jamaica into direct cable communication with Great Britain, *vid* the Halifax and Bermudas Cable Company's system from Halifax, Nova Scotia. The prospectus (which will be found set out on another page) states that the Jamaica Legislative Council have adopted a recommendation in favour of granting an annual subsidy of £2,000, and a highly advantageous contract has been entered into with the Telegraph Construction and Maintenance Company (Limited), for the construction and laying of the cable by Jan. 31 next. More than half the share capital now offered has been already subscribed by the directors and their friends, and the debentures are secured by the transfer to the trustees, the Right Hon. Lord Strathcona and Mount Royal and Mr. Thomas Skinner, of the Government subsidy above referred to, and also of the cable to be laid by the Company under the agreement and of all stations, buildings and plant to be erected, acquired or used by the Company for the purpose of working the cable. The debentures will be redeemed by purchase or by drawing at par, and these drawings or purchases will be commenced on June 30, 1900. There is no waiver clause, and all documents which subscribers to the issue might desire to inspect can be seen at the Company's offices, 33, Old Broad-street, London, E.C.

ELECTRO-CHEMICAL COMPANY (LIMITED).—The report of the Directors of this Company, just presented, states that, in accordance with the wish expressed at the last annual meeting, the offices of manager, secretary, engineer, electrician, and chemist are now filled by separate officials. Mr. Leith's engagement as general manager terminated last April, when he was replaced by Mr. F. W. Fidler, as superintendent at the works, and Mr. R. Shaw has been appointed secretary. Shortly after the last meeting the working of the steam turbine dynamos (forming two installations of 550 H.P. each) had to be discontinued, and had not been resumed since. Serious loss had been sustained by the Company owing to the great delay in the first delivery of this machinery, and its inefficiency when set to work. Every endeavour had, however, been made to push forward as rapidly as possible the completion of new engines and dynamos, and the Directors were able to report that three new installations of 800 H.P. each were now running efficiently and doing their work well. Excellent caustic soda, bleaching powder and chlorate of potash, all of full commercial strength and of the highest quality, were being turned out by the Company's electrolytic process, and were readily sold at the best market prices of the day.

RHEINISCHE SCHUCKERT-GESELLSCHAFT FUR ELEKTRISCHE INDUSTRIE AKTIEN-GESELLSCHAFT MANNHEIM.—This Company has been formed, with capital of M.3,000,000 (£150,000), for the purpose of taking over the Mannheim, Strasburg and Sankt Johann A. S. branches of the Schuckert Company.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have appointed Wednesday, the 10th inst., a special settling day for 14,470 Six per Cent. Cumulative Preference Shares (Nos. 5,531 to 20,000) and 10,025 Ordinary shares (Nos. 29,626 to 39,650) of the British Insulated Wire Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Oct. 29th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,048.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Aggregate—to date. Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Oct. 30	3,590	+398	...	...	...
Bristol Trams & Carriage	,, 29	2,571	+687	17	46,029	+6,047
City & South London Ry.	,, 31	1,018	+ 2	18	16,538	− 173
Dover Tramways	,, 23	122	...	8	1,036	...
	,, 30	117				
Dublin United (Southern)	,, 29	477	+ 63	17	12,267	− 607
Liverpool Overhead Rly.	,, 31	1,364	+252	18	26,089	+3,487
Sheffield Tramways	,, 31	961	+131	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Oct. 27.	Price Wednesday, Nov. 3.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 30. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	3/0	Central London Ordinary	9¾ 10¼	9¾ 10¼	2 17 2	June and December	..	..
146,106	10	1/3	Do. (£6 paid)	5½ 6	5½ 6	3 0 0	,, ,,	⅛	—
£000,000	Stock	2	City and South London Railway Con. Ordy.	69 71	69 71	2 12 10	January and July	70½	69½
8,419	£10	5%	Do. 5% Perpetual Preference	15½ 15¾	15½ 15¾	3 4 6	,, ,,	..	..
£:26,761	Stock	4%	Do. 4% Perpetual Debenture ..... xd	138 140	137 139	2 17 7	May and November	..	..
54,000	10	⅛	Waterloo and City Ordinary	12¾ 13¼	12¾ 13¼	2 5 3	June and December	..	..
27,000	10	3	Liverpool Overhead Railway Ordinary	11⅛ 11¼	11⅛ 11¼	2 12 2	February & August	—	—
14,000	10	5%	Do. 5% Preference	10 10½	10 10½	3 0 7	,, ,,	—	—
125,000	Stock	4%	Do. 4% Debentures	110 112	110 112	3 11 5	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Oct. 27.	Price Wednesday, Nov. 3.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending Oct. 30. Highest	Lowest
			TELEGRAPHS			£ s. d.			
£923,960	Stock	14/0	Anglo-American	57 59	57 59	4 13 3	Feb., May, Aug., Nov.	57½	..
£3,038,020	Stock	23/0	Do. Preferred	104 105	104 105	5 6 6	" "	106⅞	104
£3,038,020	Stock	5/0	Do. Deferred	12¼ 12⅝	12 12½	..	" "	12⅝	12⅜
£137,400	£100	4%	*African Direct Telegraph (Red)	101 105	101 105	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	5½ 6½	5½ 6½	..	" "	..	..
130,000	10	5/0	Brazilian Submarine	16 16½	16 16½	4 4 10	Mar., June, Oct., Dec.	..	..
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	114 118	114 118	4 5 10	June and December	16⅜	16
10,000,000	$100	7%	Commercial Cable Capital Stock	178 183	183 183	3 14 6	Jan., Apr., July, Oct.	..	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105 107	105 107	3 14 9	" "	106½	105⅞
16,000	10	8/0	Cuba Submarine	8½ 9½	8½ 9½	8 8 5	February and August	9½	..
6,000	10	10%	Do. Preference 10 per Cent.	18½ 19½	18½ 19½	5 2 7	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞ 106⅞	103⅞ 106⅞	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10½ 10¾	10½ 10¾	5 12 8	Jan., Apr., July, Oct.	10⅝	10½
400,000	£10	2/6	Eastern	16¾ 17¼	16¾ 17¼	3 15 4	" "	17¼	16⅞
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18 19	18 19	3 3 8	" "	18⅛	18½
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.) xd	132 135	130 133	3 0 2	May and November	134	..
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101 104	101 104	4 14 9	February & August	..	..
250,000	10	2/6	Eastern Extension xd	18 18½	18 18½	3 17 9	Jan., Apr., July, Oct.	18⅝	18⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	131 134	131 134	3 0 0	February & August	132	131
£125,700	£100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	100 104	100 104	4 17 4	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	100 104	100 104	4 17 4	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103 106	103 106	3 15 8	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.) xd	109⅞ 112⅞	109⅞ 112⅞	3 12 9	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust xd	11½ 12	11½ 12	3 15 0	Jan., Apr., July, Oct.	11⅞	11⅝
180,042	10	6%	Do. 6 per Cent. Preference xd	17½ 17⅞	17 17⅛	3 8 7	" "	17½	17½
150,000	10	5/0	Great Northern of Copenhagen	26½ 27½	26½ 27½	3 13 1	January, April, July	26⅞	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	102 105	102 105	4 15 3	March & September	..	..
17,000	25	12/3	Indo-European xd	54 57	53 56	4 9 3	May and November	56	54½
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1901.	107 110	107 110	5 9 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	107 110	107 110	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	136 141	136 141	4 5 1	" "	133	..
15,609	10	6/0	West African Telegraph	5 6	4½ 5½	5 0 0	.. ..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103 106	103 106	4 14 4	March & September	..	..
30,000	10	2/0	West Coast of America	¾ 1¼	¾ 1¼	..	.. ..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	106 108	106 108	3 14 10	June and December	..	..
88,321	10	-/6	West India and Panama	⅛ 1	⅛ 1	..	May and November	..	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¾ 10¼	9¾ 10¼	6 0 0	" "	10¼	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107 110	107 110	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	9¼ 9½	9¼ 9⅝	3 2 6	May and November	9½	9½
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½ 8	7½ 8	3 15 2	" "	..	..
33,129	7½	1/6	Do. Deferred Ordinary	2¼ 2⅝	2¼ 2⅜	..	" "	2⅝	2¼
£382,230	..	4%	Do. 4 per Cent. Debenture Stock	106 109	106 109	3 14 1	June and December	..	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902 xd	106 110	103 107	6 10 10	Feb., May, Aug., Nov.	..	..
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	..	..
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	8½ 3¾	8½ 3¾	5 6 8	August	..	..
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16 1/16	1/16 1/16	..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference xd	2 2½	2 2½	8 0 0	October	..	..
484,597	5	3/0	National	6⅜ 6⅝	6½ 6⅝	4 12 4	February & August	6 1/16	6 5/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15 17	15 17	3 10 7	" "	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	15 17	15 17	3 10 7	" "	15	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fullypaid)	6 6½	6 6½	3 16 11	" "	..	..
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104 109	104 109	3 5 0	June and December	106½	105¼
171,504	1	0/4	Oriental xd	1/16 1⅛	1/16 1⅛	4 2 4	April and October	⅜	..
58,000	5	5/0	United River Plate	3¾ 4¼	3¾ 4¼	5 17 8	July	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102 107	102 107	4 14 4	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.						
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	11¾ ..	12 ..	..	March	..	..
£50,000	5	..	Do. (New Issue) £3. 10s. paid	.. ..	.. ..	..	.. ..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	25 26	25 26	2 13 10	February & August	25⅜	25
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17 18	17 18	3 6 8	January and July	17 1/16	17 1/16
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131 136	131 136	3 14 3	June and December	..	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12 13	12 13	2 0 0	February & August	12	..
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6 6½	3 6 8	" "	6⅜	6¼
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	— —	— —	—	January and July	..	..
£36,000	5	2/6	Chelsea Electricity Supply Ordinary	10 10½	10 10½	3 11 5	March	10½	10½
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	110 113	110 113	3 19 8	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	12¾ 13½	12⅝ 13½	..	..	13⅛	12⅞
20,000	£10	6%	Do. 6% Cumulative Preference	15¼ 15⅝	15½ 15⅝	3 16 2	March & September	15 1/16	15⅜
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9 9½	9 9½	..	..	..	..
10,000	£5	7%	Do. 7 per Cent. Preference	10⅜ 11¼	10⅜ 11¼	3 2 1	March & September	18⅛	11
111,000	£5	..	London Electric Supply Ordinary	2 2¼	2 2¼	..	..	..	..
48,050	£5	..	Do. Preference	4⅝ 4⅞	4⅝ 5	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	17½ 13½	17½ 18½	2 19 6	April and October	18½	17 3/16
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	17 18	17 18	..	" "	17⅜	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119 123	119 123	3 13 6	June and December	..	..
6,452	10	8/0	Notting Hill Electric Ordinary	15 16	15 16	2 10 0	March	..	..
275,000	1	..	Rand Electric	1 1/16 1 3/16	1½ 1⅝	..	..	..	..
£125,000	Stock	..	River Plate Elec. Lt. Tr ct'n, Ltd., 5% 1st Mor. Deb.	93 98	93 98	..	..	..	..
150,000	$100	..	Royal Electric Company of Montreal Shares	148 150	148 150	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	103 105	103 105	4 5 9	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	16 17	16 17	3 7 8	February & August	16 1/16	..
20,000	5	3/6	Do. 7 per Cent. Preference	9½ 10½	9½ 10½	3 6 8	" "	..	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	103 106	103 106	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	14½ 15½	14½ 15½	3 4 0	March & September	14 1/8	14 3/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	£3	1/6	Brush Electrical Engineering	1½ 1⅝	1½ 1⅝	—	—	1 5/16	1 3/16
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	1⅞ 2⅛	1⅞ 2⅛	..	—	—	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	107 111	107 111	4 1 8	February & August	—	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	98 102	98 102	4 9 7	June and December	101	..
10,000	£10	..	British Aluminium Ordinary	..	—	—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference	..	—	—	—	—	—
20,000	£5	4/0	Callender's Cable Construction, Limited, Shares xd	7 8	7 8	3 15 8	June and December	..	..
£90,000	Stock	4½	Do. 4½% Mort. Deb. Stock	108 113	108 113	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½ 1⅝	1½ 1⅝	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1½ 2	1½ 2	—	—	—	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	89 94	89 94	5 6 5	January and July	..	..
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2¼ 2⅜	2¼ 2⅜	5 8 8	February & August	2⅜	2⅛
17,139	5	2/9⅜	Do. (£5 paid)	4 5	4 5	5 6 0	" "	..	..
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101 103	101 103	3 17 8	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2 2½	2 2¼	4 13 4	February & August	2 1/16	..
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3⅛ 3⅜	3⅛ 3⅜	4 3 4	August	3 1/16	..
91,196	1	10/0	Elmore's Patent Copper Depositing	⅛ ⅜	⅛ ⅜	..	..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	19½ 20½	19½ 20½	4 15 3	February & August	20½	20⅛
3,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 12 0	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 10	" "	..	..
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	21½ 23½	21 22	4 10 11	" "	21¾	21⅛
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103 107	103 107	3 14 9	March & September	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	36 39	36 39	4 12 4	March and July	37½	36¼
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102 105	102 105	4 15 3	January and July	..	..
£22,500	£5	3/6	Willans and Robinson Ordinary	8½ 8⅝	8½ 8⅝	4 0 0	April and October	..	..
£22,500	£5	3/0	Do. 6% Cumulative Preference	.. ..	.. ..	..	.. ..	..	..

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NOTES.

A communication to *The Times* of Tuesday last gives an evidently authoritative explanation of the proposal recently laid before Her Majesty's Government for an all-British cable to Australia *vid* the Cape of Good Hope. A great deal of misconception has already occurred, and many incorrect statements have been made in regard to this matter, both in the general and especially the technical press. It has been stated, for example, that the route chosen would expose the new cable to disaster from submarine earthquake disturbances, one critic having made the mistake of first wrongly stating the route proposed, and, in the second place, of having attributed to seismic influence during a single year a number of cable interruptions extending over a period of many years and arising from a variety of causes, the chief of which—the teredo—is no longer formidable, having been effectually combated. Other statements made by the same authority are equally wide of the truth, but are so transparently inaccurate as to be scarcely worth demolishing. Upon the supreme national and, indeed, cosmopolitan importance of an all-British cable over the proposed route—triplicating, as it would do, the communication with South Africa and Australia—too much emphasis cannot be laid; and it is to be hoped that the scheme, which may be fairly termed the only practical one before the authorities, will meet with the success its importance warrants. We reprint in another column the article of *The Times* correspondent dealing with this matter.

The Annual Report of the Director-General of the Indian Telegraph Department, dated August, 1897, is just to hand, and is full of varied and most interesting matter relating to the growth and present condition of the telegraph system of that great dependency. Notwithstanding the two deplorable visitations with which India has been afflicted during the past year—the one paralysing trade, the other crippling agriculture over vast tracts of country—the telegraph revenue has not materially suffered. The number of telegrams has, in fact, maintained its normal growth; and if the receipts have not increased in quite the same proportion it is owing to the public making more and more use of the "deferred" rates, telegrams under this head having latterly been delivered by hand instead of, as formerly, by post—a circumstance of which the public are not slow to take advantage. A conspicuous feature of this Report is the revenue and capital account, which is drawn up on business lines strikingly contrasting with the corresponding document dealing with British telegraphs at home. One result of this is that we can see whether the system pays its way, judged by the laws which govern ordinary commercial undertakings; and in the case of the Indian telegraphs it would appear that they yield nearly 4½ per cent. on the capital outlay. We would commend this Blue-book to the attention of the authorities here, both on account of the matter it contains and the manner of its compilation.

In connection with our remarks, under the heading of "Conduit Tramway Conversion in Washington," in our issue of Oct. 22nd, on the use of an electric motor for driving the cable grip plant in one of the power houses of the Chicago City Railway, the description by Mr. Charles Grover, in the current number of the *Street Railway Review*, of the cable line of the Metropolitan Street Railway of Kansas City is of interest. The cable machinery in the power house at Ninth and Washington-streets in that city was until lately operated by a Wright engine, but is now driven by a 300 kilowatt four-pole motor. It has been observed that when operated by motor the speed of the cable is more uniform and less jerky than when driven by steam. The motor, built as a "G.E." standard 300 kilowatt four-pole

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generator, drives from a 34in. pulley on the motor, by means of a 36in. belt, on to a wheel 24ft. in diameter, mounted on the intermediate shaft of the winding gear. The speed of the motor is 380 revolutions per minute. Owing to numerous long and steep grades the load varies enormously, and occasionally the motor acts as a generator and delivers current back to the Central-avenue power-house (whence it otherwise derives its power), and from there to the electric lines, to the extent of 20 H.P. From this condition as a generator the load on the machine varies until its load as a motor rises to over 650 H.P.

FIGURES giving the cost of operating by steam and by electric motor show a very decided saving in the change to the use of the latter. Operating directly under steam the total generating costs, during an average month last year, were £205; while in July of the present year, when the plant was operated by electric motor, the total cost amounted to only £73. 12s. The items in which a saving was effected are interesting; thus, whereas £59 per month was formerly paid in wages for engineers, firemen and oilers, the motormen who have replaced these receive only £10 per month; or, again, while £121 was formerly paid for coal, the charge against electric energy supplied from the electrical department of the tramway power house was only £62. We notice that the amount charged for electric energy was at the rate of about one farthing (0·48 cent) per unit.

IT would be rash to infer from these figures that they represent the relative costs of steam-driven cable haulage and electric traction, or that they point the moral that cable systems should in every case be driven by electric motors. They do nothing of the kind. Rather do they tend to show the advantage of grouping a number of separate loads into one larger and more equable load, and in dispensing with duplicated items of cost where it is possible to make a single item serve for two departments. We may, however, reasonably deduce from the above figures, coupled with the general success of the electric system of cable-driving at Chicago and Kansas City, that in the many existing cases where both electric and cable cars are operated from the same power house it is advantageous to dispense with separate engines for the cable sections. We may even go further, and say that where a cable tramway concern can obtain cheap electric power from a neighbouring electric power station it would probably pay it to use this instead of steam power.

Royal Society Award.—The Davy medal of the Royal Society has been awarded to Dr. J. H. Gladstone.

A Wide-Gauge Electric Railway.—A heavy electric railway from Mons to Boussu is being built for the Belgian State railway administration. The line is to be opened in September, 1898.

Obituary.—We regret to announce the death of Prof. Ernst Schering, at Göttingen, at the age of 64 years. Prof. Schering was director of the magnetic department of the Observatory of Göttingen.

Applications of Electricity on Battleships.—Electric turret-turning gear is to be used on the American battleships "Wisconsin, "Alabama" and "Illinois." The order has been placed with the General Electric Company of Schenectady.

Personal.—We regret to announce that owing to ill-health Mr. W. H. Preece has been ordered by his medical advisers to take a prolonged rest, and he will shortly go abroad. We sincerely trust that rest and change will thoroughly restore Mr. Preece to health.

A Faraday Memorial.—On Monday afternoon next a marble bust of Faraday will be publicly unveiled at the Michael Faraday School, Faraday-street, Walworth. The memorial was presented by the Royal Institution, and is a copy of the work executed by Matthew Noble.

A Suggested Rubber-Covered Wire "Pool" in America.—The *Electrical Review* of New York states that about 20 companies engaged in the manufacture of rubber-covered wire are discussing the advisability of a "pool" with a view to keeping up the price of this material. It is stated that prices during the last few years have been so severely cut by competition that "profits have entirely disappeared."

The Great Telescope at the Yerkes Observatory.—The completion of the Yerkes Observatory and its great telescope with a 40in. objective has been duly noted in the daily Press. It is interesting to mention that the huge instrument is rotated by electric motors controlled by a keyboard within reach of the observer at the eye-piece. The mass requiring to be moved in this manner is said to weigh 20 tons.

The Zerograph.—On Wednesday last we had an opportunity of examining a type-printing telegraph, named the "Zerograph." This instrument, the invention of Herr Leo Kamm, was exhibited at the Royal Society's *soirée* last May, and has since been perfected. Owing to pressure on our space this week, we are compelled to hold over a description of the machine until a later issue.

Lectures on Boiler and Engine Testing.—Mr. H. R. J. Burstall will shortly deliver a course of lectures on "Practical Boiler and Engine Testing" to the workmen, apprentices and pupils at Messrs. Crompton and Co.'s works at Chelmsford. There will also be an elementary course of lectures for the benefit of youths at these works, these being delivered by Mr. A. Hutchings, a member of the Company's staff.

Fire at an Accumulator Works.—The Hagen accumulator works at Kalk, near Cologne, suffered considerable damage by fire on the 31st ult. In spite of the efforts of the factory fire brigade, the volunteer brigades of the neighbouring works, and a fire engine from Cologne, which arrived 18 minutes after the outbreak, the main building was burnt to the ground. The machine room, forming rooms and carpenters' shop were saved.

Energy Meters for Electric Tramcars.—It is significant that a complete knowledge of the distribution of waste and utilised power on electric street railways should be held in such high estimate as to justify the introduction of recording watt-meters, of the Thomson type, for installing on streets cars. These are being introduced by the General Electric Company of America. They will serve one useful purpose, at any rate, in indicating which motorman handles his controller to the best advantage. Recording meters are also used on the Leeds cars, described in our issue this week.

Cable Interruptions and Repairs.—

	Date of Interruption.		Date of Repair.
Obidos—Parintins	Dec. 7, 1896	...	—
Hong Kong—Macao	Sept. 28, 1897	...	—
Cayenne—Pinheiro	Sept. 29, 1897	...	—
Otranto—Vallona	Oct. 11, 1897	...	—
Santarem—Alemquer	Oct. 21, 1897	...	—
Paramaribo—Cayenne	Oct. 25, 1897	...	—
Cadiz—Teneriffe	Oct. 26, 1897	...	—
Santiago de Cuba—Guantanamo	Oct. 29, 1897	...	—
Bundaberg—New Caledonia	Nov. 4, 1897	...	Nov. 9, 1897
San Thomé—Loanda	Nov. 8, 1897	...	—

Röntgen Society.—As announced in our last issue, the Röntgen Society held its inaugural meeting under the presidency of Dr. Silvanus P. Thompson, at the St. Martin's Town Hall, last Friday night. Dr. Thompson, in an interesting and lucid introductory address, reviewed the history of radiography, and gave in outline an account of its practical and scientific bearings. The proceedings were enlivened by a large display of radiographic apparatus and photographs—

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mostly of human skeletons. Prof. W. C. Röntgen has been made first honorary member of this society. Among the list of officers we notice the names of Dr. J. H. Gladstone and Mr. Fletcher-Moulton as vice-presidents, and Dr. Hedley and Mr. A. A. Campbell Swinton as members of Council.

Society of Arts.—The Society of Arts will commence its 144th Session on the 17th inst. with an address on "The Colonies: their Arts, Manufactures and Commerce," by Major-Gen. Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., the Chairman of the Council. There will be four meetings on successive Wednesdays before Christmas, at which Papers will be read, among others, by Prof. James Douglas, on "The Progress of Metallurgy and Metal Mining in America during the Last Half-Century"; by Bennett H. Brough, on "The Stockholm Exhibition of 1897." The first course of Cantor Lectures will consist of three lectures, to be given on Monday evenings, commencing on the 29th inst., by Dr. Eugene F. A. Obach, F.C.S., on "Gutta-Percha."

The New Council of the Royal Society.—The following is a list of those who have been recommended by the President and Council of the Royal Society for election into the Council for the year 1898 at the anniversary meeting on November 30th; names of new members are printed in italics :—President, Lord Lister; Treasurer, Sir John Evans, K.C.B.; Secretaries, Prof. Michael Foster, Prof. Arthur William Rücker; Foreign Secretary, Sir Edward Frankland, K.C.B. Other Members of the Council: Prof. William Grylls Adams, Prof. Thomas Clifford Allbutt, *Sir Robert Stawell Ball*, *Rev. Thomas George Bonney*, *Prof. John Cleland*, Prof. Robert Bellamy Clifton, Prof. James Alfred Ewing, *Alfred Bray Kempe*, *John Newport Langley*, *Joseph Larmor*, *Prof. Nevil Story Maskelyne*, Prof. Raphael Meldola, *Prof. Edward Baynall Poulton*, *William James Russell*, *Dukinfield Henry Scott*, Prof. Walter Frank Raphael Weldon.

Conduit Systems for New Orleans.—A tendency has been displayed in some cities of the United States, even in some of lesser magnitude, to replace the unsightly overhead wires by underground conduits. And whereas the overhead construction has invariably been carried out in the roughest manner possible, the work below the streets shows careful design and thoroughly good workmanship. We commenced in a recent impression a detailed description of the conduit construction now being carried out in St. Louis as a result of the recently-passed "underground ordinance." A similar "ordinance" has now been issued by the local authorities of New Orleans. The various companies in that city have been asked to combine in devising the best plan for a conduit system, and there appears to be a majority in favour of a common subway. In St. Louis, although some companies are using a system of cement-lined iron pipes jointly, the majority have elected to build their own separate conduits.

A Modification of the Joubert Contact-Maker.—In the *Elektrotechnische Zeitschrift* for October 21st, Herr Wilhelm Kübler describes a modification of the Joubert contact-maker, which has been found useful in Messrs. Ludwig Loewe and Co.'s electrical laboratory. The idea is to overcome the sparking, which is always a trouble in the usual patterns of this device. The voltmeter is connected in series with a resistance across the terminals of the source of E.M.F., whose wave-form is to be investigated. A drum driven by a synchronous motor, instead of having one contact-point on its periphery, has a nearly continuous metallic surface, broken only by a bar of insulating material at one point. Two brushes bearing on the drum are connected to the terminals of the voltmeter, and these are a trifle narrower than the bar of insulation. The voltmeter is thus short-circuited, except at one point of the cycle corresponding to the position of the bar of insulation. Ordinary Weston instruments are used in conjunction with this contact-maker, and there is no difficulty from sparking, even when testing high-pressure circuits.

A Surface-Contact Tramway System.—We learn from our American contemporaries that the surface-contact street railway system, which has been developed by the General Electric Company of America, though not yet in practical use, except over an experimental track at their Schenectady works, is being laid down over a distance of about three miles in Monte Carlo by the French Thomson-Houston Company. In this system there are two rows of surface knobs between the rails, the knobs in one row being positive and in the other negative or return. Corresponding to these two rows are two longitudinal shoes, one picking up for the car motor and the other discharging to the negative knobs the current, which before reaching the rails or return circuit has to traverse and operate automatic switches, which put the positive knobs immediately under the car body temporarily into connection with the power supply. Distinctive features of this system are the placing of a collection or "bank" of these automatic switches (of which there is, of course, one for the control of each positive knob) in a manhole from which radiate the cables connecting them with the knobs controlled, and the use of magnetic blow-outs to break the arc at each of these automatic switches as they open by gravity when the car leaves this contact knob. The use of a small secondary battery on the car is also involved for the purpose of actuating the first switch in starting a car, this battery being otherwise unused and being charged while the car is in motion.

Why Railway Rails Break.—Writing in the *Street Railway Review*, Mr. T. L. Harris, in stating the case for double trucks for electric railway cars, makes some observations which are interesting as showing the reason why street railway tracks often exhibit signs of rapid deterioration. Contrasting the conditions obtaining on steam railways and electric street railways, Mr. Harris says that while few steam roads use rails that are heavier than those considered standard for street railways, the weights per wheel are quite different on the two roads. On street railways the normal weight per wheel is from 4,000lb. to 5,000lb., while on steam roads the weight per wheel is as high as 20,000lb. for locomotives and attains 12,000lb. for coaches; besides which, at high speeds the counterbalances on the driving wheels of locomotives bring up the maximum pressure on the rail to fully 75 per cent. above the normal. Speed on steam roads is as high as 50 miles per hour, while on other than inter-urban electric roads it is nearer fifteen. Engineers of steam roads say their tracks are never injured by well-designed locomotives run at their intended speeds. On the other hand, the street railway men complain that their tracks are torn to pieces by the electric cars. Mr. Harris says there is only one reason for this, viz., that the plunging and rearing of cars mounted on four-wheeled trucks pound the track and loosen the joints. When it is remembered that cars on short-base single trucks often plunge sufficiently to throw practically all the weight on to the front and rear wheels alternately, the damaging effect of this pounding will easily be realised.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the proposed Council of the Institution of Electrical Engineers for the year 1898. Names of new members and of members serving in a new capacity are given in italics :—

PRESIDENT.

Joseph W. Swan, F.R.S.

VICE-PRESIDENTS (4).

Prof. S. P. Thompson, D.Sc., F.R.S.	*W. E. Langdon.*
Prof. John Perry, D.Sc., F.R.S.	*James Swinburne.*

ORDINARY MEMBERS OF COUNCIL (15).

S. L. Brunton.	Herbert Taylor.
Prof. J. A. Ewing, F.R.S.	Charles Henry Wordingham.
W. P. J. Fawcus.	Henry Edmunds.
Major R. Hippisley, R.E.	*Robert Kaye Gray.*
Prof. J. A. Fleming, M.A., F.R S.	*P. V. Luke, C.I.E.*
E. Manville.	*W. M. Mordey.*
John S. Raworth.	*A. A. Campbell Swinton.*
Dane Sinclair.	

ASSOCIATE MEMBERS OF COUNCIL (3).

H. W. Miller.	*Sydney Evershed.*
Sydney Morse.	

HONORARY AUDITORS.

F. C. Danvers.	*E. Garcke.*

HONORARY TREASURER.

Prof. W. E. Ayrton, F.R.S., Past President.

HONORARY SOLICITORS.

Messrs. Wilson, Bristows and Carpmael.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Dissipation of Positive Charge.—The dissipation of a negative charge by metals under the influence of light has been studied by a good many of our best workers, including Hertz, Thomson, Righi, Branly, and Elster and Geitel. There appears to be a prevalent belief that there is some causal connection between this dissipation and the corresponding acquisition of a positive charge when the neutral body is illuminated. But that this is not so is shown by G. C. Schmidt's experiments on fluorspar and selenium. He cut some cubes of English fluorspar, and illuminated one face with limelight, testing the charges acquired by a small proof-rod and a gold-leaf electrometer. The centre of the surface acquired a negative charge, while the charge was usually positive at the edges and the corners. These parts were also found to be the most effective in dissipating a negative charge under the influence of light. But even those parts which acquired a negative charge, dissipated a negative electrification imparted to them, whereas no dissipation of a positive charge could be made evident, not even in such a body as selenium, which acquires a strong negative electrification under the influence of light.

[Schmidt, *Wied. Ann.*, No. 11, 1897.]

Mutual Influence of Cathode Rays.—Some interesting experiments, accompanied by rather hesitating conclusions, are contributed by Julius Bernstein on the subject of the apparent

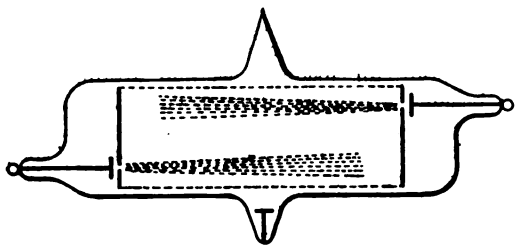

Fig. 1.

repulsion between two beams of cathode rays, first observed by Crookes, and interpreted by him on the supposition that cathode rays consist of projected particles, and are equivalent to elastic conductors carrying a current. As might have been expected from a German source, Bernstein's results tell against this view, and in favour of some kind of wave hypothesis. In the first place he investigated the influence of the direction in which the rays travel. Mounting two cathodes, one at each end of the tube (*see* Fig. 1) with a slit in front of each, he obtained two opposite beams

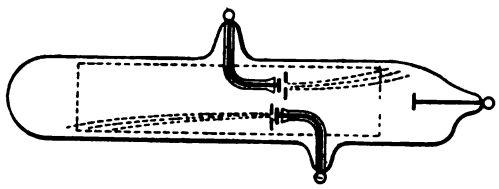

Fig. 2.

running side by side, which did not affect each other in any way. But when the cathodes were placed side by side (Fig. 2) the beams were bent outward as long as the glass funnels protecting the wires left the cathode plates bare. When they projected beyond their surfaces no effect was produced. The direction of the emerging rays is, therefore, of no account. Further experiments proved that the action is probably exerted by one cathode upon the beam from the other cathode at its origin. But to this action an electrostatic effect between the cathodes may be added.

[Bernstein, *Wied. Ann.*, No. 11, 1897.]

Cathode-Ray Colorations.—Goldstein was the first to discover that common salt is coloured brown, and potassium chloride violet, by the action of the cathode rays. The discoverer attributed this phenomenon to some physical change undergone by the salts. Wiedemann and Schmidt attributed it to their partial conversion into sub-chlorides, and Giesel actually succeeded in preparing similarly coloured sub-chlorides in a chemical way. But the chemical hypothesis is now invalidated by the painstaking researches of R. Abegg. He obtained the salts in question in a pure and finely-powdered state, so as to be able to colour them all through. His first experiments showed that the colouring does not spoil the vacuum in the tube as it should if chlorine were evolved. The salts were rendered colourless again by high exhaustion, producing rays with a strong heating effect. The substances could be coloured and uncoloured any number of times in succession. When the coloured salt was dissolved, it produced no reducing or alkaline reaction. When undissolved in a saturated solution it retained its colour. All this tells against a chemical change. Moreover, an easily-reduced chloride like $CuCl_2$ is not reduced by the cathode rays. It is well to remember that the coloration of these alkaline salts is a phenomenon not produced by light. On the other hand, cuprous chloride is blackened by light, but not acted upon by the cathode rays.

[Abegg, *Wied. Ann.*, No. 11, 1897.]

The Arc.—R. Herzfeld publishes the results of some experiments on the arc which are of both practical and theoretical importance. To test the hypothesis that the "counter E.M.F." of the arc is due to the deposition of electrified particles upon the cathode, he deflected these particles in their course by a strong electric field, and made them deposit themselves on one of the condenser plates. This deflection produced no effect upon the voltage. The particles only deposited themselves upon the insulated plate, even when that was 15 times farther off than the other plate. The author also investigated the nature of the much-discussed fungoid deposit upon the electrodes which Mrs. Ayrton described as characteristic of a hissing arc. Herzfeld found that this growth was much increased by enclosing the arc in a glass tube, and he attributes it to the lack of oxygen necessary for the complete combustion of the carbon. He also noticed a curious phenomenon. The growth is deposited in a spiral form whenever magnets are about. The path of the projected particles is twisted in a direction contrary to that of the currents in Ampere's molecular magnets. The author also endeavoured to determine the precise influence of temperature upon the voltage of the arc, and for this purpose blew a current of cold carbonic acid from the solid substance against the electrodes. The voltage was increased equally whether the anode or the cathode was impinged upon. This shows that the counter E.M.F. is probably not a thermoelectric effect.

[Herzfeld, *Wied. Ann.*, No. 11, 1897.]

Retardation of Spark Discharge.—E. Warburg found some time ago that the encouragement of the spark discharge by ultra-violet light is due to a shortening of the period elapsing between the establishment of the necessary difference of potential and the actual passage of the spark. This period is known as the "retardation," and when it is very short it may be determined by establishing this difference of potential for a measured time interval, and finding whither the spark passes. The author now gives some further results. The retardation is diminished by moisture, but not by ether or benzol vapours. Previous discharges diminish the retardation, probably owing to some action on the electrode surfaces. But the most important observation is that the retardation is increased or diminished by a magnetic field, according as to whether the magnetic field favours or retards a current proceeding from the positive to the negative electrode. Warburg concludes, therefore, that during the period of retardation a very feeble non-luminous electric current is passing, whose presence cannot at present be demonstrated in any other way. The magnetic effect relied upon to substantiate this hypothesis is especially prominent at low pressures.

[Warburg, *Wied. Ann.*, No. 11, 1897.]

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ELECTROMAGNETIC PHENOMENA IN CONNECTION WITH THE SHIELDING, EXERCISED BY IRON, OF A MAGNETIC FIELD FROM ONE OR MORE CONDUCTORS.

BY JAMES RUSSELL.

Let two rectangular coils A and B (Fig. 1) be formed into a rigid system, and connected in series in such a way that a current flowing through them will be in one direction in the central wires, and consequently in the opposite direction in the external wires. Place this system in a uniform external field, as indicated by the dotted arrows, and it is evident that the internal and external wires of the coils carrying a current will experience equal and opposite forces tending to distort the rigid system. Nevertheless, no motion of translation of the system, as a whole, can result. For, as is well known, the opposing forces satisfy the identity

$$Hlis - Hlis = 0, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

the symbols indicating as follows: H, external field; i current strength; l, length of wires under consideration at right angles to field; and s, number of these wires. Conversely, motion of the system at right angles, both to the lines of force of the field and the length of the wires (the conditions of maximum induction), results in no current. The impressed E.M.F.s being such that their algebraical sum is zero, being

$$Hlvs - Hlvs = 0, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where v is the velocity.

Now surround the central wires with an iron tube, which shields them to a greater or less extent from the external field. Let coils and tube form a single rigid system free to move. A current in the coils produces no motion, and motion of the

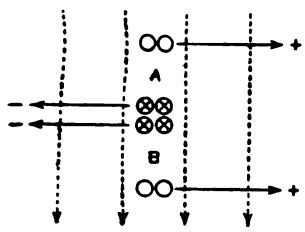

Fig. 1.

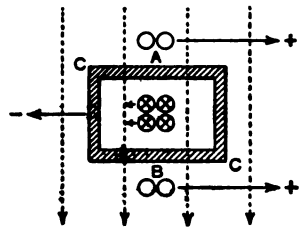

Fig. 2.

system results in no current. The algebraical sum of the opposing forces is still zero, as also the algebraical sum of the impressed E.M.F.s. Again, instead of tube and coils forming a rigid system, let the iron tube be so constructed that it is capable of a certain amount of motion relative both to the coils and to the external field, and let the coils also be free to move relative both to the tube and to the external field. Let CC (Fig. 2) represent this tube. On passing a current through the coils in the direction indicated conventionally in Fig. 2, the coils move as shown by the arrows to the right, and the tube also moves, but in the opposite direction, as shown by the arrow to the left. The external wires experience a force $Hlis$. Let this force be positive. The internal wires, in virtue of the shielding effect of the iron tube, are now in a much weaker field; it can only be a zero field, however, on the supposition that the permeability of the iron is infinite. Let this weakened field be H_1. The shielded wires must experience a negative force, H_1lis. But it has been shown experimentally that the algebraical sum of the forces is zero. Therefore the negative force experienced by the tube must be $(H - H_1)lis$. And

$$Hlis - H_1lis - (H - H_1)lis = 0. \quad . \quad . \quad . \quad (3)$$

Let now the coils be disconnected from the source of current and connected with a galvaniscope. If the iron tube CC be moved from left to right, the coils in the meantime being stationary relative to the external field, an induced current results in the same direction as if the lines of force of the external field had cut the shielded wires from right to left. On the other hand, if the tube be stationary relative to the external field, and the coils be moved from right to left, an induced current results in the same direction as if the lines of force of the external field had cut the external wires from left to right. These two motions therefore supplement each other. The resulting E.M.F. is proportional to the shielding when coils and tube are vibrated in opposite phase.

$$\text{E.M.F.} = Hlvs - H_1lvs + H_1ls\frac{v(H - H_1)}{H_1}. \quad . \quad . \quad (4)$$

The first factor is the E.M.F. impressed by the external wires cutting the external field. The second factor is the opposing E.M.F. impressed by the shielded wires cutting the weakened field within the tube. The last factor represents the E.M.F. impressed upon the shielded wires by the passage of a weakened directional flux (H_1) across the shielded space at a velocity increased in the ratio of $H - H_1 : H_1$, caused by the motion of the iron tube. [I have adopted the picture of the tubes of induction crossing a screened space with a "velocity increased in the same ratio as their section," given by Prof. H. Du Bois,* and also by Mr. Swinburne† in 1894.] In the same way, if tube and coils be moved as a rigid system a truer and more beautiful representation of the physical facts is obviously obtained by writing the equation in a manner different from that used when no screening action exists, thus—

$$Hlvs - H_1ls\frac{vH}{H_1} = 0. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Compare this with equation (2); the algebraical sum of the impressed E.M.F.s is, of course, in both cases zero.

Returning now to equation (3), compare it in like manner with equation (1). The difference between the two is obvious. It is evident that when a conductor carrying a current is

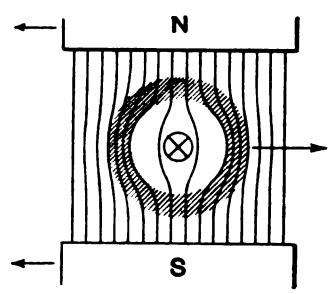

Fig. 3.

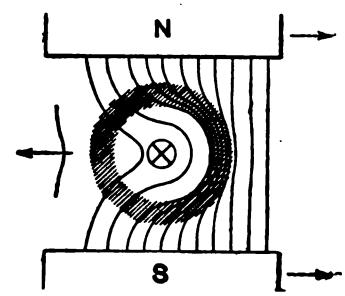

Fig. 4.

shielded to a greater or less degree from an external field, the force that would otherwise have been all experienced by the conductor is transferred to the shield (iron tube in this instance), and that in proportion to the shielding. This fact can also be shown in a very simple experimental manner by arranging a wire carrying a current so that it will revolve round the pole of a magnet (one end of the wire dipping into a circular mercury trough in the usual manner), or, better, between the North and South poles of an electromagnet of circular or tubular section. Let a light iron tube surround this radial wire, and let it also swivel on the same centre as the wire, but in such a way that tube and wire are capable of motion, the one relative to the other within the limits prescribed by the internal diameter of the tube If the tube be held, and be a sufficiently good shield, no motion of the wire will result. So soon, however, as the tube is released, the tube will move (in the same direction as the shielded wire would have moved) independently of the wire, and then will carry the wire with it in continuous rotation. It is hardly necessary to add that the force experienced by the wire itself in virtue of its being in a weakened field will be very slight, and insufficient to overcome the resistance of the mercury trough connection.

This motion will now be considered in detail. Let Fig. 3 represent the shielding of the external field from a central wire exercised by an iron tube. The wire is supposed to be connected with a galvaniscope. The lines of force of the external field pass through the sides of the tube, with the exception of two lines which are shown crossing the central space. These lines may be pictured filling the whole space

* *The Electrician*, August 27, 1897, p. 579.
† *The Electrician*, June 4, 1897, foot note, p. 190.

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as an attenuated directional flux. Now move the tube from left to right, and, adopting the usual theory regarding lines or tubes of force it is evident that just as many lines as enter on the right and leave on the left, must cross the shielded space and cut the shielded wire from right to left, producing an induced current (opposing the motion of the tube) in the wire flowing down through the paper. This is confirmed by experiment. Now let the tube and wire be fixed relative to each other, and move the field NS from right to left, thus causing the lines of force to cross the shielded space in the same direction. A current is induced in the wire in the same direction as in last experiment. Let it be remembered that the peculiarity of the shielding tube is such that motion of the tube in one direction and motion of the field in the opposite direction (both as shown by the arrows, Fig. 3) alike move the lines of force of the field across the shielded space in the same direction (from right to left) inducing a current in the same direction (down through the paper) in the wire. The motion of the tube impresses an E.M.F. proportional to the velocity with which it causes the attenuated magnetic flux to cross the central space (*see* equation 4).

$$+\text{motion of tube produces a} + \text{E.M.F.} = H_1 ls \frac{v(H - H_1)}{H_1} . \quad (6)$$

The motion of the field, on the other hand, compels the same attenuated flux to cross the central space at a greater velocity (*see* equation 5).

$$-\text{motion of field produces a} + \text{E.M.F.} = H_1 ls \frac{vH}{H_1} . \quad (7)$$

Let, now, Fig. 4 represent the same arrangement, but the wire is supposed to be in connection with a source of current, flowing down through the paper. Both tube and wire now find themselves in distorted fields, and it is at once evident that the former will move to the left, as shown by the arrow, the motion at the same time causing the lines of force to cross the shielded space from left to right, and inducing a back E M.F. in the wire. On the other hand, if both tube and wire be fixed relative to each other, the supporter of the field NS will move to the right, as shown by the arrows, the motion at the same time causing the lines of force of the field to cross the shielded space in the same direction, and inducing a back E.M.F. in the wire. In other words, a current in the wire results in a thrust being experienced between tube and external field. The force may be written (*see* equation 3),

$$f = (H - H_1) lis. \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

There is also a thrust experienced between the wire and the external field (*see* equation 3),

$$f = H_1 lis. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

The sum of these thrusts is simply the force experienced between the wire and the field, had the former not been shielded, viz., $Hlis$. It may be as well also to note that as before the opposite motions of tube and field result in back E.M.Fs. of the same sign, just as the opposite motions of unshielded wire and field do.

These experiments were performed by me about June, 1896, and I have observed from *The Electrician* of Aug. 27 last that Prof. H. Du Bois has also lately been investigating, with entirely different objects in view, the shielding effects experienced by a linear conductor when surrounded by an iron tube and placed in a homogeneous external field. He says "the force on the protected conductor is correspondingly only IH^1 per unit of length, and the principal force $I(H - H^1)$ is exerted upon the iron cylinder." With this statement I entirely concur. Prof. Du Bois proceeds: "This is not only true for circularly-magnetised hollow cylinders, *i.e.*, for iron tubes, but also for ring magnets. *A ring magnet experiences a side thrust when in an external field, whose lines of force are in the same plane as the ring: and conversely it exerts a thrust in the opposite direction upon the supporter of the external field.*" He adds, "This deduction, so astonishing at first sight, I have proved to be verified by experiment." In my opinion this deduction is inadmissible, and it is also directly negatived by experiment —unless the effect to which Prof. Du Bois refers is a ballistic one. To enable the force experienced by the iron tube or ring to be measured by the zero method I had used a torsion wire and the usual torsion head arrangement. In this instance the tube was reduced to a rectangle of No. 16 (B.W.G.) steel wire. The value of H of the external field was maintained by a solenoid of many turns and was kept constant. By means of the coils AB (Fig 2) the value of H round the rectangle could be increased from zero up to 70 C.G.S. units, with a corresponding magnetic induction, B. The maximum force experienced by the steel wire rectangle was about 800 dynes. Now, dispensing in the meantime with the external field, the steel rectangle was magnetised up to the highest value of B (round the rectangle) which the ampere turns of the apparatus allowed. The connections with the source of current were then broken, and the pointer was adjusted to zero. Here, then, was a ring magnet (to all intents and purposes) arranged in such a manner that if any thrust were experienced it could not only be noted, but its strength measured. On exciting the solenoid for the production of the external field I could not detect the slightest movement of the pointer. The conclusion is therefore inevitable that if any thrust be exerted it must in this particular case either be less than three or four dynes or be a ballistic effect lasting for so short a fraction of a second that it could not be detected with my apparatus. If the possibility of such a thrust exists it is obviously one that can only occur during the process of the straightening out of the circular magnetic lines under the influence of the external field, *i.e.*, during the process of demagnetisation. It would therefore be very interesting to obtain particulars of the experiment on which Prof. Du Bois founds his deduction relative to a ring magnet experiencing a side thrust in an external magnetic field.

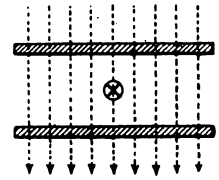

Fig. 5.

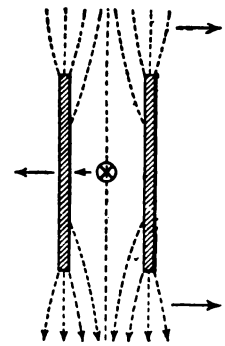

Fig. 6.

Reference has hitherto only been made to iron tubes and to rectangles or rings experiencing a force relative to the external field in proportion to the shielding. But it is obvious that any structure whatever will experience this thrust if it shields to ever so slight an extent a wire or wires carrying a current from an external field. Iron tubes may be slit lengthwise in one or more places, rectangles and rings may be so reduced that only sides or arcs (or even one side or arc) are left. In all cases, however, where shielding exists the motion of the wire will be taken up by the shield, and motion of the shield will induce an E.M.F. in the wire, both motion and induction being proportional to the shielding. Examples of this principle may be given. Let two light iron bars be joined together, and be capable of motion from right to left, and *vice versâ*, and let them be placed in a uniform external field as shown in Fig. 5. There is here no shielding action and none of the special phenomena will emerge. If, however, these same bars be placed as in Fig. 6, it is evident a considerable amount of shielding will exist. If a current be supposed to be flowing down through the paper in the central wire, a thrust will be experienced between the bars and the field, as shown by the arrows, and so on. It is interesting to note the difference in the action had these bars been steel magnets. Fig. 7 shows the thrust between wire and field.

When an iron tube, ring, or other structure shields more or less perfectly a uniform external field from a conductor, the conclusions that have been already drawn in this article may be summarised as follows, viz.:—

(i.) That if the shield only be moved, the induced E.M.F. is of the same sign as the E.M.F. induced if the conductor had

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been moved in the same direction in an unshielded field, and is such that if a current result the motion of the shield is opposed, also that the induced E.M.F. is proportional to the velocity with which the attenuated field H_1 cuts the conductor, which is that of the shield increased in the ratio of

$$H - H_1 : H_1. \quad [E.M.F. = H_1 ls \frac{v(H - H_1)}{H_1}; \text{ or } E.M.F. = (H - H_1) lsv.]$$

(ii.) That if the conductor only be moved the induced E.M.F. is proportional to the velocity with which it cuts the attenuated field H_1. $[E.M.F. = H_1 lsv.]$

(iii.) That if both shield and conductor be moved in the same direction the E.M.F. induced is the sum of the electromotive forces induced when shield and conductor are moved separately; and if a current result, the motion of the shield and the conductor respectively is opposed, in proportion to $H - H_1$ and H_1 respectively. That the sum of the electromotive forces induced is the same as if the conductor had been moved in an unshielded field.

$$E.M.F. = H_1 ls \frac{v(H - H_1)}{H_1} + H_1 lsv = H lsv.$$

(iv.) That if the conductor be carrying a current, the magnetic thrust that would otherwise have all been exerted between conductor and field, is transferred to a magnetic thrust between shield and field in proportion to the shielding. Force $= (H - H_1) lis$. That if the shield move, a back E.M.F. is induced, reducing the current in the conductor.

(v.) That if the conductor be carrying a current, a magnetic thrust is exerted between the conductor and the field, in so far as the conductor is unshielded. Force $= H_1 lis$. That if the conductor move, a back E.M.F. is induced, reducing the current in the conductor.

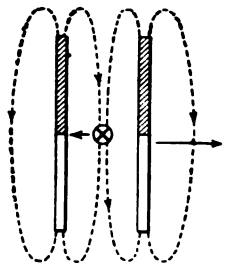

Fig. 7.

(vi.) That if the conductor be carrying a current, when the conductor and shield form a rigid system, the total force is the same as if the conductor had not been shielded, *i.e*, $Hlis$; but the thrusts are borne by the shield and conductor respectively in proportion to $(H - H_1) lis$ and $H_1 lis$ respectively. That if the rigid system move, the back E.M.F. is the same as if the conductor had not been shielded.

(vii.) That the shielding is a function of the permeability (μ).

It will be at once perceived that the above deductions are quite in harmony with the usual elementary conceptions of the known laws of electromagnetic action. The phenomena, however, seem at first sight peculiar, and they do not seem to have been hitherto discussed specially, or experimentally verified.

It would be strange if a motion of this kind could not be turned to some practical use. If the external field, for instance, were maintained by a solenoid in series with a shielded wire or wires, the conditions as laid down by a leading article in this Journal* as essential for a delicate measurer of an alternating current seem to me to be in a great measure fulfilled. Whatever form of shield be adopted, it could carry a reflecting mirror and could be made as light, while the suspension would be as delicate as desired. Reducing the number of turns of the solenoid to one, and with the shield surrounding, in whole or in part, one linear conductor, naturally suggests a non-inductive wattmeter to be used in an alternating-current circuit.

Again, the shielding is a function of the permeability. By means of the torsion instrument already referred to which measures $(H - H_1) lis$ current may be plotted against deflection.

* See *The Electrician*, June 4, 1897, p. 172.

When steel wire is used for the rectangle (Fig. 2) the curve with an increasing current takes a very much *higher* value than with a decreasing current. The obvious reason is that the residual magnetism of the steel lowering the permeability, the shielding power of the rectangle is correspondingly reduced. With this instrument, not specially adapted for measuring permeability, I have drawn out $H - \mu$ cycles, which may be described as the usual H – B inverted.

It is, however, possible to design an instrument which will weigh the force $H_1 lis$. As this force is determined by the permeability of the iron, the instrument will constitute a balance by means of which permeability (μ) is weighed in terms of the current. Obviously this result can be obtained in many ways. Or the instrument might assume another form. Let one side of a balance beam weigh the force determined by the permeability of a standard sample of iron, while the other side of the beam weighs the force determined by the permeability of a sample of iron, the magnetic properties of which are to be measured or compared. Let these forces oppose each other, and it is evident that, the differences of the forces being weighed at all stages of magnetisation, the permeability of the iron under test can be determined in terms of the standard. Also if the instrument be excited by an alternating current, the actual permeability can be determined under as nearly as possible the conditions, as to hysteresis, &c., of alternating-current work. It should be pointed out that in both instruments the permeability determined is the permeability of the iron, in any given magnetic state, to the external field, which may have as small a value as desired.

THE DAVY ENCLOSED ARC LAMP.

The Davy enclosed arc lamp, the invention of Messrs. W. J. Davy and G. Thomas-Davies, is constructed in two patterns, for continuous and alternating currents respectively, and is manufactured by the Davy Electrical Construction Company.

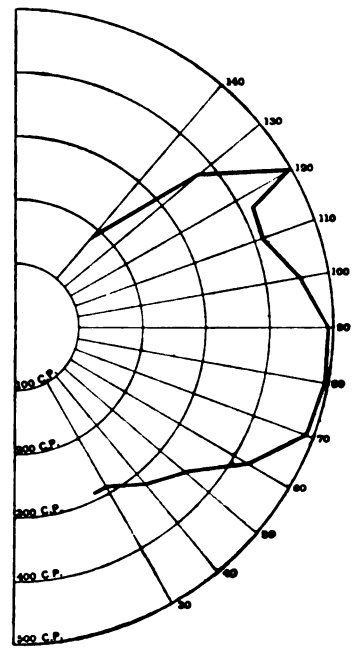

Fig. 1—Curve showing Distribution of Light, in a vertical plane, by the Davy Enclosed Alternating Arc Lamp.

The Alternating Lamp.—The alternate-current pattern is designed to run with from 4 to 12 amperes, with a pressure across the arc, in all sizes, of 65 to 70 volts at all frequencies. When series-wound the lamp runs on 100-110 volt mains, no choking coil or resistance being used when the frequency exceeds 83 cycles. The distribution of volts on an 8·4 ampere lamp showed 70·5 volts on the arc, 27 volts on the series coil, 88 volts on the terminals and 36 volts on the choking coil. The power supplied was 598 watts, the power factor of the

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arc being 80 to 82 per cent. Fig. 1 shows the distribution of light as photometered. With carbons 12in. and 5in. long, and 13mm. diameter, both cored, the lamp will run without retrimming for 90 hours, after which the residue of the top rod serves for a new bottom rod. The arc is usually drawn to ½in. length. These lamps are often run two in series on 200 volt mains. The details of construction are somewhat different from those of the continuous-current pattern, but in general principle the resemblance is very close. Figs. 2 and 3 show views of the lamp with the globes and casing removed. Fig. 2 shows the solenoid that controls the lamp, and Fig. 3 shows the core, the solenoid, together with the lower portion of the lamp having been removed. It will be clear from the following description of the continuous current pattern what is the action of the mechanism shown in these two views.

Continuous-Current Pattern.—Figs. 4, 6 and 7 are scale drawings of the continuous-current pattern and its details. This pattern is constructed for from 2 to 8 amperes, and is wound either in shunt, series or differentially, for running either in series or parallel. The voltage on the arc ranges from 65 to 75 volts, and the usual length of arc is ⅜in. Both carbons are solid or un-cored and are usually of 13mm. diameter. In Fig. 4 an iron casting, A, is screwed into a cover, C, which carries the

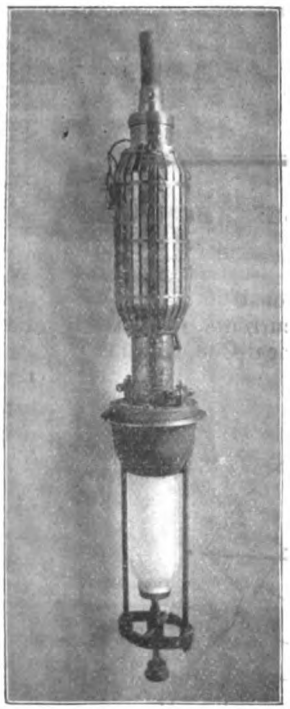


Fig. 2.—Davy Enclosed Alternating Arc Lamp, with Casing and Outer Globe removed.

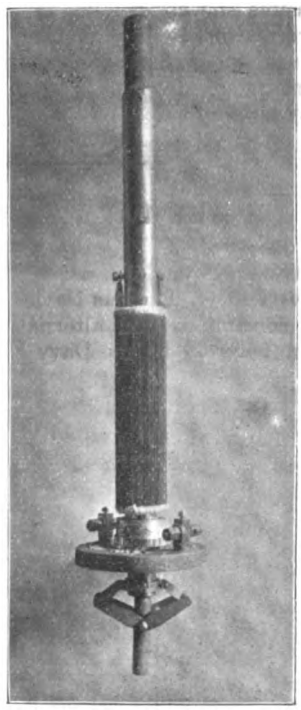
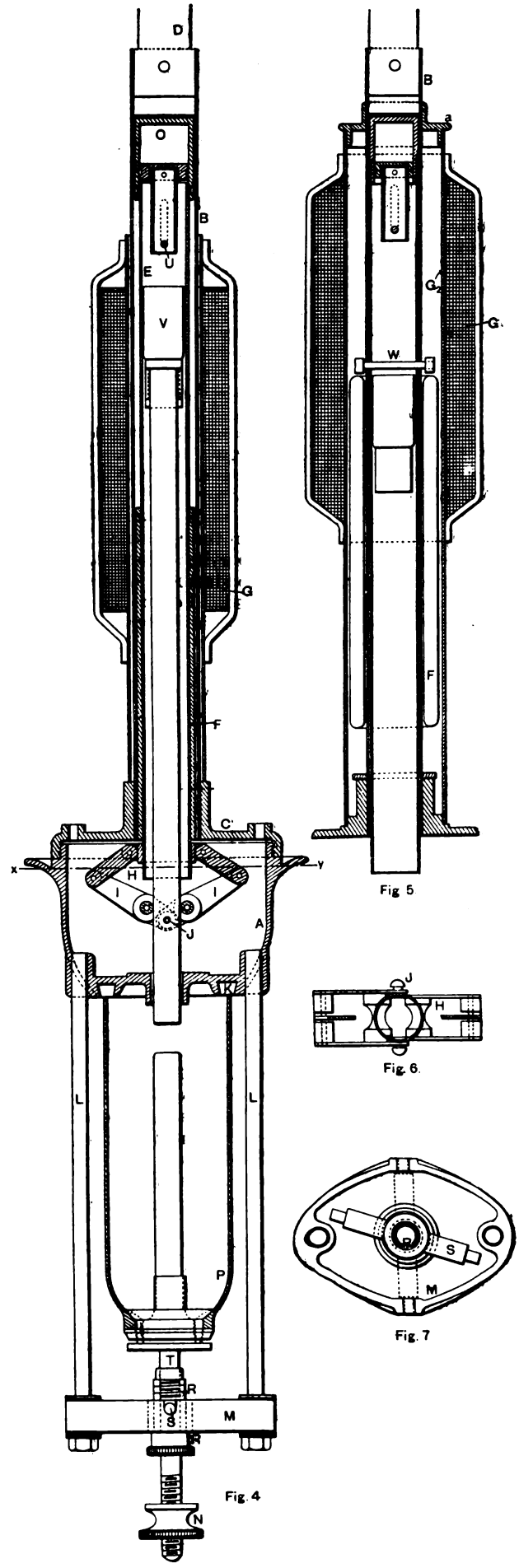


Fig. 3.—Davy Enclosed Alternating Arc Lamp. Details of Controlling Mechanism.

terminals, the suspension arrangement being attached to an insulating plug, D. Within the tube B slides with clearance another tube E, to which is attached the annular iron core F of the iron-clad solenoid G. Attached to the lower end of the tube E is the carbon-gripping device H, which acts on the toggle principle. A plan of this device is seen in Fig. 6. The parts II are linked together, but to nothing else, at J, so that the whole grip is free to rise or fall with the core till, in falling, when it rests on the bottom of the chamber A, the carbon is released and fed. Secured also to the casting A are two stanchions, L, which carry the frame M, a plan of which is shown in Fig. 7. This frame supports the lower carbon holder and the inner globe P by means of a hollow screw, R, which screws up through the arm S. The moving tube E carries an air dash-pot, O, to damp its motion. Current passes to the upper carbon through a flexible copper cord attached to the carbon-holder V.

Fig. 5 shows the upper part of an alternating enclosed lamp. The core F, shown also in Fig. 3, is of carefully laminated soft charcoal iron. It slides outside the frame tube B and actuates the inner grip-controlling tube through the medium of



The Davy Enclosed Alternating and Continuous-current Arc Lamps.

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a transverse pin, W. The bobbin G_2 of the solenoid has been designed so that it shall be quite air-tight when the cap *a* is fitted on. The ironclading of the coil G is carefully laminated. The arc in either pattern of lamp is first enclosed in an air-tight opal or clear cylindrical globe, outside which is a much larger globe, not air-tight, which is either clear or opalescent

The action of the lamp is as follows. The carbons being initially in contact and the core and grip being at the lower limit of its range of motion, when current is passed through the lamp the series solenoid is excited and sucks up its core, raising with it the grip device. This, directly it leaves the bottom of the chamber A, grips the upper carbon between its jaws and lifts it, thus striking the arc. To feed the carbons together, as previously explained, it is simply necessary that the pull of the solenoid shall have decreased sufficiently to allow the grip device to be lowered to the bottom of the containing chamber, when the carbon is released.

For particulars as to the performance of the alternating-current enclosed lamp we may refer our readers to our account of some tests we recently made on this lamp, which was given in our issue of Oct. 29th last. We understand that several of these lamps have been running satisfactorily for several months past in the electric light and power station at Havre.

ELECTRO-CHEMICAL PROGRESS.

BY BERTRAM BLOUNT, F.I.C., F.C.S.

It is at times useful to consider recent developments in a given branch of science or industry less with the view of cataloguing a long list of improvements or suggestions—fruitful, promising, possible, dubious or merely absurd—than with the aim of ascertaining what, if any, capital advances have been made, and of determining in what direction the stream of thought and activity is tending. In the necessarily brief and hasty chronicle of facts and opinions which must serve for immediate consumption, only a faint sense of proportion and perspective can be attained, and to all save the expert, capable of picking his mental pabulum and provided with an unerring instinct for the rejection of the trivial and the inane, the discrimination of a considerable achievement from a pretty artifice is scarcely possible. A certain detachment of mind is requisite for such judgment, and it must be associated with so innate, or at least ingrained, a critical faculty that every statement is automatically apprehended and brought before the tribunal of sound knowledge, where it must suffer the assaults of the sceptic (who may be regarded as a benevolent devil's advocate) before being finally stamped with approval and passed into the domain of the positive.

This is a lofty ideal, and one may fall short of it comfortably, and with the retention of a modicum of self-respect sufficient for all practical purposes. But its enunciation will convey what is my general intention. The publication of a sort of subject-matter index I leave cheerfully to the compiler, whom I salute with an alien's respect. Taking advantage of his very necessary labour, let us consider what are the most noteworthy features of recent work in industrial electro-chemistry.

The conversion of the capitalist is the most significant achievement of the modern electro-chemist. Not many years ago electrolytic processes were regarded by those who were at once enterprising, opulent and sane as sinks for surplus cash. Without giving unqualified consent, one may admit that this view was at least tenable. It is, of course, obvious from the purely technical standpoint that the chief use of the capitalist is to embark in new enterprises which are too risky and expensive to be practicable for men of modest means, and that his failure and ultimate commercial extinction are mere incidents in the march of progress which he should himself contemplate with resignation, if not with equanimity. But from the very fact of his existence it usually follows that the capitalist is a shrewd and selfish person, inaccessible to this ideal; if of choleric disposition he has been known to denounce it as nonsensical, or even thievish. Possessed with these sentiments he must be approached by a lowlier read. It must be shown that any given process has a tolerable chance of success; that it is a fair industrial risk, to be undertaken by anyone capable of expecting interest from a gold mine. Given this modest level of expectancy, capital will be forthcoming.

Experience indicates that this level has now been reached. Any electro-chemical process which can be shown to work well on a small scale, and is favourably regarded by an independent and competent consultant, will not go long a-begging. It will be taken up, not necessarily in this country, but on the continent or in America, and a trial on a practical scale accorded to it. Should this prove successful, manufacturing in earnest will be begun, and no capital expenditure, however large, is likely to deter the true merchant-adventurer. It is matter for congratulation that in the growth of industrial electro-chemistry there has been nothing comparable with the period of inflation and reckless finance which disfigures the early history of electric lighting, and there has been no consequent depression and disgust to endure and overcome.

But the development of electro-chemical industries has been delayed by another cause, now slowly diminishing. Not many years ago the quack inventor was rampant. He was usually a person comprehensively ignorant of chemistry, electricity and mechanics, and he devoted his powers to the elaboration of methods of electrolytic manufacture illustrative of this nescience. The result has been injurious, though not prohibitory, to true progress. Money has been embarked in ill-considered schemes, to the impoverishment of those resources which would have sufficed for the full trial of sound methods, and the blurred record of past failures sullies the page on which new attempts are to be inscribed. Nevertheless, when due allowance is made for all drawbacks, there is at the present time a spirit of healthy enterprise, not unduly sanguine and eager to believe in the electrolytic transmutation of all ions into those of Au, but reasonably hopeful of the conversion of a fair proportion into a negotiable form.

This phase of progress is illustrated by the condition of some of the more flourishing branches of industrial electro-chemistry. The oldest and largest is the refining of copper. The refining of copper by electrolysis must be sharply distinguished from the winning of copper from its ores by the same means. The former is a complete and colossal success; it constitutes a huge and established trade. As far as published records go the latter has not passed beyond the stage of experiment on a large scale. Several promising processes have been devised, launched with acclamation, and dropped into limbo. To deal first with the success, electrolytic copper refining has been practised on a large scale, and with singularly little flourish of trumpets, in South Wales for a good many years. It is possible that this curious quietude arose from the knowledge that the profits of the industry are large, and a belief that there is some treasured manufacturing secret to be jealously guarded. It may be conceded that, in the hands of competent men, the experience of some years must have as its outcome many minor improvements conducive to smoothness of working, economy of production and excellence of product, but it is none the less true that all fundamental facts concerning electrolytic copper refining are matters of common knowledge, and that an obscurantist attitude comes perilously near absurdity. In the United States there is a smaller tendency to reticence, and information concerning new works or methods is published freely; but it is quite conceivable that many essential facts are suppressed. Be that as it may, it is certain that the change in the copper trade has been revolutionary. It is barely ten years ago when I was consulted by the inventor of an excellent method for refining copper by a modification of an ordinary metallurgical process. At that time there was room for such a process, but, nevertheless, I warned its author that he must make "hay while the sun shone," as it was about to set beneath the horizon of the beautiful blue-green liquid of an electrolytic tank. To-day the prediction has become an accepted, commonplace fact. Of more general importance than the fate of this particular process is the shifting of the balance of trade in electrolytically-refined copper to the United States. Huge works have been erected with that

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financial courage which distinguishes our friends across the water, and the output of these now dwarfs that of Europe.

Far otherwise is it with the electrolytic winning of copper from its ores. In the early days it was thought that it would be feasible to refine copper electrolytically, using anodes of copper matte of the grade known in copper smelting as "coarse metal," and containing in round numbers equal parts of copper, iron and sulphur. This idea proved to be illusory, and attention was directed to leaching out copper from its ores and electrolysing the resulting solution with insoluble anodes. In such a case, where the energy represented by the heat of dissolution of the copper in the electrolyte—available in the ordinary process of copper refining to balance the energy necessary to be expended in the precipitation of copper in the metallic state from the electrolyte—was not forthcoming, a higher voltage, and therefore a larger consumption of electrical energy, were required, But this was the least of the evils; much more serious were the practical difficulties encountered in leaching the ore, in finding permanent anodes and diaphragms, in keeping the electrolyte free from objectionable impurities, and in maintaining the purity of the copper deposited. Reflecting on the trials and troubles of the Siemens-Halske process and of its variants ("improvements" the inventors call them), and of the Hoepfner process in its numerous and ingenious developments. one may easily see that a practicable method of electrolytically winning copper from its ores is as difficult to devise as it is alluring to imagine.

Refining zinc by electrolysis is not practised, probably because any large demand for exceptionally pure zinc could be met by re-distilling the metal. The great cost of winning zinc from the ore is not due to the fact of its distillation, *qua* distillation, but to the circumstance that the temperature at which zinc oxide is reduced by carbon is very high, and, being above the boiling-point of zinc, compels the conduct of the operation in retorts instead of in a smelting furnace. But when once zinc is reduced to metal, its redistillation is a simple matter. It can be effected at so moderate a temperature that for experimental purposes the distillation may be done in glass vessels, provided that a fair vacuum be used. It is a pretty sight to see zinc distilling easily and rapidly, and condensing to a brilliant mercury-like liquid, with apparatus no more elaborate than a piece of combustion tube and a good aspirator. Thus it comes about that the electrolytic *refining* of zinc is not likely to be undertaken, and, equally, that its electrolytic *winning* offers many advantages. Several processes—notably one devised by Hoepfner—are on the market, and one (at Duisberg) is said to be paying well. There is a possibility of a revolution in the zinc trade similar to that which has actually taken place with copper, and it would be not only possible, but highly probable, if there existed a demand for pure zinc as large and discriminating as is the demand of the electrician for pure copper.

Nickel is in a different case. Lately it has been found that it is possible to deposit nickel from hot solutions of its chloride or sulphate in massive form. The old trouble, caused by the metal curling off the cathode as soon as it reached more than a film-like thickness, has been overcome by heating the electrolyte. But the deposited metal is not particularly pure, and unless and until it is, it will have no great advantage over that prepared by ordinary dry processes.

Dismissing the minor heavy metals, one may consider the two light metals which have attained an industrial existence within the last few years—sodium and aluminium. Sodium, strange to say, is being made, not from the cheap chloride, but from the comparatively costly hydroxide (caustic soda), by the Castner process. It is pleasing to remember (1) that critics (believed to be competent) demonstrated conclusively that to use caustic soda when one could get common salt at a tenth the price was ridiculous, and (2) that not only is the Castner process using caustic soda, thus reverting to the original method due to Sir Humphry Davy, but that it has practically driven competitors off the field. The other side of the picture is that sodium at 1s. 4d. per lb. in ton lots attracts few buyers; large uses for it have yet to be found, and when that is done we shall see it quoted £100 per ton or under. As for aluminium, its success in its own field is sufficiently assured to make its production quite a humdrum affair. That considerable quantities should be made and sold seems surprising considering that there is no single large use for it. Its consumption is a curious proof of the enormous aggregate value of soap-boxes and camera tripods.

The present revival in the interest taken in the electrolytic production of alkali and chlorine is a sign of the conversion of the capitalist, commented on in a former paragraph. It cannot be maintained that the career of existing processes has been an unqualified success. Abroad, several firms are said to be doing well, but authentic information is difficult to obtain. At home, one company is struggling and another is about to reap some reward, if an increase of plant is any indication of prosperity. Altogether, the situation of a new company is by no means assured. But, in spite of the moderate prospect of return, a new undertaking has been launched to exploit the Rhodin process. That there may be litigation with the holders of the Castner-Kellner patents is sufficiently obvious, and, indeed, the lawyers seem to have got to work already. But with this prospect before them, a number of gentlemen, who have sufficient faith in ultimate success to induce them to take up a good part of the issue, have not hesitated to put down their names as directors of the new company. Could anything be more significant of the march of electro-chemistry out of the wilderness into a (comparatively) happy land?

On the subject of calcium carbide, it is decent to maintain a discreet reserve. More than enough has been said, and one may wait with commendable self-restraint until a little has been done. Shameless persons have suggested that the whole of the present output—the magnitude of which has been frequently debated—is absorbed by the experiments of inventors of acetylene lamps. This is credible, if it be remembered that the average inventor of an acetylene lamp is wholly free from any vulgar tendency to experiment—he draws.

The present situation of electro-chemical industry may be summed up in a few words: The refining of copper is a thorough success, and its ultimate predominance is assured; the winning of zinc is about to come; the aluminium industry is on a firm and broad basis; sodium can be made cheaply, but wants buyers; soda and chlorine products are just rounding the corner, and their manufacture is being seriously undertaken; the co-operation of the capitalist in all reasonable enterprises has been secured. There has been much solid progress, and we may fairly look for further and substantial advances in the near future.

THE ELIESON ELECTRIC MOTOR CAR.

In the pioneer days of electric tramway traction it was the practice to secure the motor to the car body, and to drive the wheels by means of gearing which was required to adapt itself to every change in the relative position of the car and the axles. It was soon found, however, that the attachment of the driving mechanism to the car body was a mistake, for it wore out both motor and car body, transmitted every vibration and jolt to the passengers, and rendered the problem of gearing the motor to the wheels in such a way as to allow for the movement of the springs difficult, and every solution of it unsatisfactory. The remedy was discovered only when the motor truck was invented.

Similarly, in the earliest days of a still youthful industry—the manufacture of motor cars and mechanically-propelled road vehicles—it was the invariable practice to attach whatever machinery was required to the upper part of the vehicle itself, and not to a rigid under-frame, with precisely the same unhappy results as in the pioneer electric tramcars. We ourselves have always felt that eventually the solution of the motor car problem would be found to follow identically the lines of the solution of the tramcar problem, and that makers would finally abandon the plan of attaching the motor to the body of the vehicle and would place it on a suitable under-frame or truck, upon which the vehicle would be carried by means of springs. We are

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pleased to notice that in the new Elieson electric motor car this method of construction has been adopted. Mr. Elieson places his motor and driving gear on a self-contained truck, upon which, with the very minimum of trouble, any shape or pattern of carriage or cart may be placed. The general construction of this truck, which is a reasonably light structure, is shown in plan and elevation in Fig. 1, while in Fig. 2 is

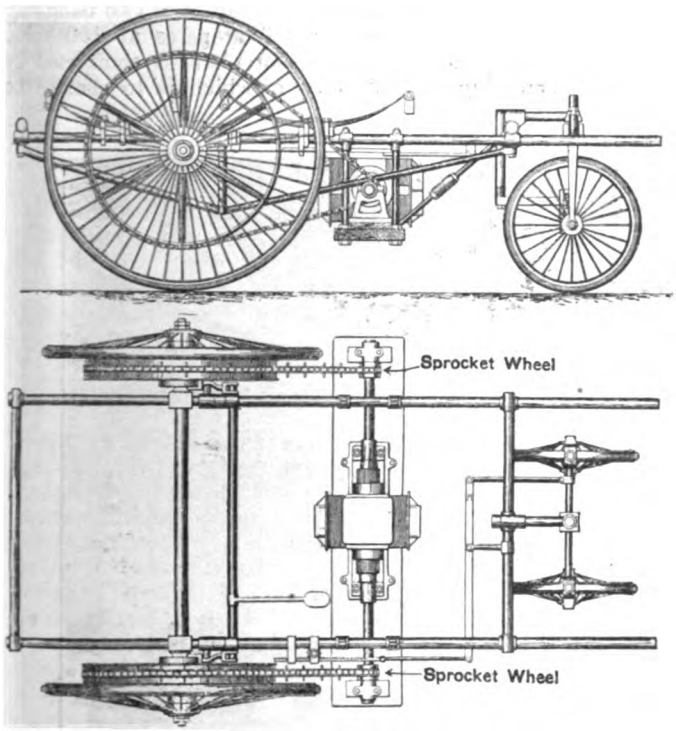

FIG. 1.—Plan and Elevation of Motor Truck of the Elieson Electric Car.

shown one pattern of motor car mounted on one of Mr. Elieson's trucks. For such a truck or under-frame lightness combined with strength is essential, and to this end in the present instance the frame is made of Mannesmann weldless steel tube. The two side trusses are held apart and stiffened with similar tubes. As shown in Fig. 1, the motor is

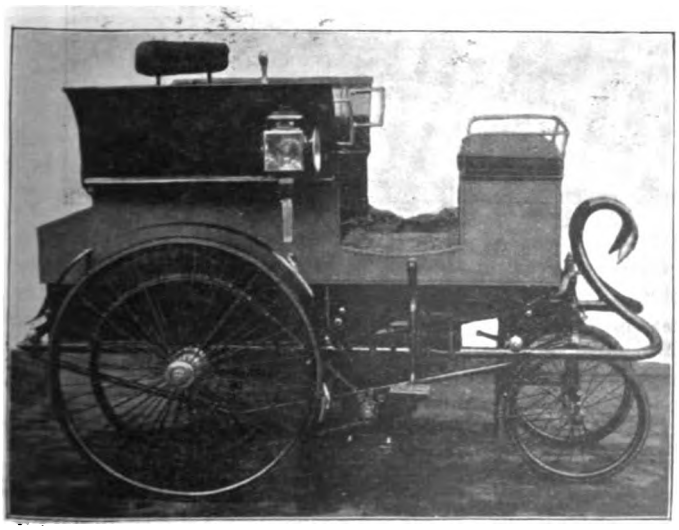

FIG. 2.—The Elieson Electric Motor Car.

suspended from the trussed frame, and drives a spindle that extends the entire width of the frame and projects somewhat beyond on either side. By means of a novel form of chain gear each end of the motor shaft is made to drive a working pulley on a rear wheel. The motor spindle carries a small sprocket wheel, with which the chain engages; but every third link of the chain is provided with a pin or pair of lugs sticking out beyond the width of the link, as shown in Fig. 3. The pulleys on the car wheels carry no sprockets, the grip of the chain being determined purely by the frictional adhesion of the projecting lugs of the chain, which press upon two leather rims, also shown in Fig. 3. Between these rims or bands there is sufficient clearance to permit of the chain itself riding clear of the pulley. It is claimed that this form of gear "secures what no other gearing has ever before attained—namely, the combination of a positive driving with the advantage hitherto peculiar to belt driving alone; viz., that in turning corners it permits slip to take place on one side." We are not sure that that can be called "positive driving" in which "slip can take place," nor are we altogether confident that the gear adopted by Mr. Elieson—doubtless not without considerable experience of it—is best suited to the purpose; but as a motor car driven by this gear is stated to have mounted a gradient of 1 in 15 at a good speed the question is probably rather one of durability than of reliability when fairly new.

Electrical energy for the Elieson motor car is stored in a battery of Lamina accumulators, usually carried by the under-frame. We do not know the reason for placing the cells there rather than in the vehicle body, but we should suppose they would be subjected to less vibration if carried in the last-named place, a matter which might considerably enhance their life. The plates of the Lamina battery are of the Planté type, composed of perforated and corrugated lead sheets, so arranged

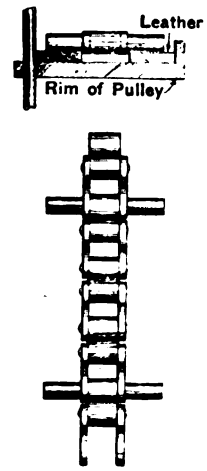

FIG. 3.—Details of Driving Gear of Elieson Electric Motor Car.

that the corrugations run alternately vertically and horizontally. These sheets or plates are contained in an envelope of perforated and corrugated lead, riveted through and burned. It is stated that the cells withstand very high rates of discharge, and that the output is not seriously diminished by such treatment. The cost of energy for a 30-mile run on one of these motor cars is stated to be one shilling.

It is gratifying to see the number of successful electric motor vehicles steadily increasing, and to find that, as is the case with the Elieson motor car, this result is largely due to careful attention to details of structural design.

GLASGOW MUNICIPAL ELECTRIC SUPPLY STATION.

The accompanying illustration, prepared from a photograph kindly sent us by Messrs. Willans and Robinson, gives an excellent view of the interior of the electric supply station of the Glasgow Corporation. Probably there is not in existence a more crowded, and at the same time an equally convenient arrangement of generating plant, in a station of the same capacity; for, now that the machinery room is accommodated with all the plant it can contain, there is an aggregate of about 8,400 H.P. on a total floor space of 2,814 sq. ft., including gangways. The plant-density, therefore, to coin

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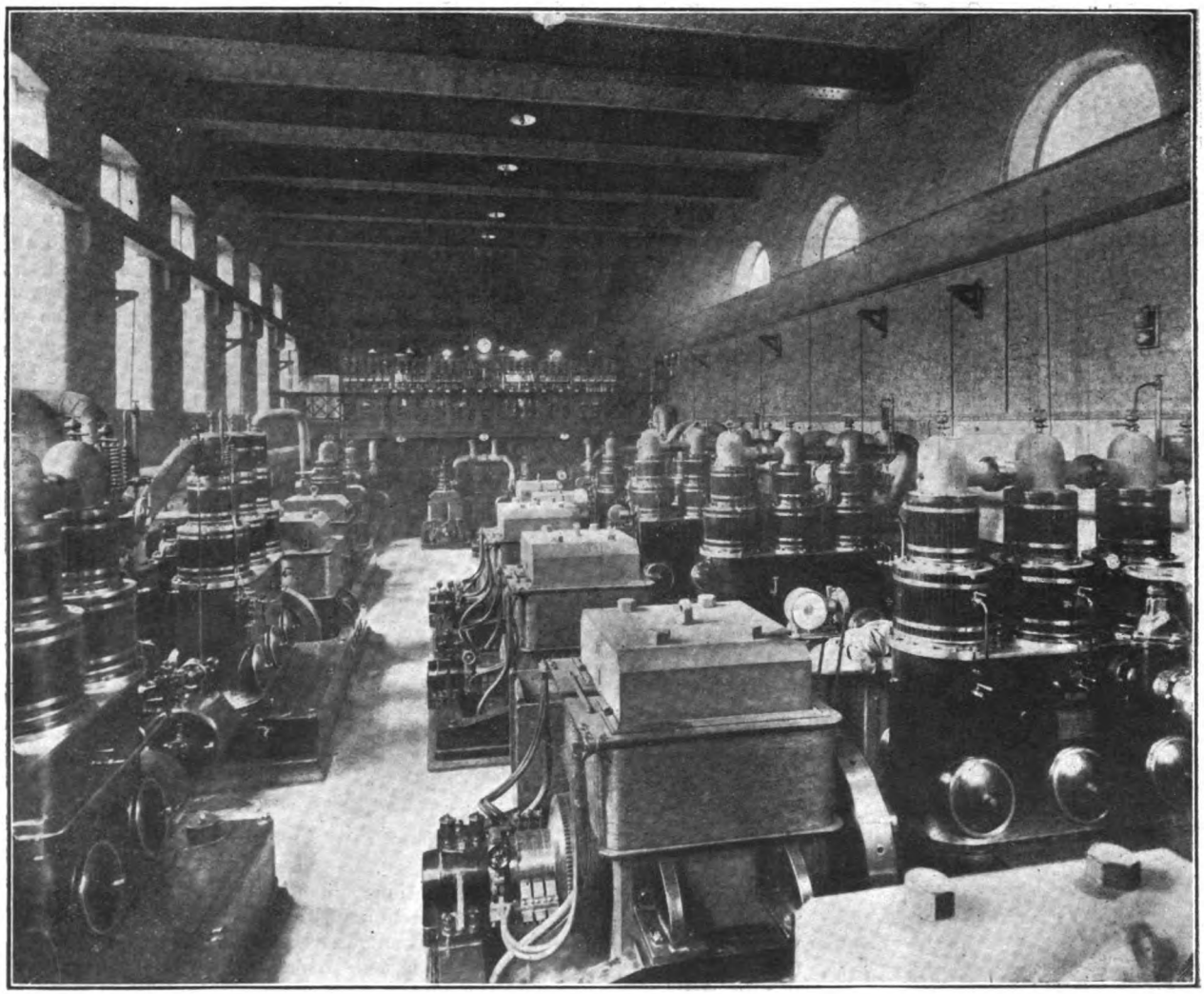
another catch-phrase, is about 1·2 H.P. per square foot. It is scarcely necessary to say that this degree of compactness is only attained by the use of direct-coupled high-speed generating sets.

The station has already been described at some length in our columns (see *The Electrician*, Vol. XXXII., p. 727; also Vol. XXXIII., p. 509), it will, therefore, be unnecessary to enter upon a lengthy description now. The system for which the station was originally designed, and upon which it now works, is the three-wire continuous-current system; but whereas at first little use was made of storage batteries, it is now intended to equalise the load on the machinery by means of sub-station accumulators. The generating machinery in the room shown in the accompanying illustration comprises 18 direct-coupled steam engines and dynamos. All the engines are of the well-known Willans type. Six of the sets consist of 360 H.P. three-crank compound engines coupled to Siemens continuous-current two-pole drum-wound dynamos, running at 350 revolutions, and developing 940 amperes at 240 volts, or, by an alteration of the field, 1,125 amperes at 200 volts. Three sets are 240 H.P. two-crank compound engines, running at 350 revolutions, coupled to Latimer Clark dynamos, developing 670 amperes at 230 volts. There are also two balancing sets, consisting of two 80 H.P. two-crank compound engines, running at 450 revolutions, coupled to two balancing dynamos, capable of developing 400 amperes at 100 volts. The entire equipment of generating plant is completed by the two remaining sets, the duty of which is to charge the batteries. These sets each consist of a 150 H.P. compound two-crank engine coupled to a two-pole machine, capable of developing 400 amperes at 230 volts when running at a speed of 380 revolutions per minute.



Glasgow Municipal Electric Supply Station. View of the Machinery Room.

LEEDS MUNICIPAL ELECTRIC TRAMWAY.

Although some of the construction work in connection with the electric tramway at Leeds remains yet to be completed, a few electric cars for some weeks past have been running, and the work is now sufficiently far advanced to render an account of what has thus far been accomplished of interest and instruction to our readers. We hope at a later date, when the whole of the work has been carried out, to return to the subject and complete our account of this important addition to English electric tramways. Leeds was associated quite early with the electric traction movement in this country, for it was over a portion of the route taken by the newly-equipped line that the historically-interesting Roundhay line was laid—the first practical use of the trolley in this country. With the work carried out when that earlier line was built the present equipment, however, has nothing to do, the recently-opened line having been constructed according to more modern practice and without making use of any of the original plant or materials.

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Leeds tramways were formerly controlled by a limited liability company under powers obtained by Act of Parliament in 1871. The concession expired in 1894, in which year the Corporation decided to avail itself of the famous purchase clause in the Tramways Act, and thereby to acquire the 22 miles of then existing lines belonging to the Company, and to consolidate these with short lengths of tramway already built by the Corporation. As required by law, the Corporation sought to lease the tramway system to a new Company, the lines being in the meantime worked by a staff under the direct control of the Corporation; but, as has so frequently happened in other towns, it was found impossible to arrange such a lease, and the Corporation were driven by the combined force of circumstances and popular feeling to seek from Parliament the necessary power to work the tramways permanently for itself. This power was granted in 1896. Prior to the passing of the Act which conferred it, the advisability of running the lines by electric power instead of partly by horses and partly by steam locomotives, as was then the practice, was discussed, and it was decided to make practical trial of the trolley system on a working scale. The line selected for the experiment was that from Kirkstall to Roundhay, a line passing through the principal streets of the city of Leeds and offering considerable attractions to pleasure seekers at its two termini. It is this line that has recently been opened, and that we are now about to describe.

It will doubtless be recollected by our readers that in the early part of last year it was announced that the Tramways Committee contemplated using a closed conduit system on the portion of the experimental line which passed through two of the most important streets, viz., Boar-lane and Briggate; and that the Westinghouse surface-knob system had been recommended by Dr. John Hopkinson. The City Council, however, decided not to adopt the recommendation of its Committee and their consulting engineer, but to employ the overhead trolley system on the entire line, and this plan has accordingly been carried into execution. Before describing the construction work that has been thus far completed, we may say that the line terminates, at the Kirkstall end, at a point just outside the precincts of the ruined and ivy-*dis*mantled Kirkstall Abbey—indeed a picturesque attraction, even now when its vesture of thick ivy has been ruthlessly torn from it. From this point the line takes a south-easterly course to Leeds, on passing through which it turns almost at a right angle, and takes a north-easterly course to Roundhay Park, at the entrance to which—in a room over the lodge—is the storage battery plant. The terminus of this part of the line is within the park, about a mile from the battery sub-station. The entire line extends about seven miles, and is of double track throughout. There are several curves and gradients, but these are, generally speaking, not severe. The shortest radius is probably that at the junction of Boar-lane and Briggate; while the steepest grade, a matter of 1 in 21, is near Roundhay Park.

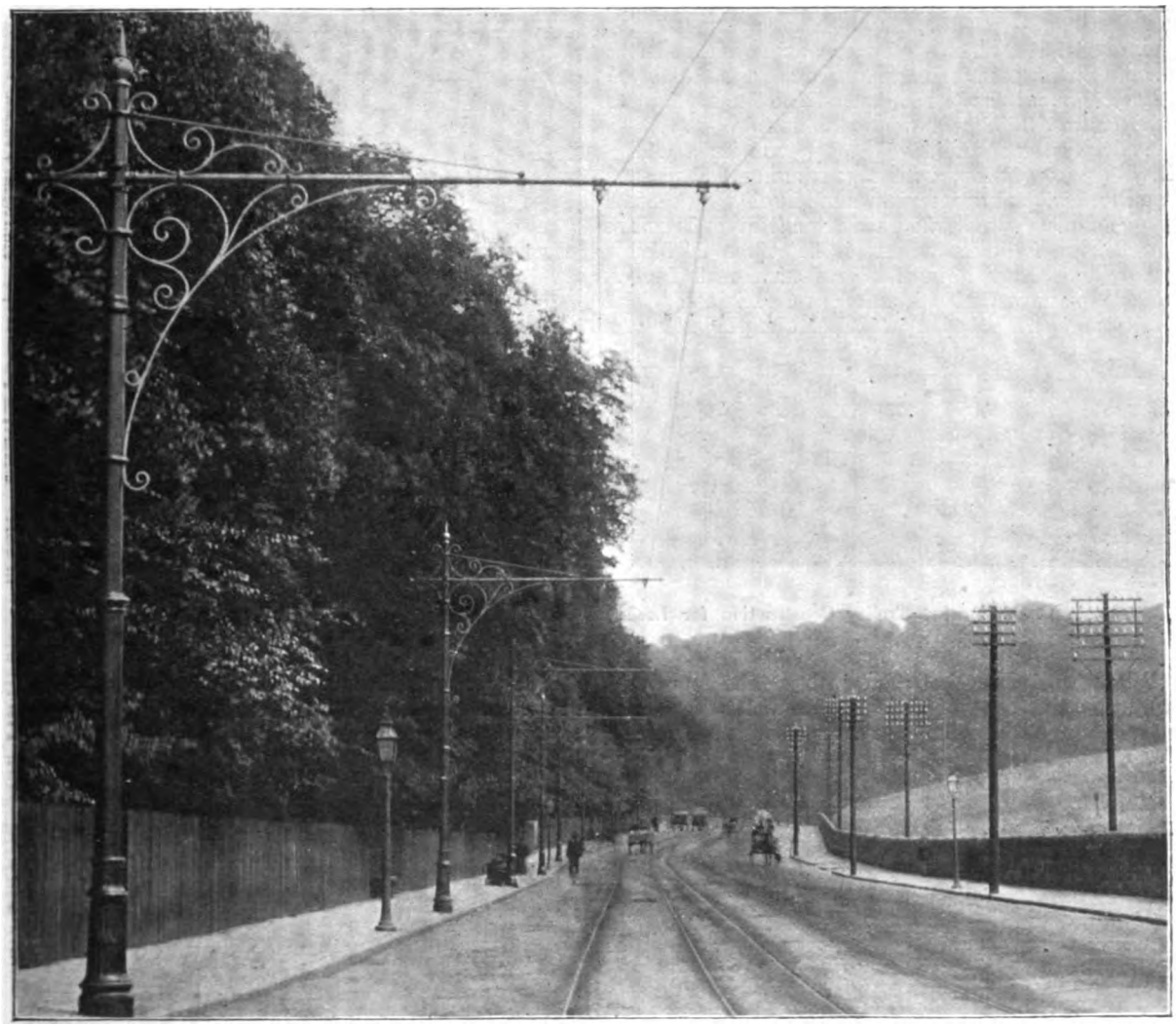

FIG. 1.—Side-pole Single-bracket Trolley Construction on Leeds Electric Tramway.

Permanent Way.—English practice has been exclusively followed in making the permanent way, unless we are to include in this the electrical bonding of the rail joints. The concrete bed varies from 6in. to 12in. in depth, being generally the former, and the composition of the concrete is four parts of 2in. stones, two yards of sand and one part of

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Portland cement. Grooved girder rails are laid upon this bed weighing 100lb. per yard and having a base and depth each measuring 7in. The rail joints are made in the following manner: Beneath the flanges a 24in. sole plate, weighing

FIG. 2.—Centre-pole Double-bracket Trolley Construction for Leeds Electric Tramway.

40lb., is bolted with three bolts on each of the four half-flanges, while on the sides of the webs are bolted a pair of fish-plates weighing 47lb. The bare copper bonds are carried beyond the rail joint, *i.e.*, they make connection with the rail webs at points outside the fish-plates; they are in duplicate and are of the "Chicago" pattern. The rails of the double track are all cross-bonded at intervals of 120ft., *i.e.*, at every fourth rail. For keeping the rails to gauge tie-bars are used at intervals of 10ft., or three bars on every length of rail.

Overhead Trolley Equipment.—The overhead trolley construction of this tramway undoubtedly attains as high a degree of artistic merit as is possible with this class of engineering work, and we remember to have seen nowhere trolley poles and brackets and all the paraphernalia of the overhead system that so completely as those at Leeds have minimised the native unsightliness of their kind. Indeed, so excellent are they in design, and with such care has their position in every instance been selected, that throughout the entire run from Kirkstall to Roundhay we saw nothing that might not grace an elegant boulevard. With what favourable opinions must the residents of the neighbourhood contrast them with the ugly span-lines and double lines of poles that formerly were to be seen along the same route.

FIG. 3.—Motor Car used on Leeds Electric Tramway.

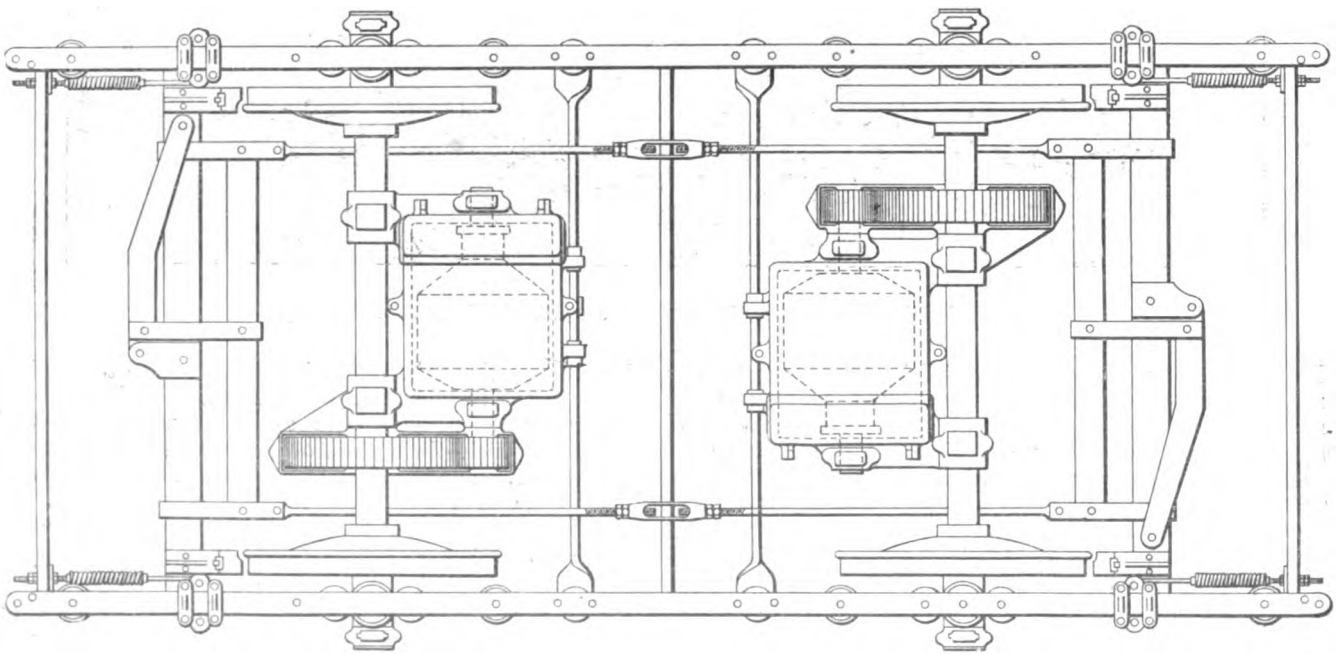

FIG. 4.—Plan of "Peckham" Cantilever Motor Truck for Cars on Leeds Electric Tramway.

Both side and centre poles are employed, with single and double brackets. For an example of the side-pole single-bracket construction we have selected a piece of the Roundhay road illustrated in Fig. 1; while in Fig. 2 is shown the centre

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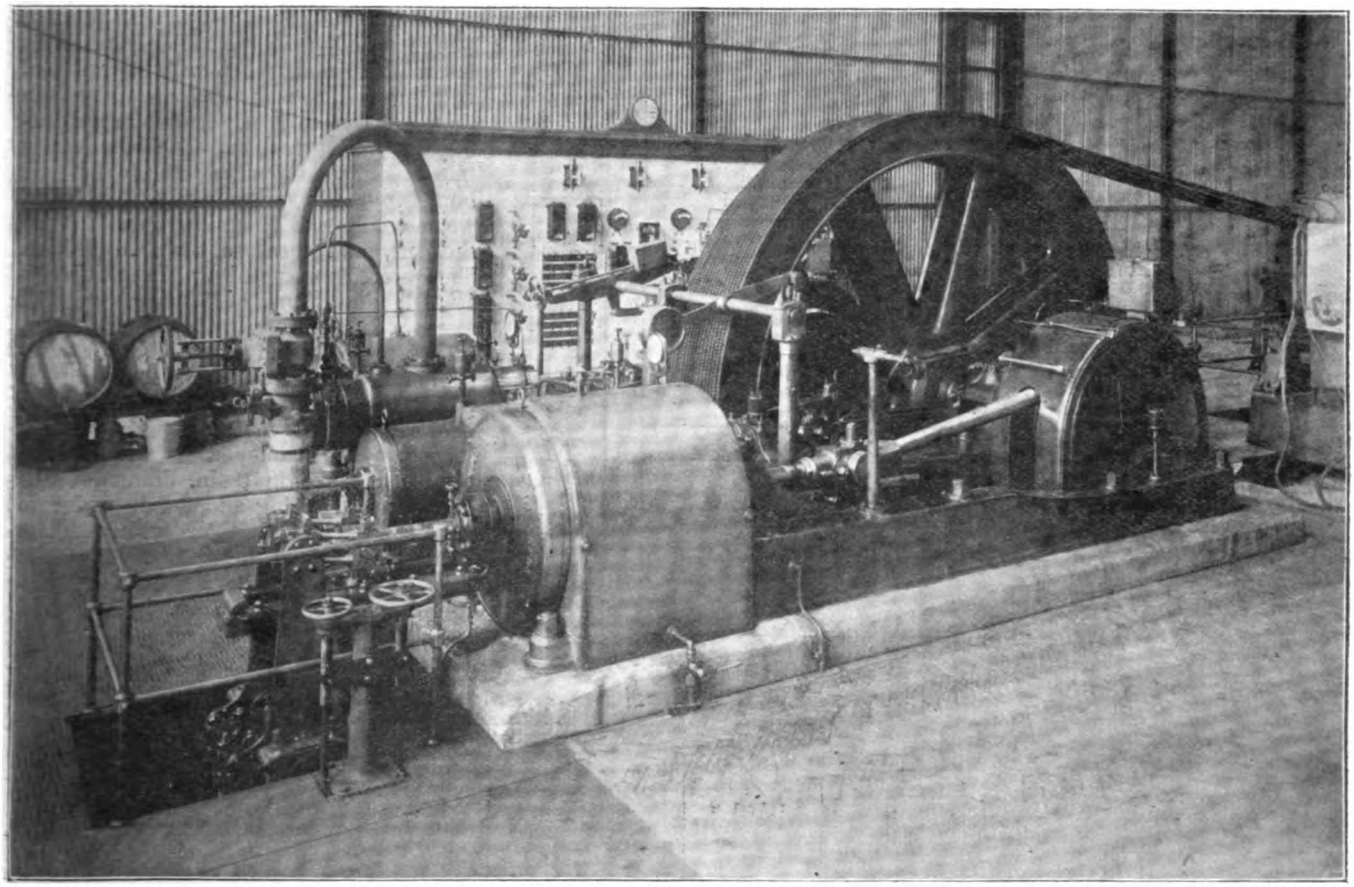

FIG. 5.—View of a Portion of the Power Station of Leeds Electric Tramway, showing the Switchboard and one of the 400 H.P. Horizontal Compound Condensing Steam Engines, built by Messrs. John Fowler and Co.

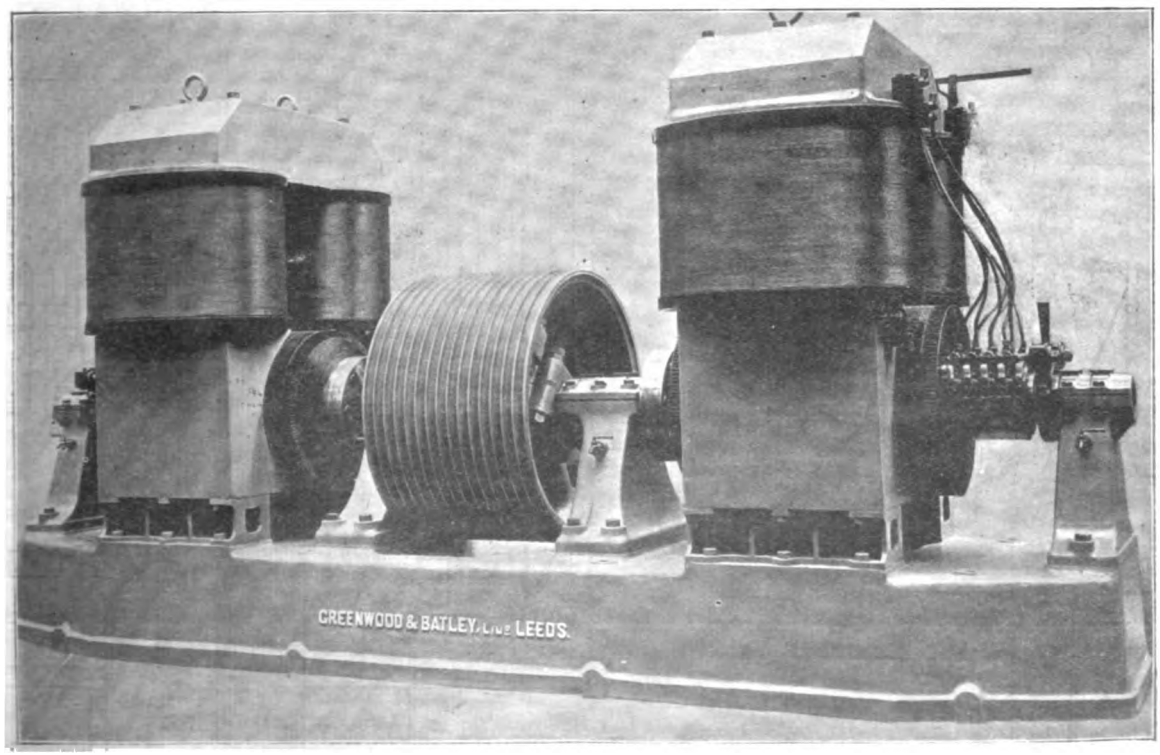

FIG. 6.—Twin Dynamos built by Messrs. Greenwood and Batley for Leeds Electric Tramway.

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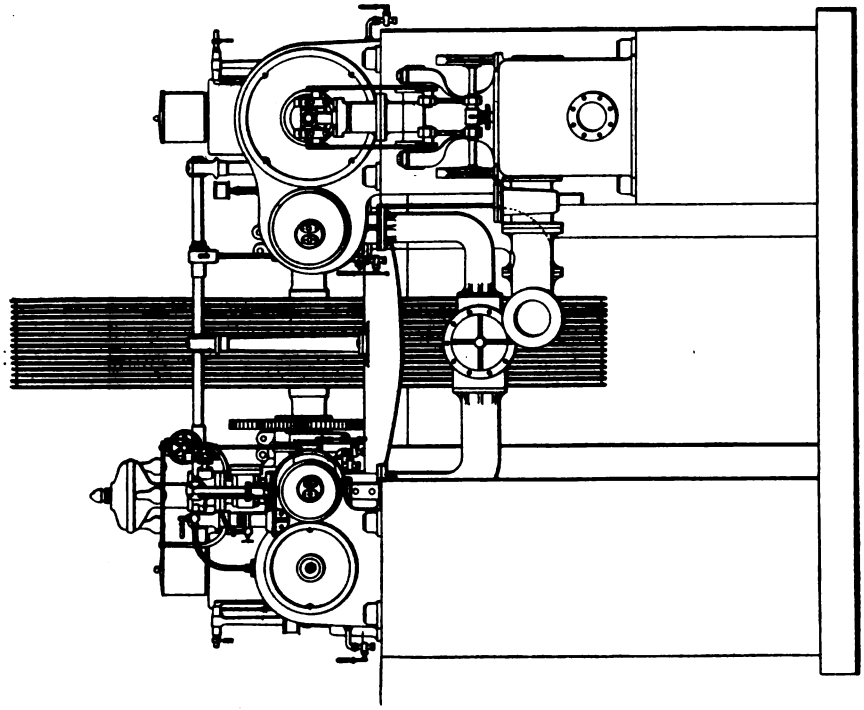

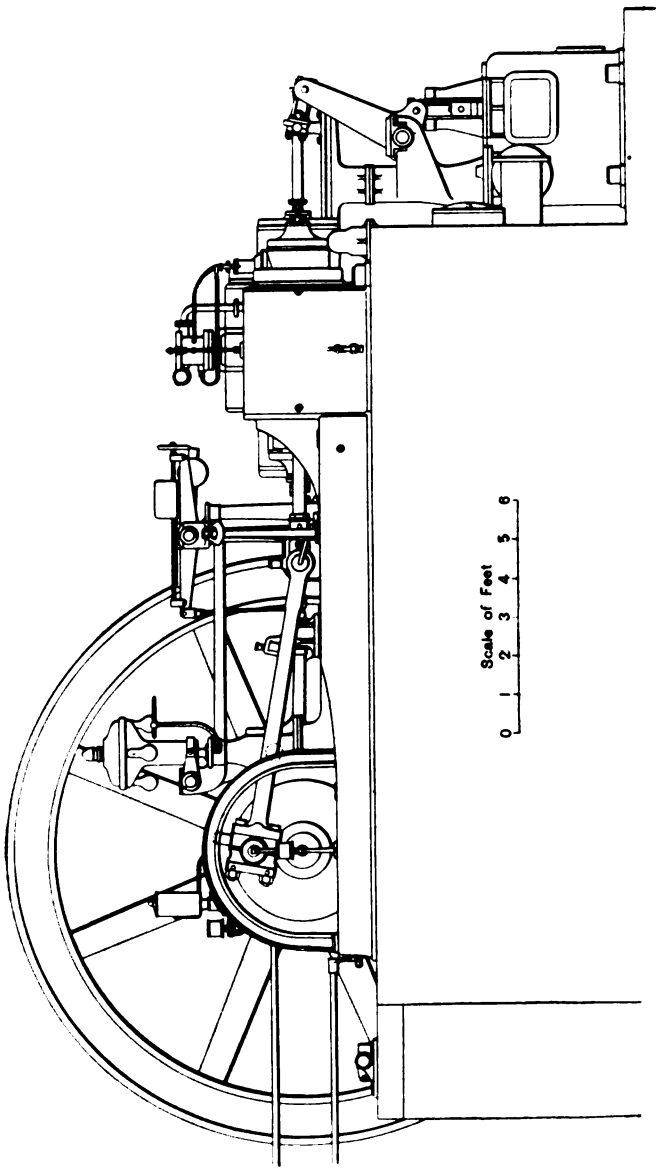

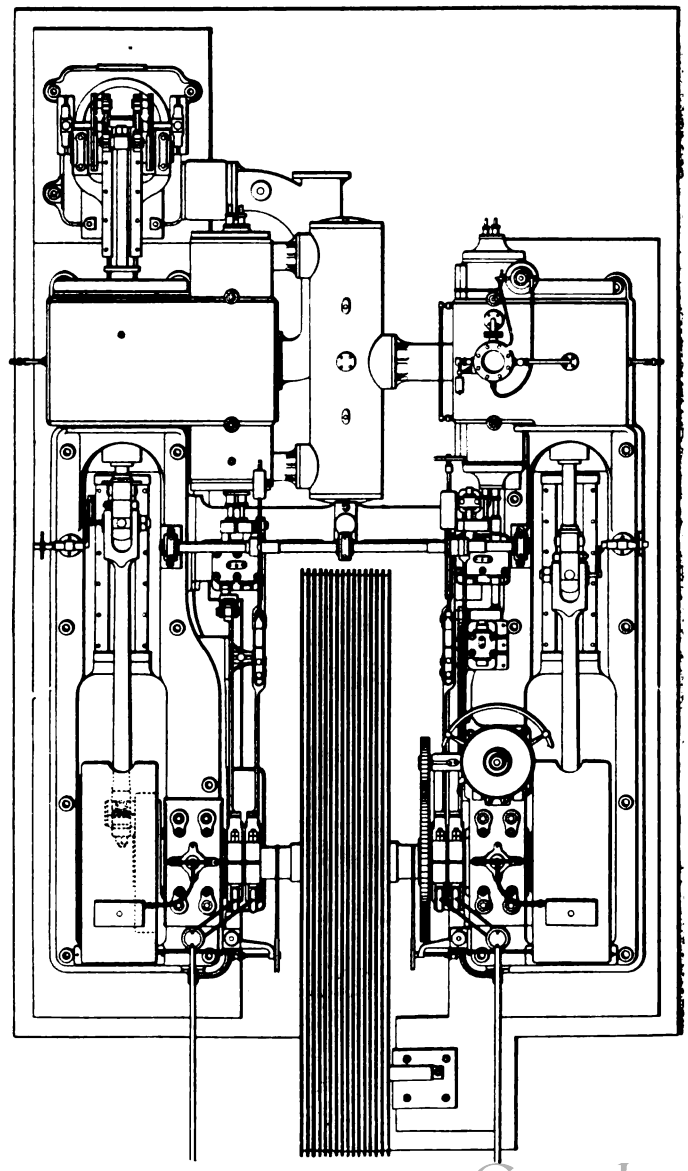

FIG. 7.—Leeds Municipal Electric Tramway. Plans and Elevations of a 400 H.P. Horizontal Compound Condensing Steam Engine, built by Messrs. John Fowler and Co., Leeds.

pole double-bracket construction adopted for Briggate and Boar-lane It is intended shortly to place arc lamps on the tops of some of these poles, and to run them—five in series—from the trolley wire. This is an experiment that will be watched with interest, as it is by no means certain that, even when a powerful storage battery is connected, the voltage of a trolley line is sufficiently steady to enable arc lamps to be run satisfactorily. The poles, we may add, are of hollow steel, in two sections, and measure 31ft. in height. They were constructed by Messrs. James Russell and Sons, of Wednesbury and Leeds. In all, there are 284 side-poles, 85 centre-poles, and eight poles for pull-overs and anchoring. The greatest length of any single bracket is 18ft., while the shortest bracket measures only 8ft. in length. The trolley wires are heavier than usual, being 0·4in. diameter, the extra weight being adopted in order to save copper in the feeder cables and to increase the life of the trolley. The wire is soldered to suspending ears of aluminium bronze, each 15in. in length, a special form of section-insulating ear being used, of course, at the requisite

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points. In this latter the insulating gap consists of vulcanised fibre. At the section termini the trolley wires are supported by strain wires, in each of which there is a strain-insulator. In many places along the route, where other overhead wires cross the tramway, guard wires are used. These details, together with the trolley wire, were supplied by Messrs. Laing, Wharton and Down.

At present there are four cables for feeding the line and charging the battery. The battery feeder consists in a single conductor of 0·17 sq. in. section; the three line-feeders are concentric cables, each separate conductor having a section of 0·34 sq. in. By the use of return conductors from all the feeding points the magnitude of earth currents and risk of electrolysis are diminished. The cables were made by Messrs. W. T. Glover and Co., and are laid in Doulton conduits.

Rolling Stock.—When completed, the rolling stock will comprise some 25 motor cars, but the majority of these are not yet running. The cars, of one of which a general view is afforded by Fig. 3, are doubled decked, and are mounted on "Peckham" rigid four-wheeled trucks (shown in Fig. 4). The car bodies were built for the contractors, Messrs. Greenwood and Batley, by Messrs. Milnes and Co., of Birkenhead, and the trucks were supplied by Mr. R. W. Blackwell, of Westminster. The cars have a wheel base of 6ft. and a spring base of 14ft.; they measure 26ft. from end to end, and have a seating capacity of 51 passengers per car. The wheels are 33in. in diameter. Upon each motor truck are two "G.E.-800" motors, with the usual series-parallel controller and reversing gear. The brake is controlled by hand, with the usual foot-ratchet detent; and, besides working the brake and the controller, the motorman has to attend with one foot to the signal gong, and with the other to the sandbox. It is stated that on each car there is a recording meter as well as an ammeter. For the trolley arm the latest pattern of Mr. Blackwell's swivel arm has been adopted, and is found to give excellent results. In this arm the spring that maintains and regulates the pressure against the trolley wire is placed in a small cast-iron box at the top of the standard.

Storage Battery Plant.—It is intended that there shall be two battery sub-stations, one feeding the line near the Roundhay end, the other feeding it at Kirkstall. The "Chloride" type of cell has been adopted for both batteries, which have been made by the Chloride Electrical Storage Syndicate, of Clifton Junction. At the Roundhay battery sub-station there are 256 cells of 15 plates, while at the other sub-station there is an equal number of cells, each of which, however, is provided with only 11 plates. As these batteries are not yet supplying the trolley system with current, we must defer until a later issue any further description of them.

Power Station.—The power station is situated at some distance from the electrical section of the Leeds tramways, but on a site which is perhaps nearer to the centre than to any other part of that section. It is constructed in such a way that it can be readily extended at any time when addition to the present generating plant becomes necessary. As there are at present only two generating sets out of a possible and contemplated eight, and as a temporary partition has been erected close to the existing sets, the machinery room wears a somewhat disproportional appearance, that will vanish doubtless when the full extent of the design has been realised. The machinery room measures at present 88ft. wide and 44ft. long—taking as the length the direction in which it can extend—and it is 47ft. in height. The boiler room is of equal height, and measures 71ft. by 47ft.; it is separated from the machinery room by a brick wall. In the angle formed by the abutment of the boiler house and machinery room an economiser house has been erected. The buildings are conveniently situated for the supply of coal and water, being close to the Aire river.

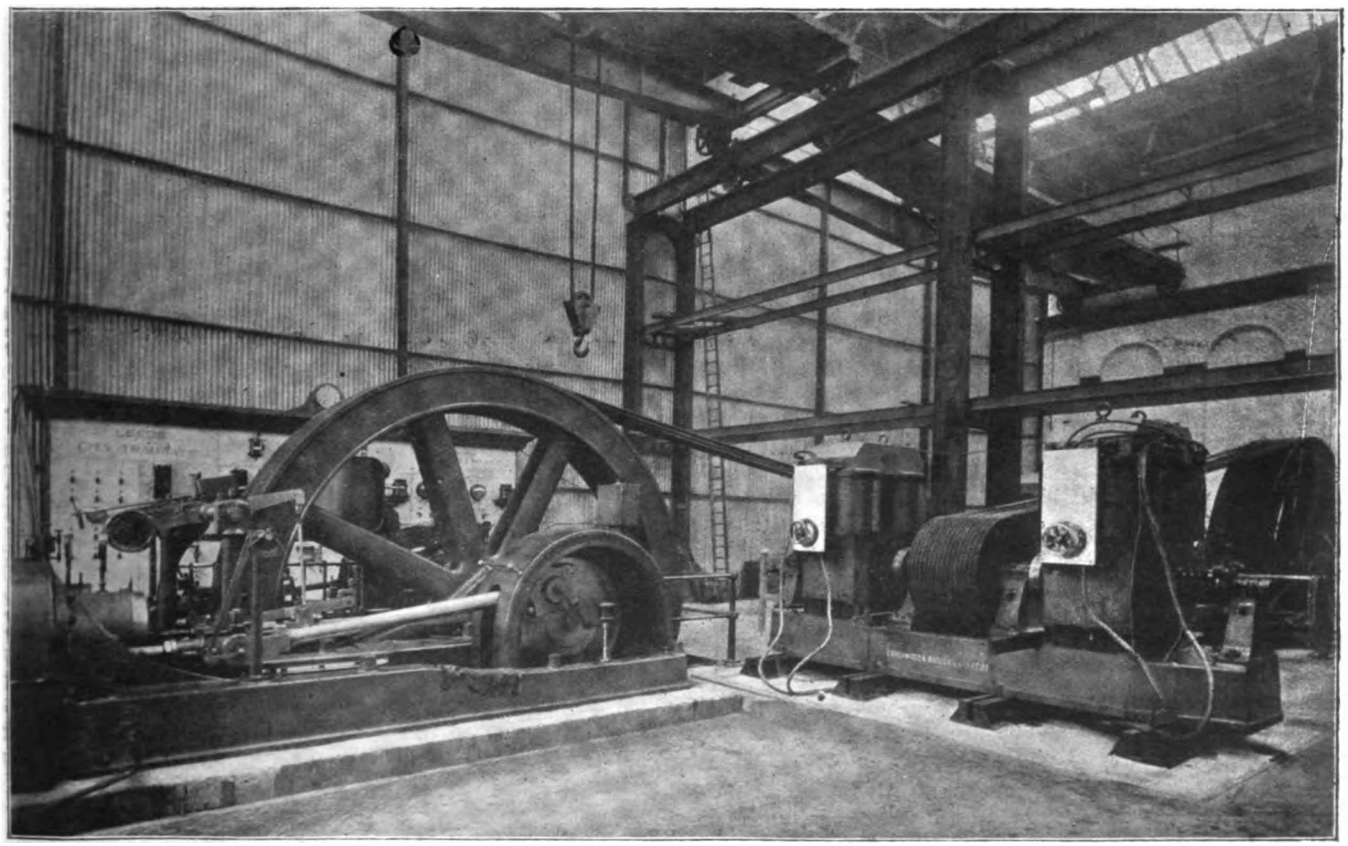

FIG. 8.—General View of the Power Station of Leeds Electric Tramway, showing the arrangement of the Generating Plant. The temporary partition, removable for extension, is shown in the background.

The two generating sets are of similar construction, each consisting of a horizontal compound condensing steam engine, built by Messrs. John Fowler and Co., of Leeds, and a twin dynamo plant, built by Messrs. Greenwood and Batley, who are the contractors for the whole of the plant and equipment. A general view of one of the steam engines is given in Fig. 5, while Fig. 6 illustrates the twin dynamo, which consists of two separate dynamos built on to a single bed and with a pulley

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common to the two machines. We will now consider these items of plant in detail.

Fig. 7 shows scale drawings of the plan and elevations of one of the steam engines. The engine is of the horizontal cross-compound type, a receiver being placed in the space between the high and low-pressure half-engines, and the cranks being at right angles. Each engine runs at a speed of 98 revolutions per minute, the piston speed being 490ft. per minute; and when supplied with steam at 120lb. pressure and working on the condensers, it is capable of developing 400 I.H.P. The cylinders are 18½in. and 32in. in diameter, and are both jacketed. A 15ft. fly-wheel on the crank shaft is grooved for 15 ropes. It is scarcely necessary to state that the governor controls the expansion valve and not the throttle, but it is noteworthy that the governor is not of the crank-shaft type but is driven by spur wheels and chain gear. The engines are said to vary no more than 5 per cent. from the normal speed, between zero and full load. As already indicated, the steam plant is provided with condensers, the pumps of which are actuated by the tail-rods of the low-pressure pistons.

Each dynamo set, as shown in Fig. 6, consists of two generators which, electrically speaking, are separate in their action. Either or both may be connected direct to line or to battery, or one may be used for the one purpose, while the other performs the alternative operation. Each independent dynamo is a two-pole drum-wound over-compounded continuous-current generator, capable of a normal pressure of from 500 to 550 volts, and an output of 200 amperes. A switch mounted on the field-magnets enables the shunt coils to be cut out, or connected in series or in parallel, with or without resistance, in series with them. The normal speed of the dynamo shaft is 450 revolutions per minute.

Doubtless with a view to economise floor space, the two generating sets have been erected in such a manner that the dynamos of each set occupy a position beside the rope drive of the other set, as shown in Fig. 8. When the machinery room is extended, and if similar sets are added, each dynamo set will occupy a place between the rope drives of the two adjacent sets, the engines being placed alternately on the right and left sides of the room.

In the boiler house there are now two Lancashire boilers and space for four additional boilers of the same type. These steam generators were supplied by Messrs. Clayton, Son and Co., of Leeds, and are each 30ft. in length and 8ft. internal diameter. They are constructed to work under a pressure of 120lb. Bennis mechanical stokers have been fitted to the furnaces, and the economy of steam generation is still further enhanced by the addition of a Green's economiser in the flues. This economiser is built of 192 tubes, and the scrapers are worked by a small donkey engine, which also operates the mechanical stoker gear.

Conclusion.—The following list of contractors, sub-contractors and makers of the various details of the plant and equipment for this tramway may be of interest:—

The entire contract	Messrs. Greenwood and Batley, Leeds.
Steam engines	Messrs. John Fowler and Co., Leeds.
Boilers	Messrs. Clayton, Son and Co., Leeds.
Economiser	Messrs. E. Green and Son, Manchester.
Mechanical stokers	Messrs. E. Bennis and Co., Bolton.
Overhead travellers	Leeds Engineering and Hydraulic Co., Leeds.
Dynamos	Messrs. Greenwood and Batley, Leeds.
Switchboard	Messrs. John Fowler and Co., Leeds.
Storage batteries	The Chloride Electrical Storage Syndicate, Clifton Junction.
Trolley poles and brackets...	Messrs. J. Russell and Sons, Leeds.
Trolley wire and details of overhead equipment.....	Messrs. Laing, Wharton and Down, London.
Feeder cables	Messrs. W. T. Glover and Co., Salford.
Feeder conduits	Messrs. Doulton and Co., London.
Car trucks.....	Mr. R. W. Blackwell, London.
Car bodies.....	Messrs. Milnes and Co, Birkenhead.
Motors, controllers, &c.	General Electric Company, U.S.A.

In conclusion we take great pleasure in discharging our duty to thank Mr. Burbridge, the Corporation electrical engineer, and Mr. William Wharam, the energetic manager of the Leeds tramways, as well as many of the numerous contractors and sub-contractors, for their kind assistance in the preparation of this article, and especially for the photographs and drawings with which it is illustrated.

THE FERROMAGNETIC PROPERTIES OF IRON AND STEEL.*

BY PROF. J. A. FLEMING, D.SC., F.R.S.

(*Concluded from page 50.*)

Chemists have long ago recognised that there is a very peculiar quality in certain atoms of high valency, and particularly in the carbon atom, of combining with itself to form a complex chain or ring of atoms. The whole of the great science of organic chemistry rests on the fact that such a ring or chain of carbon atoms can group round itself atoms of oxygen, hydrogen, and various other elements or radicles. In fact, organic chemistry has been called the chemistry of the carbon compounds. This peculiarity seems to appertain to certain other polyvalent atoms; and as iron is a tetrad element like carbon, it is possible the same property characterises the iron molecule. I shall ask you to accept, merely as a provisional conjecture, that in a mass of solid iron there is such a bonding together of some at least

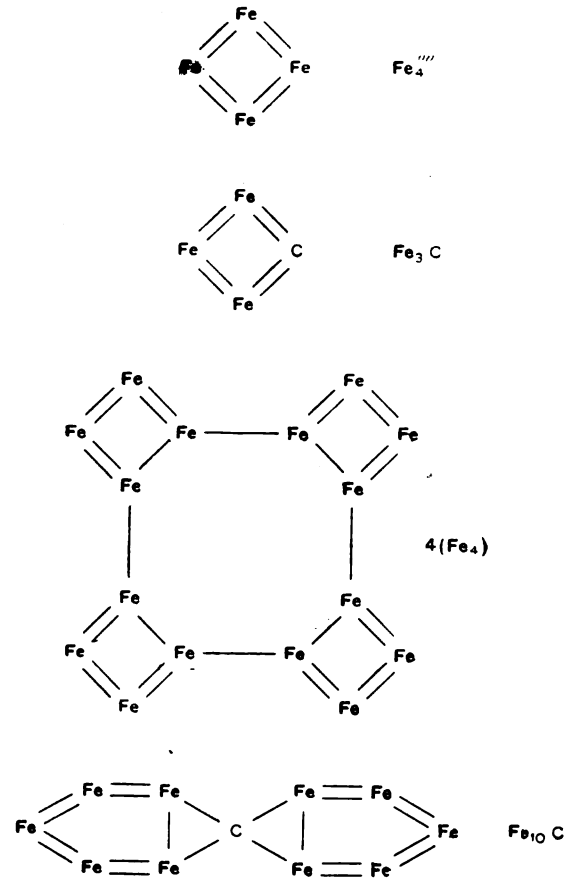

FIG. 8.

of the iron molecules, which we will, as before, consider to be four-atom molecules of tetrad iron, somewhat in the fashion suggested by the appended graphic formulæ (*see* Fig. 8). This molecular bonding of iron molecules may be greatly assisted by the presence of a polyvalent element, like carbon, also disposed to auto-combination. These formulæ show also the manner in which certain recognised carbides of iron may be formed. At the same time, there will be in the interstices of the *molecular network* so formed other molecules in a more detached or less closely united condition. Let me, for the sake of brevity, speak of these more closely-bonded molecules as forming a *web*, and the remaining molecules, in a more or less unbonded condition, as constituting the *matrix*. I conceive, therefore, a mass of solid iron as consisting of this *web* of bonded molecules, and of the interstices between the meshes as filled in with less firmly attached *matrix* molecules, the whole structure

* A lecture delivered October 18, 1897, to the Sheffield Society Engineers and Metallurgists. *Copyright.*

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having something of a *sponge-like* structure, only infinitely more fine grained. The formation of a *web* is assisted by the presence of certain grouping elements, such as carbon, in small proportions. Heating to a high temperature, whatever other chemical changes it may produce, breaks up this web, and cooling slowly brings the iron into an annealed condition, in which the web is not fully reformed and in which the metal mass is more uniform in texture but in a somewhat unstable internal state. Hammering or pressing assists in the reformation of the web. The structure which I am here suggesting is an *ultra-microscopic* one, and is quite apart from any far coarser crystaline conglomerate due to mixtures of metallic iron and carbides. Since, then, magnetisation consists in colineating the magnetic molecules, it is clear that the more easily the molecules can turn round, the less will be the magnetising force required to produce a definite percentage of colineation. But this is expressed by saying that the ratio of **B** to **H** is large, or the permeability is great. This is the case in pure slowly-annealed iron. Hence large magnetic permeability implies considerable ease in facing round in the molecules. Please imagine a crowd of men, a number of whom take hold of hands so as to form a sort of network, and the remainder are packed in the meshes of the network. Suppose some sound were made or other noise created which disposed every man to turn round and face in the same direction, the *free* men would be able to face round, but the *bonded* men could not easily do so. If, however, the men-network is broken up and all the inter-connections freed, the amount or percentage of facing round for a given small inducement would be greater. In other words, the *permeability* of the crowd would be increased. I suggest, therefore, that the increase in permeability under small magnetic forces which takes place by rise of temperature in iron is to be interpreted as meaning that the increase of temperature, although it decreases the magnetic moment of each of the molecular magnets *per se*, yet by breaking the intermolecular connections so much more greatly gives them increased freedom to colineate under a given force; that greater total magnetic moment, that is, greater permeability, results. In other words, the average molecular freedom to colineate is increased at first faster than the average magnetic moment diminishes when the colineating force is small.

It will then be said: Why is it that this marked increase in permeability only shows itself for feeble magnetic forces and not for larger ones? The answer, I take it, is this: Under large forces the web molecules are colineated at lower temperatures as well as the matrix molecules, and hence heating the metal does not so much affect the general facility of colineation, but shows itself chiefly in the diminution of magnetic moment of each molecule.

To carry out our analogy with the crowd of men. If the inducement to face round in the same direction is only a small one, a little more elbow-room for each *free* man will promote considerable facility in so facing round in the same direction. If, however, the inducement to turn round is a strong one, not only the free men but also the men holding each other's hands will wrench themselves round just as completely, whether they are packed very closely or not. There is a very curious magnetic fact which is quite consistent with the above suggestion.

Dr. D. K. Morris has shown* that there is, for small forces, a curious temporary decrease of permeability at about 550°C., and he has drawn attention to Prof. Tomlinson's remark, that it is at that temperature that the internal friction of iron begins to rise rapidly and the so-called "Coefficient of the Thomson effect" changes sign.

A very simple experiment shows how great is the facility for colineation in the magnetic molecules of annealed wrought-iron. If a bar of such iron, say 18in. long, is held in a vertical position, its lower end in northern latitudes becomes a *north-seeking* pole, and attracts the *south-seeking* pole of a pocket compass. In the next place lower the bar carefully into a horizontal position, and test the end that was uppermost with the compass needle. It will be found to be a *south-seeking* pole. Lastly, very slowly raise the bar again into a vertical position, keeping the same end near the compass needle. At a certain stage, the lower end of the bar will reverse its polarity and the compass needle will fly round. In any event a slight tap with the finger will be enough shock to create the magnetic change.

The above facts are consistent with the view that large permeability denotes ease of colineation of the molecules, or a condition of not very great molecular constraint. We see then on this theory a reason why the presence of combined carbon in large amounts by probably facilitating the formation of a *web* lowers permeability. The co-linked molecules have less freedom to colineate. Hence, high carbon steels, when in the hard condition, have low magnetic permeability. The low carbon steels, on the other hand, when in the annealed condition, are more like annealed soft iron. Hammering or pressing annealed iron by promoting molecular union and the formation of a web lowers permeability. Also, since annealing slowly after heating to a very high temperature promotes increased permeability when the iron is cold, we must consider the high temperature has broken up the web and it is not reformed on slow cooling.

Hysteresis is diminished by rise of temperature because the falling-off of molecular-magnetic moment reduces the total or integral work expended in making a new colineation of the magnetic molecules, and reduces also the forces tending to make them vibrate when falling into new positions. It is curious to note that there is in some of the curves showing decay of hysteresis, with rise of temperature, a partial recovery of hysteretic value at about 600°C., indicating some increase in work to produce molecular colineation.

On this view the hysteretic *ageing* of iron by slow heating is due to the gradual re-formation of the web, which has been broken up on annealing. It would be an interesting confirmation of this opinion if we could show that magnetically *aged* iron has less ductility than virgin iron. Hence it is that in freshly-annealed iron which has not been re-heated there is the greatest possibility for magnetic hysteretic change in the direction of deterioration or increase. Hysteresis in iron, at least in the purer forms of iron and mild steels, seems far more closely connected with the physical state of this metal than the mere chemical composition, and steels almost alike in composition may yet have immensely different hysteretic constants. If, however, the iron is not annealed, or is in the hard condition, the web being already more or less formed, there is less room for change in the direction producing increased hysteresis, and this is in agreement with facts. If this speculation has any real accordance with actualities it goes to show that to produce an iron with small hysteretic constant and small ageing qualities we must have an iron in which the non-annealed condition does not greatly differ from the annealed in physical properties. I cannot but believe that the *ductility* of the metal, other things being equal, is closely connected with small hysteretic value.

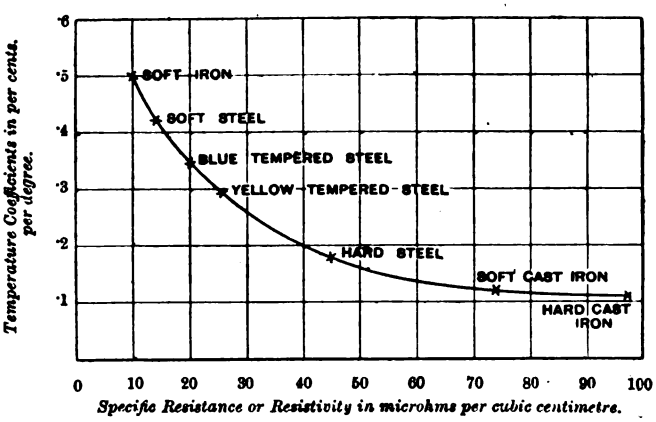

FIG. 9.—Relation between Resistivity and Temperature Coefficients.

Then, finally, with regard to electric resistivity in iron and steel. It is a very curious fact, as shown by the appended diagram (*see* Fig. 9), that the resistivity of an iron or steel increases with the amount of carbon in it, but at the same time the *temperature coefficient* or percentage

* *Phil. Mag.*, Sept., 1897, p. 213, Vol. XLIV., V. Series.

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change in resistivity per degree diminishes.* There are many facts which go to show that high resistivity in a metallic conductor means that it has considerable power of taking up or absorbing the energy of a magnetic field round it, just as chemically complex gases or liquids are good absorbers of radiant heat. It appears to be a general rule that if the resistivity is relatively high or the electrical conductivity small, then rise of temperature does not much increase the resistivity of the metal. If, however, the resistivity is small, then rise of temperature very considerably increases it. If you look at the permeability curves of iron rather below the critical point, or between 600°C. and 800°C., you will find the same thing true of the magnetic permeability. When the magnetic permeability (which is the magnetic analogy of electric conductivity) is large, then temperature change between the above limits has a much greater effect on it in altering its value than when the permeability has a small value.

With regard to the cause of the differences in electric resistivity and temperature co-efficients between different metals, I think we must regard the matter in the following light. If an electric current is, as we say, flowing through a conductor, all that we really know about the phenomenon is that there is a magnetic field in and around the conductor. This field represents a store of energy. The molecules of a conductor have the power of absorbing this energy of the circumjacent magnetic field and converting it into thermal energy or heat. This process goes on at first at the surface of the conductor, and what we ordinarily call a *good conductor*, or conductor of *low resistance*, is one which for a given surrounding magnetic field dissipates the field energy relatively slowly. On the other hand, a bad conductor is a good dissipator. This dissipation of energy may be considered to depend upon the power of the outer layers of molecules to hand on to those underneath the particular motions of the field, the energy of which is dissipated. If these molecules do not communicate to each other easily or quickly the motion (using the term in its most generalised sense) then the body is a good conductor or poor dissipator. This I conceive will be the case if the molecules are not strongly bonded or interconnected. It is in a remarkable degree the case at very low temperatures for pure metals when the molecular motion is very much reduced. Hence we find that good electric conductors are metals which are ductile, plastic, or malleable, like silver, copper, gold and aluminum. In these instances, however, rise of temperature by promoting better opportunities for a communication of energy between molecules will considerably increase resistivity or diminish conductivity, that is to say, will make the body a better dissipator of the magnetic field energy. On the other hand, if the molecules of the metal are much bonded or inter-connected, forming what I have called a *web*, then communication of energy from the surface molecules to those beneath is more facilitated. Hence these metals are relatively worse conductors or better dissipators. But in them rise of temperature has not such a marked effect in facilitating dissipation of the magnetic field energy, because the connection between the surface and the inner molecules is already very intimate. Hence these bodies have a relatively small temperature coefficient. In the case of liquid metals, such as mercury, the freedom of motion of the molecules affords them abundant opportunities for handing on the energy they have taken up from the field to other molecules, and then afresh taking up more energy from the field. Hence these liquid metals must be good dissipators of magnetic field energy, or, in ordinary language, bad electric conductors. The addition of bonding elements like *carbon* to iron will always then increase its resistivity, decrease its temperature coefficient, decrease its magnetic permeability, increase its hysteretic constant, and also increase within limits, if it is combined carbon, its rigidity and tensile strength. I think there is some indirect evidence, therefore, that in a solid metal like iron we have to deal with *two classes of molecules*, some more free and independent and some less free and independent, and this theory fits in with many facts; and it offers a suggestion as to the reason *bonding elements*, like polyvalent atoms of carbon, sulphur, manganese, phosphorus and silicon, have even in small proportions such a marked effect upon the magnetic, electric, and mechanical qualities of iron.

I do not propose at present to draw out these conjectures to any greater length. My object has merely been to outline an hypothesis of ferromagnetism in approximate accordance with main facts, and which may at least serve to stimulate further investigation. It is hardly probable that the actual structure of a molecule of iron is anything so simple as I have suggested. The spectrum of iron vapour with its multitudinous lines seems rather to suggest a very complex molecular architecture. If, however, it can be shown that nothing more is necessary to explain the facts of the wonderful magnetic properties of iron than the rotation of a molecule built up of *electrons*, or atoms carrying electric charges, some step in advance will have been made. We must, however, add to this some hypothesis as to the physical structure of those bodies we call *solid* bodies, and which evidently have, even in the case of most rigid solids like steel, properties linking them by continuity with those we call *liquids*. I have sought for this in the speculations presented to you here, and given, as I said at the beginning of this discourse, not in any dogmatic spirit, but handled merely as a working hypothesis, to be moulded, if possible, to fit in with all the observed phenomena, but abandoned at once if they can be shown to be in contradiction with known or future-found facts of Nature.

A CARBON DETECTOR OR RECEIVER FOR HERTZ WAVES.

BY FREDERICK J. JERVIS-SMITH, M.A., M.I.E.E., F.R.S.

Detectors of the Hertz electromagnetic oscillation (such as those of M. E. Branly, *Comptes Rendus*, 785, 1890) consist of small tubes partly filled with metallic filings, furnished with pole-pieces in contact with the filings. M. E. Branly, in his excellent Paper, makes no mention of having tried carbon as a Hertz wave receiver. I find that receivers having carbon contacts have been spoken of as useless. Prof. Oliver Lodge in his book—"The Work of Hertz"—mentions in a footnote (p. 30) that Prof. Fitzgerald has succeeded with carbon, but no references are given to experiments on the point.

Thinking it possible that the smallness of the particles of carbon might affect the result, and that powdered carbon might not act in the same way as an ordinary carbon microphone which had been tried, I reduced some electric lamp carbon to the finest powder, and placed it in a thin glass tube furnished with terminals; the detector I thus made was placed in a circuit, including a dead-beat galvanometer (resistance 50 ohms), one dry cell E.M.F., 1·4 volt, and about 8,000 ohms added resistance.

When the circuit was closed, the carbon receiver having been previously tapped or gently shaken with a vibrating fork, the galvanometer indicated that a small current was flowing in the circuit. The carbon detector was exceedingly sensitive to the slighest electrical disturbance. To get the best result the resistance of the carbon receiver should be such that a small current can flow through it. This condition is easily obtained by furnishing the carbon receiver with pointed terminals, which can be screwed to any required depth into the powdered carbon. On trying to set up the same conditions with a detector containing metallic filings (nickel, iron, copper, silver), difficulty was experienced in so adjusting the terminals

*For a note on the Resistivity of Electrolytic Iron, by M. Houllevigue, see *Journal de Physique*, May 1897. He gives the temperature coefficient in per cent. per degree as follows:—

Soft Iron	= 0·45
Soft Steel	= 0·40
Hard Steel	= 0·20
Cast Iron	= 0·105
Electrolytic Iron	= 0·096

Electrolytic iron appears also to have a much higher resistivity than annealed pure wrought iron, and it is much harder. It probably contains some hydrogen, but its high resistivity and low temperature coefficient are more probably due to its physical state. According to Prof. Tomlinson, the order of the resistivity of most common metals is the same as the order of their "viscosity." Hence metals with high internal friction are relatively bad conductors of electricity. This agrees with the views suggested above.

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that a small current should flow, but with carbon the difficulty entirely vanishes.

The carbon receiver proved itself to be a most interesting instrument. During a thunderstorm which took place within a few miles of Oxford on the 27th July, the galvanometer indicated that each flash slightly reduced the resistance of the carbon receiver, and the spot of light was shifted by successive jerks in the same direction till quite off the scale; the night being still, the gradually approaching storm could be well observed.

After the movement of the spot of light the time was taken with a stop chronograph watch, and after 50 seconds the thunder could just be heard, the lapse of time indicating a distance of over 10 miles. During 40 minutes, the time between the indication of the carbon detector and hearing the thunder changed to 10 seconds, which was the minimum time.

Some detectors similar in dimensions, but made so that they could be exhausted, were tried at the same time, the different detectors being thrown into the circuit by means of a switchboard; the vacuum does not appear to improve the action. The tubes were carefully made by the late Mr. E. Cetti, and exhausted in November, 1896. From these, and many other experiments, I believe that carbon, instead of being a useless substance as a detector of Hertz waves, will be found (when in fine powder) to be both reliable and certain in its action.

During the storm I have spoken of the apparatus was placed on a table in a room the door and windows of which were closed. The instrument was not in connection either with the earth (except in as far as it rested on a deal table) or with any conductor extending into the air outside the house.

I have fixed a mast to the roof of the house, so that a conductor may be easily hauled up it; when the detector is connected to this and also to the earth, atmospheric electricity interferes considerably with telegraphy with a Branly or my powder carbon detector.

AN ALL-BRITISH CABLE TO AUSTRALIA VIA THE CAPE OF GOOD HOPE.*

As several incorrect and misleading statements on this subject have been recently made public a few facts relating to the proposition laid before Her Majesty's Government may be of interest. The first part of the project is to lay cables from Porthcurnow, in Cornwall, to Gibraltar (1,198 knots), Gibraltar to Sierra Leone (2,379) or Bathurst, thence to Ascension (1,168), on to St. Helena (810), and from there to Cape Town (1,910). This will afford a triplicate route to South Africa largely clear of existing cables, and not likely to be affected by causes producing interruption of the present lines, such as earthquakes or, in the case of cables on the coast, river floods. All experience shows that duplicate cables, even when separated by such a continent as Africa, do not afford sufficient security against interruption of communication, and the new route referred to will, if laid, be welcomed by all connected with South Africa as diminishing the risk of communication being cut off.

The second part of the scheme is to lay a cable from Natal to Mauritius (1,818 knots). This, in conjunction with the present Zanzibar-Seychelles-Mauritius line, will also have the effect of providing an alternative to the following sections, should they at any time be interrupted:—Zanzibar-Mozambique (already duplicated), Mozambique-Delagoa Bay, and Delagoa Bay-Durban. From Mauritius the route may be to Rodriguez Island (406 knots), thence to Cocos or Keeling Island (2,218), and on to Perth, Western Australia. It is proposed that these cables should be laid by the Eastern, the Eastern and South African, and the Eastern Extension, Australasia and China Telegraph Companies.

When completed this new route from England to Australia will form a very considerable addition of about 13,684 nautical miles to the existing submarine cables, which have been manufactured and laid by British industry and enterprise, and are worked by British clerks, as already stated, the new cables will land only in British possessions, and will form a triplicate route to Australia, removed from the volcanic dangers of the Java Seas; while experience on both sides of Africa shows that interruptions from seismic disturbance there are not frequent.

This scheme is put forward in the judgment of the companies concerned as being preferable in every way to the Pacific route to Australia, where a single break in the chain would interrupt communication; while in the proposed scheme, except in the case of the cables from Mauritius to Perth, if any of the sections were broken there would be two alternative lines as far as Zanzibar, and one between that place and Mauritius. Some of the depths in the Pacific are very great, while in the projected line the recorded soundings indicate no depth greater than cables are already lying in. Again, in the Cape route the distances are all practicable without making the cables too expensive, because in a section much above 2,000 miles in length the amount of copper and gutta-percha insulation used would have to be largely increased to secure a good working speed.

In place of the route given above it has been erroneously stated that the projected lines were to go from Mauritius to Ceylon, Singapore and Batavia to Australia; and in one Press reference to the matter it has been stated that such a cable would be liable to prohibitive dangers from seismic interruptions, but it may be pointed out that the existing lines from Madras to Australia have not by any means ruined the proprietor company by the cost of repairs, and that communication between this country and Australia has not been once interrupted since 1890. This pessimistic view of the matter is supported in the case referred to by attributing all the interruptions which have occurred during periods of from nine to seventeen years on the Madras-Penang, Singapore-Batavia, and Java-Port Darwin cables to a single year, and further giving a seismic or volcanic cause to all the breaks or faults which have occurred on those sections; whereas most of the trouble of the early days was due to the teredo boring-worm and abrasion over rocky ground. Fortunately an effectual remedy appears to have been found in respect to the former danger by the adoption of a brass taping laid spirally round the gutta-percha insulator, and, in regard to the latter, the cable was re-laid on a better bottom. When it is remembered that interruptions may be due to many other causes—from a fish-hook to a whale—it will be seen how greatly the earthquake danger has been exaggerated. Finally, it may be said that the land-line communication between Perth and the south and east of Australia is ample and reliable.

* From *The Times* of November 9th.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 12th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Isothermals of Ether," by J. Rose-Innes; (2) "On the Variation with Temperature of the Electromotive Force of the H-form of Clark Cells," by F. S. Spiers and F. Twyman.

TUESDAY, November 16th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be discussed: "The Manchester Ship Canal," by Sir E. Leader Williams.

WEDNESDAY, November 17th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square, W.

INSTITUTION OF ELECTRICAL ENGINEERS.

7.30 p.m. Students' Annual Meeting at 28, Victoria-street, for the election of Committee and Secretary.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Opening Meeting of the Session.

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Wednesday noon.

What a Watt is.—When members of a Gas Committee endeavour to explain to one another the meaning of electrical terminology the result is often ludicrous enough. At Middleton, the other day, a worthy councillor on the Gas Committee sought from his fellows information as to the nature of that vaguely-named thing—a unit. To him made answer an alderman, who essayed to put the matter in a nutshell: "A unit is a 1,000 watts for one hour," which was all right as far as it went. But when there came the inevitable inquiry from the heckler, "What is a watt?" the alderman went out of his depth. "A watt," said he, "is equal in light to about 4 c.p. The lights in incandescent globes range from 8 to 32 c.p. They are supposed to consume about four watts to one candle, and 500 watts lighted for two hours would be considered as a unit, and for that 6d. is generally charged"!

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THE COHERER.

Four articles in our issue this week deal with matters intimately connected with the theory and applications of the coherer—that aptly-named modern product of a line of physical research reaching back into a now somewhat remote past. Of this past, and of its influence in the gradual evolution of the coherer, Dr. Oliver Lodge writes interestingly in his article on "The History of the Coherer Principle." We see the phenomenon of cohesion, in a little-understood electrical action, recognised first—and before the actual coherer instrument had taken definite shape—in the observations of dust phenomena by Guitard, in 1850, and later, of water jets by Lord Rayleigh. The actual coherer, as a specialised instrument, made its first appearance in 1866; curiously enough, not as an instrument of laboratory research, but as a lightning bridge for telegraph circuits, the inventor being Mr. S. A. Varley. Indeed, as far back as 1852, the high resistance of un-cohered metallic powder had been observed by Mr. Varley; and four years later he detected its sudden and remarkable fall in resistance during a thunderstorm. As a laboratory instrument, the coherer does not seem to have made its appearance until much later, when it was re-discovered by the professors. There is something to be said, however, for a re-discovery which lifted the invention out of the region of the incomprehensible, or nearly so, into the light of the newly-discovered Hertzian waves. For many years the coherer enjoyed the position of an instrument of physical research of unrivalled sensitiveness, viz., in that particular field of research on the theory of which Mr. Oliver Heaviside contributes an article this week. But those who used th

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instrument most were so preoccupied with its laboratory possibilities that they were unwittingly blind to its practical applicability, with the result that the world remained ignorant of its commercial importance. The world is not to be blamed; it cannot be expected rightly to appreciate unaided what is going on in the secret recesses of the physical laboratory; nor is it matter for wonder that it should attribute to the first man who successfully "booms" the invention the honour of being its first inventor. Meanwhile, others than either professors or mere adventurers have been quietly working out the commercial applications of the coherer, and not without considerable success in many directions. Among these the name should be mentioned of Mr. A. C. Brown, who, in an article on "The Applications of the Coherer," sketches for our readers this week the developments which have been, or which promise soon to be made.

Notable as has been the use of the coherer as an instrument of pure research, its utility in commerce and applied science promises to be transcendently important. Already it has become the central figure in more than one valuable patent, and it is subject for special congratulation at the present time that these patents promise to lay the foundation of one more industry in which Great Britain will play the leading part. Patents relating to applications of the coherer have been acquired by more than one well-known scientist, but, so far as we have been able to examine specifications and to compare dates, we judge that those of Mr. Brown are the broadest and most far-reaching in their scope. As will be gathered from his article, Mr. Brown has applied the coherer successfully to considerably more than wireless telegraphy. Indeed, he regards this latter as by no means the most important application. As an instrument for signalling or telephoning through a totally-disconnected submerged cable, or through bare earthed conductors, the coherer is of great practical value, and the experiments already carried out in these directions are of striking interest.

In regard to the commercial development of the coherer, it is greatly to be hoped that a promising industry, if not an extensive group of industries, will not be retarded by a repetition of those time-wasting patent litigations which have hindered the progress of other industries in the past. With a view to avoid this calamity, and to bring about that full development which inventors and public alike desire, it would seem expedient for all who are interested in patents relating to the coherer to come to some amicable arrangement by which the invention and its numerous applications could be worked in an united interest.

THE HISTORY OF THE COHERER PRINCIPLE.

BY DR. OLIVER LODGE, F.R.S.

Probably the earliest discovery of cohesion under electric influence was contained in that of old forgotten observation of Guitard in 1850, that when dusty air was electrified from a point the dust particles tended to cohere into strings or flakes. The same thing no doubt occurs in the formation of snowflakes under the influence of atmospheric electrification; and the cohesion of small drops into large ones in the proximity of a charged cloud is exceedingly familiar, since it results in the ordinary thunder-shower. Great light was thrown on these meteorological phenomena by the discovery of Lord Rayleigh in 1879 of the curious behaviour of a small fountain or vertical water-jet when exposed to the neighbourhood of a stick of excited sealing-wax. A smooth orifice being arranged to throw a jet of water about three or four feet nearly vertically, the jet breaks into drops, and the drops scatter in all directions, rebounding from one another and giving a shower of fine spray; but if a stick of sealing-wax be rubbed on the sleeve of a coat and brought within one or two yards of the place where the jet breaks into drops, it will be found that the scattering ceases, the fine spray is no longer formed, and the broken jet rises and descends in great blobs of water. The rain-shower has, in fact, been converted into a thunder-shower. Further experiments, conducted chiefly with two jets, elucidated the phenomenon.* Arranging two nearly parallel jets from neighbouring orifices so as to impinge against each other, they were found ordinarily to rebound after colliding, a sort of film or superficial layer appearing to prevent amalgamation of the jets into one; but if a slight difference of electric potential were maintained between the two jets, say by connecting them to the terminals of a Leclanché cell, then the boundary layer broke down,—the two colliding jets no longer separated with a rebound, but amalgamated and became one.

Lord Rayleigh developed a similar explanation for the single jet. The scattering of the jet in its ordinary state was due to the rebound of colliding drops, as could be *seen* by examining it with a sufficiently instantaneous or intermittent mode of illumination; but if an electric charge were in the neighbourhood it must be supposed that a trace of potential difference existed between the drops, which caused them to amalgamate into one whenever they collided, and thus speedily to become united into a comparatively few large drops, which then continued on their parabolic way.

At first sight it would seem as if the neighbourhood of a negative charge should charge all the drops positively at the place whence they break off from the earth-connected parent jet, and should thus cause them all to repel each other. And if the electrified sealing-wax is held too close, this is exactly what happens. All the drops are then similarly electrified, and scatter more violently than ever, never in that case coming into any rebounding or other contact with each other. But under a gentler electric influence the similar charging has a less marked result, and a polarisation difference of potential of one or two volts may without difficulty be supposed to exist in the air between drops, partly because they are not all equally charged and partly because each is a conductor acted on inductively by a neighbouring electrified body. In this connection it must be remembered that rubbed sealing wax is at a potential of several thousand volts, and therefore can readily cause a potential gradient of two or three volts per millimetre throughout a yard or two of space.

The next stage was the rediscovery, in 1888, of Guitard's old dust phenomenon by the present writer and the late J. W. Clark (*Nature*, July, 1888; *Phil. Mag.*, March, 1884), when they were working together at the dust-free region seen over hot bodies when strongly illuminated in dusty air. The fact of such dust-free spaces was discovered by Tyndall, and they can readily be seen by placing a lighted spirit lamp or a hot poker in the beam of an electric lamp. Tyndall thought the dust was calcined or burnt up, and that thus the air was freed from it; but this is an utterly erroneous explanation, and the true explanation is of a more recondite character, being connected with the bombarding effect of gas molecules as illustrated in Crookes's radiometer. The dust particles are beaten away from the hot body by a molecular bombardment, which manifests itself even at ordinary pressures on bodies of sufficiently small size, as indeed was also otherwise shown by Tait and Dewar and Osborne Reynolds in the course of remarkable theoretical and practical investigations.†

Before arriving at this explanation, however, we experimented to see if the phenomenon was caused by the air having become slightly electrified, perhaps by reason of its having streamed as an upward convection current over the surface of the warm solid, at which we were looking, in a thick smoky atmosphere, in the concentrated light of an electric arc. We therefore purposely electrified the rod, to see what that would do, and we found to our surprise, directly the electric machine was turned, that the smoky atmosphere almost instantaneously disappeared, and the box became quite clear.

* *Proc.* Roy. Soc., 1879 and 1882.
† "Dimensional Properties of Matter," *Phil. Trans.*, 1879.

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This experiment, after development, though described in July, 1883, was shown in public for the first time at the Dublin Royal Society (*Nature*, April 24, 1884), and subsequently at the British Association meeting in Montreal* in 1884, and was applied to the experimental clearing of rooms from dense smoke or fume. It has often been shown since, by Mr. Swan and others, and has become fairly well known.†

The next observation of cohesion under electrical influence was made by the writer in 1889, while working at the protection of telegraphic instruments and cables from lightning,—a research which resulted in the use of choke coils as supplementary to the air-gaps of the ordinary lightning guard, and thus to the forms of instrument constructed by Dr. Alex. Muirhead for telegraphic work in this country, and to the supplementary additions adopted by the Westinghouse Company for their non-arcing guards adapted to electric light and power installations in America. The observation of cohesion was a bye-issue, noticed when the knobs of the lightning guard were brought too close together.‡

When lightning itself strikes a guard, it has indeed often been found that the opposite sides of the protective air-gap are fused together. This, no doubt, may be partly due to a straightforward melting or welding by heat, but it is probably not solely that. Molten metals without a flux do not so readily weld. It is almost certainly due to a cohesive action also, the difference of potential between the molten terminals resulting in adhesion and amalgamation, a phenomenon also observed in the frequent locking of an electric arc formed between two metallic electrodes. However this may be certainly the phenomenon occurs on a small scale, for if the pair of knobs or points placed as a shunt to protect a galvanometer or other telegraphic instrument from lightning (or what is easier experimentally and essentially the same thing, from a Leyden jar discharge) be set too close together, the galvanometer will be found to be short-circuited after a spark, and the knobs will be found, both by mechanical and electrical tests, to be feebly united at a single point.§ Not only, however, is the galvanometer short-circuited by the metallic junction so formed, but at the instant of the formation of the joint it experiences a very perceptible kick, indicating a momentary current, coincident no doubt with the electric discharge, but one from which it would have been protected had not the junction occurred. The galvanometer kick is clearly an effect due to the uniting metals, but it has not yet been fully elucidated; it may possibly be thermo-electric, as Prof. Hughes, who first observed it, thinks likely; but it may also be electro-chemical, or it may be connected with an effect observed later by FitzGerald in his galvanometer mode of detecting Hertz waves, which he published at the Royal Institution in 1890. The point of present interest is the cohesion which sets in between the knobs when the spark occurs: an extremely feeble spark was found sufficient to produce the effect, provided the surfaces were already almost infinitely close together, *i.e.*, provided they were already in what would be called contact, with the merest imperceptible film of (probably) oxide separating them, just the kind of film which a chemical flux is useful in removing. The electrical stimulus appears to act as such a flux, and the adhesion of the two surfaces was demonstrated by an electric bell and single cell in circuit. Every time the spark occurred the bell rang, and continued ringing until the table, or some part of the support of the knobs, was tapped so as to shake or jar them asunder again.¶

If the electric bell stands on the same table as the support of the sparking knobs, or, still better, if it be put into mechanical contact with them, its tremor is quite sufficient to break the contact asunder again, unless the spark, and therefore the adhesion, has been too strong. Raising the bell into the air, it ceases to interrupt the spark-induced continuity, and in that case continues to ring; but directly it is replaced so that its vibration can reach the covered surfaces through their solid supports, and not only through the air, it usually happens that a few strokes—often, indeed, the first stroke—of the bell, sometimes even the incipient movement of the hammer preparatory to a stroke, is sufficient to break the circuit and suspend instantly the action, restoring the gap to its original condition and leaving the circuit ready to be completed again by another spark.

The spark in these experiments was usually supplied from the outer coats of a pair of oppositely-charged small Leyden jars, whose knobs sparked into each other; the idea being to ascertain all the conditions pertaining to the feeble residue of a lighting discharge which is liable to be conducted by telegraph wires to a distance, and there cause some damage to sensitive instruments not suitably protected from sudden electric jerks, whose laws of flow are quite different from those proper to steady currents.

Meanwhile, in 1887 and 1888, had been performed the great experiments of Hertz on electric waves in free space. The writer, assisted by Prof. Chattock, had also made some experiments concerning the production and detection of waves on a system of long parallel wires stretched on insulators across and around a large room, and excited by the discharge of a pair of condensers, an arrangement very similar to that now known under the name of Lecher; and clear experimental evidence of the existence of nodes and loops on such wires, as well as a method of approximately measuring the wave-length was given.* The brush luminosity of the wires, afterwards observed more strikingly by Tesla, were also seen and shown to the Physical Society. The interest of these experiments was, however, altogether eclipsed by the brilliant and masterly investigation at Carlsruhe by Hertz, who, as everyone except the British public is aware, put into practice FitzGerald's 1883 suggestion that Leyden jar discharges should emit Maxwellian radiation, and conclusively demonstrated the existence and some of the properties of such waves by this very means; using, however, Leydens of small capacity, and with the coatings well separated, so that the electrostatic energy of the charge should have an intensity comparable with the magnetic energy of the discharge, even at some distance from the circuit.

The whole subject of electric waves was thus laid open to physicists, and many have been the workers in the field. Trouton, of Dublin, worked long and successfully at their optical analogies, with the very inadequate means of detection then known;† and since better means have been known perhaps the most complete set of experiments published, after Hertz himself, is that contained in the book "Optice Elettrica," by Prof. Righi, of Bologna, but some account of several previous researches is contained in the second edition of "Modern Views of Electricity," in the chapter called "Recent Progress," of date 1892. The means used by Hertz and his immediate followers to detect the waves was simply the little spark which they excited in conductors upon which they fell, electric currents being set up in such conductors by the act of reflection. The effect was often at that time attributed to electric resonance or syntony, but there was very little true resonance in these experiments; the first swing was usually much more powerful than any of the succeeding ones, and was competent to cause the little spark; if it failed the remainder of the swings had but a poor chance of success. Consequently precision of tuning was not really important, though no doubt it would help a little.

It is interesting to note that a magnetic needle detector not unlike Rutherford's had been used long ago by Joseph Henry at Washington, and that minute induced sparks, identical in all respects with those discovered by Hertz, had been seen in recent times both by Edison and by Silvanus Thompson, being styled "etheric force" by the former, but their theoretic

* Evening Lecture on "Dust," by the writer, see *Nature*, Vol. 31, p. 265; also *Journal* of the Royal Institution, May, 1886.

† Apparatus for the purpose is now in the catalogue of Messrs. Ducretet, of Paris, but they supply a pair of combs of points. It makes a more interesting experiment if only one point is used, in a moderate space, and the electric supply regulated so as not to hurry the disappearance of the smoke too quickly, but to exhibit the stages of aggregation which precede the final disappearance by deposition. Any kind of smoke serves, but a bit of magnesium ribbon burnt under a bell jar is cleanly and effective. It should be looked at in a good light, of course.

‡ *Journal* of the Institution of Electrical Engineers for 1890, pp. 352-4.

§ "Modern Views," second edition, p. 359.

¶ *Journal* of the Institution of Electrical Engineers, 1890, p. 352.

* Verbally to Section A at Bath, 1888. *See* also *Phil. Mag.*, August 1888, p. 229; and *The Electrician*, Vol. 21, pp. 607-8.

† *Nature*, Vols. 39 and 40.

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significance had not been perceived, and they were somewhat sceptically regarded. Yet Henry, even in those pre-Maxwellian days, was led to an intuition concerning the spread of electrical disturbance surprisingly near the truth. The truth indeed it was in some sort, but it was not worked out or grasped in detail, and so cannot be considered as more than a brilliant guess; but the fact that an observation of the widespread surgings induced in the neighbourhood of a primary discharge had been made by Henry, and had been seen by others to be capable of giving actual sparks, before the time of Hertz, although it has no real bearing on Hertz's fresh discovery, and did not lead those who like the writer had long been trying to think of a detector for Maxwellian waves to discover one, nevertheless is instructive as showing how frequently it happens that a fact is lying ready to hand but is not taken up and appreciated until some special or extra stimulus has been supplied.

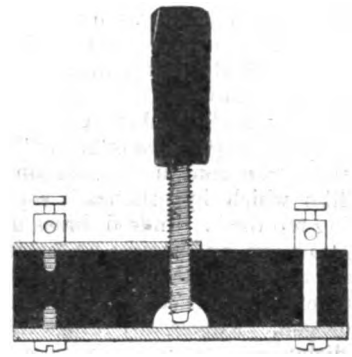
After Hertz's results had become well-known, the writer devised a plan whereby real electric resonance could be demonstrated with a pair of actual glass Leyden jars of ordinary pattern, by connecting each to a discharge circuit, the one complete, the other with an air-gap, and providing the first or receiving jar with an overflow path or bye-circuit with an air-gap across which it could give a visible spark whenever the induced oscillations or surgings accumulated in its main circuit were sufficiently intense to make it overflow.* The air-gap was most easily provided by a strip of tinfoil pasted over the lip of the jar, but it served equally well if wires led from the two coatings to a pair of adjustable knobs near together, like a lightning guard, between which the overflow spark could pass. The same knobs indeed were used as had already served for the lightning experiments; and, as in that case, if the knobs are arranged very close together and are put in circuit with a battery and a bell, cohesion sets in and the bell rings whenever the overflow occurs. The bell continues to ring until the stand is tapped, but if the bell itself touches the stand or the table, it rapidly breaks contact by its vibration, exactly as described six or seven paragraphs above. Closed Leyden jar circuits are not strong radiators, nor was this resonance then observed excited by true waves. No attempt was at this time made to apply the cohesion principle to the detection of true Hertz waves such as could be felt at a considerable distance from a strongly radiating source.

Before this time, FitzGerald and Trouton had hit upon their galvanometer method of demonstrating to an audience the occurrence of the minute scarcely-visible spark in the gap of a Hertz receiver.†

Prof. Minchin also, working at Cooper's-hill with his sensitive photo-electric cells, especially with some which he called impulsion cells that behaved abnormally when subjected to taps or other mechanical vibrations, found that when Mr. Gregory was working a Hertz radiator in another part of the same laboratory the electrometer connected to his cells responded.‡ Many other detectors have been devised and used, but this one of Minchin's almost certainly depends on the cohesion principle, though its action seemed paradoxical then. Moreover he was able, by its aid, to signal without wires over a considerable number of yards, at that early date 1890 and 1891.

About the same time, Prof. Boltzmann used a charged gold-leaf electroscope for the same purpose, having it so arranged that the electroscope was on the point of discharging across a minute air-gap, so that its leaves were dilated by a definite amount. The slightest excess of charge would make it discharge and the leaves instantly collapse. In this charged condition it was sensitive to very minute electric surgings, and if Hertz waves were excited in another part of the room, the wave disturbances caused the gap to break down and the electroscope leaves to collapse.§ This method is not a cohesion method, but it led the writer, when subsequently repeating Boltzmann's results with modifications, to realise that, if the gap were almost closed, cohesion could be made to set in by the surgings induced by regular Hertz waves.

The Boltzmann gap method was accordingly modified in several ways; one way was to make it of carbon and to connect it, with its wave collector, to the terminals of 110 volt electric light leads, so that whenever a Hertz vibrator was discharged and induced a minute spark across the gap, that same spark might close the circuit and establish an arc. This plan forced itself on my attention by the behaviour of sundry Swan lamps suspended with shades so as to illuminate my lecture table, which became short-circuited whenever a large Hertz vibrator was at work; for the lamps were at that time kept from rotation, and thereby from glaring into the eyes of the audience instead of being screened from them, by a couple of copper wires stretched across the theatre; so long as those wires were there, the fuses used to blow whenever a Hertz oscillator was started; an experiment which was interesting enough, and was shown to several people, including, I think, Prof. FitzGerald, but which was sufficiently a nuisance to necessitate the wires, which were acting as collecting wires, being taken down and replaced by stretched silk threads, which are there to this day. Another modification was to connect the gap to an Abel's fuse or to a gas leak, which exploded or ignited under the influence of a feeble spark. Yet another was to connect it to a single cell and electric bell or galvanometer, as already explained.



Air-gap of Wave-detector for use with Electroscope, or with Battery and Electric Bell, as an early form of Coherer, as described on p. 21 of "The Work of Hertz." The end of the screw is polished and acts like a knob.

Meanwhile, however, and well before these later experiments on the detection of Hertz waves were in progress, certain discoveries had been made by M. Branly, Professor of Physics in the Catholic Institute of Paris, which were of the greatest interest and importance. Prof. Branly had found that a coat or varnish of fine copper dust, porphyrised copper or other such substance, though it could only conduct a current very feebly, and much as a blacklead pencil trace conducts, under ordinary conditions, yet fell in resistance enormously whenever an electric spark occurred in its neighbourhood; somewhat in the fashion that the resistance of selenium falls on exposure to light. It is not clear that M. Branly recognised that he was dealing with Hertz waves or true electrical radiation, but his observations were most satisfactory and conclusive, and he measured the reduction of resistance caused in a number of different substances, including an assemblage of metallic filings, and conglomerates or paste of filings in various viscous liquids and in dry powders.

The account of Prof. Branly's experiments is to be found in a couple of short communications to the French Academy of Science (*Comptes Rendus*, Vols. 111 and 112) and the writer had intended to reproduce in abstract the gist of these memoirs; but to readers of *The Electrician* this is unnecessary, as a descriptive article from *La Lumière Electrique* has already been translated in full in July and August 1891 (see *The Electrician*, Vol. 27, pp. 221 and 448). Unfortunalely the writer, in common perhaps with others, must confess to having overlooked these articles at the time, probably by reason of their coincidence with the holiday season. In his second edition of "Modern Views of Electricity," published in 1892, though he refers on page 359 to the cohesion principle in this

* *Nature*, Vol. 41, p. 368; or, "Modern Views of Electricity," second edition, p. 338.
† *Nature*, Vol. 41, p. 295; and Vol. 42, p. 172.
‡ *Phil. Mag.*, March, 1891; also January, 1894.
§ *Wied. Ann.*, Vol. 40.

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connection, the writer is clearly ignorant of Branly's experiments.

The matter seems to have been ignored in this country till 1892, when Dr. Dawson Turner described the experiments to the British Association in Edinburgh, and even till 1893, when Mr. Croft brought them to the notice of the London Physical Society. Prof. Minchin at once realised that here was a phenomenon analogous to what he had been observing with his impulsion cells, and after a few trials wrote a Paper to the Physical Society recounting his repetitions and modifications of Branly's experiments.* This Paper, before it was read, was circulated by the Society to its country members, and so came to the eye of the writer, who at once wrote a short note summarising some of his work in the same direction, and pointing out that this discovery of Branly's, thus made known to him, was another case of the electrical cohesion phenomenon already observed by several experimenters. This is published along with Prof. Minchin's Paper in the *Phil. Mag.* for January, 1894, and to it the friendly reader is referred. The writer at once proceeded to try the Branly tube of filings, and found it far superior in manageability to either the Boltzmann gap or his own delicately adjusted cohering knobs; though immediately afterwards, he and FitzGerald together arranged a single point coherer of iron and aluminium (point of sewing needle resting on aluminium foil), of what was at that time extraordinary sensitiveness and of reasonable manageability. A whole series of quasi-optical experiments were then undertaken with the new detector, and were shown to students and to the the Liverpool Physical Society; moreover, before long, various improved methods of arranging the filings were gradually adopted, especially by sealing them up in vacuum or in an atmosphere of hydrogen ("Work of Hertz" book, page 80) so as to protect them from continued oxidation by the air, and to prevent the film which hypothetically separates the surfaces from growing too thick. Indeed, brass filings in hydrogen speedily got *too* clean, and became so sensitive that it was almost impossible to restore the original high resistance by tapping. Consequently, a perfect or Sprengel vacuum was preferred to hydrogen, Almost any filings tube could detect signals from a distance of 60 yards, with a mere six-inch sphere as emitter and without the slightest trouble, but the single-point coherer was usually much more sensitive than any filings tube. Mr. Shelford Bidwell has also worked with varieties of powder.

The tapping back was at first performed by hand, and for optical experiments this is still, perhaps, the most convenient plan; but automatic tappers were very soon arranged, just as with the old knobs; an electric bell mounted on the base of a filings tubes ("Work of Hertz" book, page 27) was not found very satisfactory, however, because of the disturbances caused by the little sparks at its contact breaker, to which the previous coarser knob-arrangements had failed to respond; so a clockwork tapper, consisting of a rotating spoke wheel driven by the clockwork of a Morse instrument, and giving to the filings tube or to a coherer a series of jerks occurring at regular intervals, to imitate what the writer supposed must occur in the eye, viz., a restoration to sensitiveness after an interval corresponding to the persistence of impression, was also employed. Many of these things were shown at a Friday evening lecture at the Royal Institution on June 1, 1894, while others were shown at the British Association meeting at Oxford. In both cases signalling was easily carried on from a distance through walls and other obstacles, an emitter being outside and a galvanometer detector inside the room. Distance without obstacle was no difficulty in these experiments, only free distance is not very easy to get in a town, and stupidly enough no attempt was made to apply any but the feeblest power so as to test how far the disturbance could really be detected. Mr. Rutherford, however, with a magnetic detector of his own invention, constructed on a totally different principle, and probably much less sensitive than a coherer, did make the attempt and succeeded in signalling across half a mile, full of intervening streets and houses at Cambridge.†

Numbers of people have worked at the detection of Hertz waves with filing tube receivers, and every one of them must have known that the transmission of telegraphic messages in this way over moderate distances was but a matter of demand and supply; Sir W. Crookes, indeed, had already clearly stated this telegraphic application of Hertz waves in the *Fortnightly Magazine* for February, 1892, and refers to certain experiments already conducted in that direction,* the details of which are unknown to the writer. There remained no doubt a number of points of detail, and considerable improvements in construction, if the method was ever to become practically useful; but these details could safely be left to those who had charge of the Government monopoly of telegraphs, especially as their eminent Head was known to be interested in this kind of subject.

Meanwhile the optical developments of the matter excited most interest among physicists, both here and on the continent; the writer performed some experiments of the kind, Righi performed many more, and Prof. Chunder Bose, of Calcutta, repeated several of them with addition and improvements, using as detector a sort of half-way house between a point coherer and a filings tube by squeezing a few little rolls or spirals of wire between a point and a micrometer screw. Restoration to sensitiveness was in this case achieved by relaxing the pressure of the screw, and the writer has not found Bose's form of coherer specially convenient; but Prof. Bose's whole apparatus, constructed as it was precisely on lines published by the writer in his lecture and little book on "The Work of Hertz, &c." was well designed in detail and exceedingly compact, being on the scale of an ordinary galvanometer; and with it many experiments, familiar in ordinary optics, could readily be shown with electric radiation.

In all the optical experiments made by any of these observers it was customary to place the axis of the emitter either horizontally, or vertically, or inclined, in other words to emit radiation polarised in any azimuth (or rather altitude), and to arrange the collecting part of the receiver to correspond or otherwise, according as response or no response was desired. In fact, observations on polarisation were the easiest and the most instructive that could be made with the definite kind of radiation now for the first time at command. The rotation of the plane of polarisation, the conversion of plane into elliptical polarisation, the amount of radiation reflected by substances at different angles and different aspects with regard to the direction of vibration, were readily observed. Furthermore, ever since Hertz's first discovery, whenever waves had to travel through a metal grid or alongside a plane conductor, it was natural to arrange the electric oscillations so as to be normal to the conducting lines or plane, for if they were tangential they excited electric currents therein, and their energy became wasted in the production of heat. So, in so far as earth and water are conductors, it is desirable to use radiation polarised in a horizontal plane if considerable distances are to be traversed by it.

With respect to an explanation *why* metallic cohesion is caused under electrical influence, the following considerations are offered:—

Lord Rayleigh, knowing already that electrical cohesion existed between liquids, made a liquid coherer of two globules or pools of mercury, side by side and touching, but kept apart by a thin film of grease, such as is easily given by a coat of paraffin oil. Connecting up a battery cell to these mercury pools through a key, he found that every time the key is depressed the pools move together and become one. Mr. Rollo Appleyard also has devised a liquid form of coherer, and has exhibited it to the Physical Society;† he points out moreover that mercury globules shoot out a tentacle towards the positive terminal (on the principle of the capillary electrometer, of course), and this must be taken into account in any coherer theory. It is interesting, however, to observe that in the Rayleigh form of coherer an appreciable time interval occurs between the depression of the key and the amalgamation of the mercury, the lag looking as if a film had to be mechanically squeezed out between the oppositely-charged mercury surfaces, and as if this took a per-

* *Phil. Mag.*, January, 1894.
† *Phil. Trans.*, 1897, A., communicated to the Roy. Soc., June, 1896.

* Quoted in *The Electrician* "Notes," October 1, 1897.
† *Phil. Mag.*, May and July, 1897.

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ceptible fraction of a second to accomplish. This experiment conveys the useful suggestion that cohesion may in all cases be the result of electrostatic attraction, and that the molecular films separating solids in contact may thus also have to be squeezed out, though as they only touch at single points such extrusion is almost instantaneously achieved. This may very likely be the chief cause, for although a true electro-chemical extension of the range of cohesion between polarised molecules had seemed to the writer to be a possible explanation also, he now perceives that the electrostatic force alone may be sufficient. For it is easy to calculate the force of attraction between two surfaces differing in potential by a volt, and separated from one another by the smallest known thickness of thin film; such force per unit area would be given by the square of the potential gradient divided by 8π, that is, it would amount to $\frac{1}{25}\left(\frac{10^7}{300}\right)^2$ dynes per square centimetre, which equals 44 atmospheres, and is a very considerable pressure. Ten times this attractive pressure would exist if the surfaces were within really *molecular* distance of each other, in addition to the force of true cohesion which would then, still more powerfully, operate; but the film thickness assumed above is such as would just prevent the force of cohesion from effectively acting across the gap, and would leave the electrical attraction due to the one volt alone. Three and a-half volts could therefore squeeze metals together with a force equal to a ton load per square inch, and might thus be sufficient to cause them to weld or unite, especially if the electric stimulus simultaneously acted in any way as a flux, by reducing the infinitesimal tarnish of oxide or other compound which must be supposed normally to cover them. The noble metals are not well suited to coherer purposes; they are too clean. In so far as the approximate contact is not between *surfaces*, but between points consisting of relatively few molecules, the attractive pressure is greater rather than less. Thus to take an extreme case, the attraction between two oppositely-charged molecules differing only by a volt from each other and separated by a thin film, like the black spot of a soap film whose thickness was so admirably measured by Profs. Reinold and Rücker, is over 1,000 atmospheres in intensity.

These differences of potential across the films cannot continue for any time, unless as in Rayleigh's experiment a battery is used, for the films do not really insulate, they are able however to act as dielectrics for an instant, and to be burst with what we must be allowed to call a spark, if the momentary strain caused by the impulsive rush of electricity is too great.

Such, so far as the writer is aware, was in general terms the state of theoretical and practical knowledge, at least in this country, on the subject of coherers in relation to Hertz waves; when, in the autumn of last year, there came a new development. One of the students in Prof. A. Righi's class at Bologna, having heard the Professor lecture on the production and transmission of Hertz waves across space, and their detection by the cohesion which they caused in a group of metallic filings, and, being gifted, doubtless, with a sense of humour as well as with considerable energy and some spare time, proceeded to put a coherer into a sealed box and to bring it to England as a new and secret plan adapted to electric signalling at a distance without wires. Being influentially introduced to the chief engineer of the Government Telegraphs, who, presumably, was too busy to remember what had recently been done in the Hertz-wave direction, the box was announced as containing "a new plan" which had been "brought to England." Lectures were given on it at both the Royal Institution and the Royal Society, the House of Commons voted £600 for special experiments, and trials were made by the experienced official staff with their usual skill. Mr. Marconi is to be congratulated on the result of his enterprise; the newspaper press of this and other countries have taken the matter up, popular magazine articles have been written about it, and so now at length the British Public has heard, apparently for the first time, that there are such things as electric waves, which can travel across space and through apparent obstacles to a considerable distance, and can there be detected in a startling fashion. Thus the public has been educated by a secret box more than it could have been by many volumes of Philosophical *Transactions* and Physical Society *Proceedings*; our old friends the Hertz waves and coherers have entered upon their stage of notoriety, and have become affairs of national and almost international importance. Every daily paper now has bulletins concerning the progress of the practical application of the invention, except in so far as it is still being privately worked at by uninfluential individuals.

THE PRACTICAL APPLICATIONS OF THE COHERER.

BY A. C. BROWN.

The coherer, or Branly filings tube, including various single and multiple contact modifications, as all the scientific world now knows, is the vital feature or soul of the Hertzian system of wireless telegraphy; and so much nonsense has been written around this subject in the lay Press, and so much misconception prevails even in some scientific circles as to its possibilities and probabilities, that the present article has been written by desire to endeavour to clear up the ground and lay before the readers of *The Electrician* a statement of the actual facts of the case, as to what will and what will *not* probably be the commercial uses of the coherer in the near future. The subject is here dealt with as it appears to one who has been working on various forms of wireless telegraphy since the year 1878, beginning then with the photophone (or light-beam transmission with a selenium "electric eye" and telephone repeater) in conjunction with Prof. Alex. Graham Bell, and going through and experimentally testing most other methods of transmission that have since presented themselves, including electromagnetic induction in 1879; thermal-ray transmission with thermophile telephone, and various thermo-electric resistance-varying cells or "eyes," also in 1879; sound wave transmission with electro-magnetic receiver ringing bell or making signal *locally* at receiving station, in 1885; trying even Röntgen rays for signalling purposes in 1896; also in 1896, the Hertzian or electric wave method of transmission, now so greatly to the fore.

This article, however, relates not to wireless telegraphy in itself, but to the coherer—which piece of apparatus certainly more than any other has rendered the former a possibility—because it appears to the writer that there are other practical applications and probable commercial uses to which the latter will be put, which may even outweigh in importance its use in connection with wireless telegraphy. The practicable uses of the coherer may be summarised as follows:—

1. Wireless telegraphy proper over *moderate* distances including, say, ship signalling, military telegraphy, and especially municipal telegraphy such as fire and police alarms, &c.

2. The cases where a contact or any short distance requires to be bridged across without direct connection, but where a wire can and is advantageously run for the greater part of the distance to be communicated over, and which cases cannot therefore strictly be classed as *wireless*. These especially include railway signalling, lightship cable connections, and working through breaks or faults in ordinary submarine cables.

3. Relay purposes for ordinary telegraphy, especially submarine.

4. An application which the writer has worked out, viz., for telegraphing over long lengths of bare submerged wires or uninsulated submarine cables, which may consist of simply strands of some of the present covering or protecting wires without any core. The possibilities in this respect seem, in fact, to the writer to be among the most important of all applications likely to be found for the coherer.

Among the applications which are *not* likely to be found practicable—at all events not immediately—may be mentioned:—

Long-distance wireless telegraphy, such as was promised but a short time since by the public Press, backed up unfortunately to some extent by scientific men, viz., 20 miles, England to France (23 miles), then "possibly across the Atlantic," then 60 miles, &c., such promises being now reduced in

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reality to almost a single figure. Variable atmospheric electric conditions appear to prevent any likelihood of *long*-distance transmision, even if the sensitiveness of the apparatus could be sufficiently increased. The coherer is also not just yet going to synchronise the watches in our pockets.

Wireless Telegraphy Proper.—Before going into the various branches of this application, it will be, perhaps, best to mention a great practical limitation, which at present applies to all cases. I refer to the impossibility of preventing a coherer from being affected by all electric waves arriving in its vicinity, if it is to respond sensitively to any of them. In this regard a great deal has been made about electric *syntony* and the supposed possibility by its means of confining to each receiver the signals intended for that receiver only, notwithstanding the simultaneous transmission of many other electric wave signals across the area through which it is sensitive; but the writer ventures to assert that no electric syntony whatever has yet been obtained with the Marconi form of Hertzian apparatus over any distance exceeding, say a quarter of a mile; and certainly such a close syntony as would be necessary to pick out one signal from a simultaneous batch of three or four, while rejecting the others, has not yet been made at all; nor does it seem likely that it ever will. Hertz in his laboratory, and probably, Dr. Oliver Lodge and others, may, no doubt, have obtained true syntony and some selective power over short distances, but for all useful distances in real work the elevated conductor and earth connection have been necessary, and with these there can be no syntony. The continually-varying leakage and inductive capacity arising from hygrometric and atmospheric variations and other causes would entirely and continuously alter the time period of such conductors, and thus destroy the syntony even if any could be obtained, but in practice with this apparatus none can be secured at all. A *nearer* transmitter though, wrongly rated, will affect a coherer circuit as much as a distant transmitter circuit properly syntonised. The only possibility of selective syntonic transmission over fair distances appears to be by means of nearly closed metallic circuits, which for distant transmission must be of considerable magnitude. Fortunately, however, the coherer does not necessarily need that a syntonised circuit should cause oscillations. A single impulse is sufficient to make a signal, and this in itself indicates the futility of attempting syntony for selective purposes. Much the same may be said of the idea of selecting by varying the plane of polarisation of the waves; also, to a less extent, of mirrors and the like. They are all only available within earshot.

In this connection an incident that happened at Mr. Preece's Royal Institution Lecture may be noted. After Mr. Preece had sent a signal on the wings of Hertzian waves to the coherer the receiver with its "tuned" wings had to be put into a metallic box, to show its power of working therein, but had to be doubled up to get it in, thus entirely altering the capacity and time-rate and destroying any syntony that might have previously existed. The receiver worked all the same, which was very obliging on the part of the coherer, but bad for the syntonists.

As a matter of fact, a coherer will work if the transmitter be sufficiently powerful with any and every length of wing, and at short range like that, with no wings at all. Other and altogether different means of selection than anything which can be done to the circuits will have to be found, and to this point the writer has been specially addressing himself in a long series of experiments.

Coming now to the branches of wireless telegraphy wherein the coherer may be useful:—

Ship Signalling.—For communicating between passing liners, &c., and for warships, this application seems, however, to be greatly limited by the means at present available for selecting signals. It probably will be of some use to a fleet of warships for signalling among themselves in time of peace, but could be of little use in time of war. An enemy's ship desiring to prevent signalling, for instance, has only to keep a transmitter continually generating electric waves to entirely prevent intelligible signalling anywhere in the vicinity. The methods of applying the coherer in these cases present no features of novelty, and it is not the purpose of this article to repeat the description of ordinary methods of Hertzian wave telegraphy. While speaking of ironclads, however, another matter requires reference. Captain Kennedy, in a letter appearing in *The Electrician* of 29th ult., implies that the Marconi apparatus is better than anything that has gone before, because no one has hitherto worked such apparatus inside an iron box. Who has wanted to? In regard to about the only evident application where such might be of any use, viz., for an ironclad, the writer asserts that it can only be done now *for very short distances*, unless a collecting wire projects *out* of the ironclad, say up the mast, or other convenient position, as in practice it would; and if this is done it matters not one jot where the rest of the apparatus is placed. Similar apparatus has long been worked in metallic boxes in this condition, and for short distances without the projecting wire.*

Military Telegraphy.—This, again, is greatly limited by the difficulties of simultaneous signalling within a considerable area; and the coherer, with its accessories, has here also formidable competitors in the heliograph and flag, and other ordinary signalling systems. Still, some considerable use will no doubt be made of it in this application. It will be very convenient for the telegraph corps of armies in comparative security to be able to ring a bell or work a sounder, and so call attention at the receiving end, without continually watching for signals; but in action the signalling detachment would, of course, always have to be on the look-out, so that this advantage would not hold. Hertzian wave signalling is also available across districts which might be clouded with powder-smoke or otherwise where sight signalling is not; but, on the other hand, electric signalling, as in the case of ships, could often be easily upset by the enemy; and in any case as arranged at present, only one pair of signalling parties could be allowed to work within a considerable area if they are to signal across any but very small distances.

With the present apparatus also there would no doubt be a frequent difficulty in getting sufficient elevation for the collecting wires to allow of distant signalling. Kites and balloons cannot be kept flying in all weathers and under all conditions, and tall masts are not appliances desirable for rapid military transport and quick erection. Horizontal base lines can, however, frequently be secured with far less trouble.

Referring again to Capt. Kennedy's letter, he gives figures which show that *length of horizontal wire* is worse than useless with the Marconi apparatus, but it does not appear to have struck him or the experimenters that this was the fault of the apparatus, and not of the wires, in generating and attempting to use currents or impulses unsuited to the circuits between which mutual induction was then required. By adopting suitable arrangements, so as, among other things, to apply the slower varying received current in *sudden* impulses to the coherer, the writer finds that the latter can be far more simply operated by ordinary electro-magnetic induction over considerable distances and without either tall conductors or any high-tension complications. This method of working opens up another large field for investigation, and is the subject of a recent patent.

Municipal Telegraphy, as Fire Alarms, Police Communications, &c.—This application the writer believes to be the most important and immediately available of all the applications of the coherer to wireless telegraphy, and to it therefore he has given the most attention. In this application the necessity for a good selective system is greater than ever. It is not enough merely to ring a bell at a fire or police station, the officials must also be told immediately and certainly from which point the call comes. Moreover, they must not be called up by every stray Hertzian wave that anyone may choose to send along "for a lark," or produced by other mutual signalling in the neighbourhood, if such should become popular; and the whole apparatus must be of very great certainty of action to be sufficiently reliable. The power of sending a reply signal is also a necessity. It would make this article far too long to

* See "The Work of Hertz," p. 30 (published by *The Electrician* Publishing Company in 1894) wherein Dr. Oliver Lodge speaks of the difficulty of *preventing* such apparatus, made prior to 1894, from working when enclosed in a metallic box, which may be iron, without appreciable difference.

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describe in detail the full arrangements for accomplishing the above results. Such a system has, however, been worked out and tested in practice depending on mechanical harmonic vibration, and it may suffice to say that one of its features depends on the fact that while it is impossible to prevent a coherer, which is required to work through a considerable distance, from being affected by all electric waves produced in its vicinity, it is easily and with great certainty possible to cause the receiving instrument which the coherer *controls* to be affected *only* by the particular rated set of signals intended for it out of a very considerable number of such sets, which may simultaneously or successively affect the coherer; and out of a considerable number of Morse or other signals passing around.

2. Proceeding to the second field of application for the coherer mentioned above, the effective bridging of a small space without contact, we come to:—

Railway Signalling.—Here there is a large field for putting signals directly on to running trains. There is no difficulty here in running wires, but the signals *must* be confined with great certainty each to its intended train. This can be done by running a wire from the signal box parallel with the rails, or by using the latter themselves as conductors, divided off into proper sections by insulating joints at the required fish-plates, and providing the engines with a coherer and accessories connected to a small inductor or inductive circuit opposed to the line circuit over which the signalling impulses are automatically sent.

Lightship cable connections can also be made, without directly leading the cable on board the ship, by means of bare wires either acting through the ship's wire hawser or chain, or a special wire lowered near to the looped bare end of the cable—not necessarily into contact therewith, but sufficiently near to cause the cable currents to affect the sensitive coherer on board—and so ring a bell or produce Morse signals, but in this case the telephone can also usually be applied without direct connection to speak after attention has been called by means of the coherer and bell.

Broken or disconnected submarine cables, providing that the ends remain anywhere in proximity, can also usually be signalled through by using a coherer as indicated in its next described application.

3. *Relay Purposes for Ordinary Telegraphy.*—This is doubtless another very large field of application for the coherer. Wherever for any reason the received current on a telegraph line is reduced to very small proportions, the coherer—if properly applied in conjunction with other accessories to disintegrate the received current and apply it in *sudden* impulses to the coherer—forms a most exquisitely sensitive means of appreciating and translating from those currents when reduced even to such an extent as to be inappreciable on any other form of ordinary electro-magnetic receiving apparatus at present in use, including even a telephone.

4. *Working through Bare Submerged Wires or Cables.*—This appears to be a very important application, and to which the writer has given a very great deal of attention. This application, of course, follows from the same properties as recorded in the last paragraph, viz., the extreme sensitiveness of the coherer to infinitesimal impulses *when properly applied.* It appears no doubt, at first sight, a very unlikely thing to be able to transmit signals through a great length of bare wire immersed in the sea, but it will be quite obvious that the more sensitive the receiving instrument the greater the distance along such a wire at which it will be affected, and that therefore as the sensitiveness of the receiving apparatus approaches infinity so may the length of bare wire through which it will work be indefinitely increased, and the coherer carries sensitiveness to electric impulses nearer to infinity than anything else with which we are at present acquainted. It is conceivable too, that *some* effect must take place throughout the whole length of an immersed wire on the application of a current or electric impulse at the sending end, however long it be and whatever be the proportion of current which leaks off to earth; and a rhythmic oscillatory or surging wave transmission can also here be applied, and the originating currents or impulses made very powerful. Over what *maximum* distance a bare cable can be worked in this way would be very costly to determine, because, unfortunately, the present outer covering of a cable is not suitable for the experiment without cutting the cable out at sea clear of crossings or metallic connections with the outer coverings of other cables; but it appears certain that the result in miles will not be expressed in units, and may probably run into three or four figures.

Such, in the writer's opinion, are the chief features, conditions and limitations of the present and prospective practical applications of the coherer.

ON COMPRESSIONAL ELECTRIC OR MAGNETIC WAVES.

BY OLIVER HEAVISIDE.

There are no "longitudinal" waves in Maxwell's theory analogous to sound waves. Maxwell took good care that there should not be any. He knew what he was about, and having done a first-class piece of work in producing harmony between electrostatics and kinetics in a philosophical manner, by his invention of the electric current in non-conductors and his doctrine of the circuitality of the true current, he saw that it was good, and let it be. Moreover, the phenomena of light indicated the absence of longitudinal waves; to get rid of them was a difficulty in elastic solid theories; they could not even account satisfactorily for the elementary laws of reflection and refraction at the interface of transparent media. Now, Maxwell's theory went of itself in the directions required. Why, then, should he spoil his work by introducing longitudinal waves?

Although there does not, in my opinion, seem to exist at present any distinct evidence of longitudinal waves in reality, yet, if such should be superadded to Maxwell's theory, care should be taken that the modified or extended theory is constructed so as to harmonise with Maxwell. Now, there are compressional waves in Helmholtz's theory. But I am quite unable to see that that theory harmonises with Maxwell's, and I am not aware that anyone has shown that it does. It seems to me to be out of court.

There are many ways in which compressional waves can be introduced, some simple, others complicated. But in a primary theory we are naturally limited to the simplest ways possible. Let us, then, in the first place, see how the rotational ether will furnish compressional waves. The rotational ether is known to furnish a formal analogy which is useful so far as it can be followed with advantage. The moving force per unit volume arising from the stress in a medium which opposes finite elastic resistance to shear, compression and rotation is

$$\mathbf{F} = n(\nabla^2\mathbf{G} + \tfrac{1}{3}\nabla \operatorname{div}\mathbf{G}) + \lambda\nabla\operatorname{div}\mathbf{G} - \nu \operatorname{curl}^2\mathbf{G}, \qquad (1)$$

if $\mathbf{G}$ is the spacial displacement, and n, λ, ν the elastic constants, connected with shear, compression and rotation ("Electromagnetic Theory," Vol. I., § 145, equation (313).) Here, for reasons explained (§ 153), put $n=0$, and keep ν finite instead; and, to have compressional waves, retain λ. Then

$$\mathbf{F} = \lambda\nabla\operatorname{div}\mathbf{G} - \nu\operatorname{curl}^2\mathbf{G} = c\ddot{\mathbf{G}} \qquad (2)$$

is the equation of motion for small motions, without any impressed force, if c is the density of the ether.

The most convenient form of the analogy for present purposes is to compare $\mathbf{E}$, the electric force, with $\dot{\mathbf{G}}$, the velocity of the ether, as in § 159. Then,

$$-\nu\operatorname{curl}\dot{\mathbf{G}} = \mathbf{H}, \qquad (3)$$

expressing that the rotation is elastically resisted, becomes by time differentiation, and putting $\nu^{-1} = \mu$,

$$-\operatorname{curl}\mathbf{E} = \mu p\mathbf{H}, \qquad (4)$$

the second circuital law. Also $-\nu\operatorname{curl}^2\dot{\mathbf{G}}$ is the same as $\operatorname{curl}\mathbf{H}$, so (2) above makes

$$\operatorname{curl}\mathbf{H} = cp\mathbf{E} - \lambda\nabla\operatorname{div}p^{-1}\mathbf{E}, \qquad (5)$$

which is the modified first circuital law. The expansion is $\operatorname{div}p^{-1}\mathbf{E}$, and $\lambda\nabla\operatorname{div}p^{-1}\mathbf{E}$ means the moving force due to the

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space variation of the expansion (or compression), or of the pressure, if $\lambda \operatorname{conv} p^{-1}\mathbf{E}$ be considered to be the pressure, disregarding any constant pressure which is inoperative. The other moving force, curl **H**, arises from the space variation of the torque.

Equations (4) and (5) being the working equations, it will be as well to see how λ affects the flux of energy. The mere convective flux of stored energy is disregarded. The stress on the **N** plane being

$$\mathbf{P}_N = \mathbf{N}\lambda \operatorname{div}\mathbf{G} - \nu \mathrm{V}\mathbf{N}\operatorname{curl}\mathbf{G}, \tag{6}$$

(§ 145, equation (310),) the flux of energy representing its activity is the negative of the conjugate stress on the **E** plane (because **E** is the velocity), multiplied by the size of **E** (*see* § 145). This makes, after using (3),

$$\mathbf{W} = \mathrm{V}\mathbf{E}\mathbf{H} - \mathbf{E}\lambda \operatorname{div} p^{-1}\mathbf{E} \tag{7}$$

represent the flux required. Its convergence should represent the time rate of increase of energy per unit volume. Carrying this out, and using the circuital laws (4), (5) we get

$$\begin{aligned} -\operatorname{div}\mathbf{W} &= \mathbf{E}\operatorname{curl}\mathbf{H} - \mathbf{H}\operatorname{curl}\mathbf{E} + \operatorname{div}(\mathbf{E}\lambda p^{-1}\operatorname{div}\mathbf{E}) \\ &= \mathbf{E}cp\mathbf{E} + \mathbf{H}\mu p\mathbf{H} + \lambda \operatorname{div} p^{-1}\mathbf{E}\operatorname{div}\mathbf{E} \\ &= \frac{d}{dt}\left\{\tfrac{1}{2}c\mathbf{E}^2 + \tfrac{1}{2}\mu\mathbf{H}^2 + \tfrac{1}{2}\lambda(\operatorname{div} p^{-1}\mathbf{E})^2\right\}, \end{aligned} \tag{8}$$

which is correct, since $\frac{1}{2}c\mathbf{E}^2$ is the kinetic energy, $\frac{1}{2}\mu\mathbf{H}^2$ the energy of rotation, and $\frac{1}{2}\lambda(\nabla p^{-1}\mathbf{E})^2$ the energy of compression. (*See* also § 145).

To show the effect of electric conductivity, turn (5) to

$$\operatorname{curl}\mathbf{H} = (k + cp)\mathbf{E} - \lambda\nabla \operatorname{div} p^{-1}\mathbf{E}, \tag{9}$$

where $k\mathbf{E}$ is the conduction current. The translation of the ether is frictionally as well as inertially resisted (§ 159). **W** is unchanged in (7), but its convergence, by the introduction of k, produces an extra term $\mathbf{E}k\mathbf{E}$ in the right side of (8), expressing the waste of energy.

As regards the general interpretation of (4), (5) it is to be observed that circuital **E** and **H** are propagated identically as in Maxwell's theory. Further, if **H** is polar, or divergent without curl, it remains steady in time and place. But if **E** is polar and $\mathbf{H} = 0$ or is polar, then (5) makes

$$cp\mathbf{E} = \lambda\nabla \operatorname{div} p^{-1}\mathbf{E}, \tag{10}$$

which, if c is treated as a constant, means the same as

$$\nabla^2\mathbf{E} = c\lambda^{-1}p^2\mathbf{E}, \qquad \text{or} \qquad u^2\nabla^2\mathrm{P} = p^2\mathrm{P}, \tag{11}$$

if $\mathbf{E} = -\nabla\mathrm{P}$, and $u^2 = \lambda/c$. That is, polar **E**, and the divergence of **E**, and the associated potential, are propagated at speed $(\lambda/c)^{\frac{1}{2}}$, without magnetic force. This makes longitudinal electric waves.

The strict constancy of c is impossible in the fluid case, because it then stands for the density of the fluid (with some solid properties imitated by the rotational elasticity), and we have allowed it to be compressible. The equation of continuity is

$$\operatorname{div}(c\mathbf{E}) + \dot{c} = 0, \tag{12}$$

using which, equation (10), by a time differentiation, takes the form

$$-(\operatorname{div} c\mathbf{E})\dot{\mathbf{E}} + c\ddot{\mathbf{E}} = \lambda\nabla^2\mathbf{E}. \tag{13}$$

The first term must be negligible to reduce to the standard form (11).

But electrically there is no reason visible why c (the permittivity of the ether) should not be treated as usual, as an ether *constant*. Then we have simple longitudinal waves according to (11), or waves of compression and expansion which are propagated without change of type if they are plane waves. We are not bound to follow up the analogy when we find that it fails. That is the worst of analogies. Sooner or later they have to be given up.

A serious difficulty with all analogies which represent electrical phenomena by bodily motions of an ether is that the motions have to be continuous to represent certain steady states, and then the ether gets out of shape. So the analogy may be useful only for small oscillating motions. But there are many other difficulties. There are the mechanical forces to be explained, for instance. Even the existence of electrification isolated in a dielectric involves the stretching of a point. If, for instance, **E** is the velocity of the medium, then a charged body has to be imagined to be continuously emitting fluid in all directions. That is, we have to imagine an impressed source of fluid or something equivalent. On the other hand, if **H** is velocity, the case is far worse, for an impossibility is involved. The electric force becomes rotation or proportional thereto, and the impossibility is that we have to have **E** both circuital and polar at the same time roundabout an isolated charge! Dr. Larmor's determined attempt to make the rotational ether go, with **H** as the velocity, labours under this apparently incurable defect. His electronic investigations have to be understood electromagnetically, but not in terms of the rotational ether. Of course Maxwell's theory is dynamical, without any specialised mechanical hypothesis about the ether.

Let us, then, have done with the analogy and its embarrassments, and let (4), (5) be the two circuital laws without specialised mechanical representation, or (4) and (9) in a conductor. We reduce to Maxwell by $\lambda = 0$ (or no resistance to compression in the fluid analogy). There are two kinds of electric energy shown in (8). If electrification is still to be measured by the divergence of the displacement, then we cannot have stationary electrification. Given any initial state with **H** circuital. What happens in an unbounded non-conducting uniform medium is that the circuital **E** and **H** make Maxwellian waves which go out to infinity, whilst the polar part of **E** makes longitudinal waves, which also go out to infinity. Nothing is left behind. In Maxwell's scheme, electrification persists in time and place. But according to (4), (5) if electrification has the same meaning, it only persists in the total. It does not keep its place, for one thing. Besides that, it may increase at some places and decrease at others equivalently. The persistence is merely one of total amount in the whole dielectric. To alter this amount a source is required.

The fact that $\operatorname{div}\mathbf{D}$ does not persist at any place unless $\lambda = 0$, requires us to modify equation (5), in order to show electrification stationary, and still have longitudinal waves. But, whilst we are about it, we may as well remember that *two* fluxes are concerned in Maxwell's scheme, and that we can have longitudinal waves either of $\operatorname{div}\mathbf{E}$ or of $\operatorname{div}\mathbf{H}$. Moreover, there is no present reason why we should not have both kinds at the same time, if we have any at all. Thus, let

$$\operatorname{curl}\mathbf{H} = cp\mathbf{E} + \nabla\mathrm{P} + \mathbf{g}, \tag{14}$$

$$-\operatorname{curl}\mathbf{E} = \mu p\mathbf{H} + \nabla\mathrm{Q} + \mathbf{f}, \tag{15}$$

be the circuital equations. Here **f** and **g** are introduced to represent sources; they are perfectly arbitrary vectors, and are impressed. We see at once that circuital **E** and **H** make Maxwellian waves, along with circuital **f** and **g**. Thus, if $\mathbf{E}_1$ and $\mathbf{E}_2$ are the circuital and polar parts of **E**, and similarly for **H**, **f** and **g**, we have

$$\operatorname{curl}\mathbf{H}_1 = cp\mathbf{E}_1 + \mathbf{g}_1, \tag{16}$$

$$-\operatorname{curl}\mathbf{E}_1 = \mu p\mathbf{H}_1 + \mathbf{f}_1, \tag{17}$$

for the circuital parts, as in Maxwell's system, and

$$0 = cp\mathbf{E}_2 + \nabla\mathrm{P} + \mathbf{g}_2, \tag{18}$$

$$0 = \mu p\mathbf{H}_2 + \nabla\mathrm{Q} + \mathbf{f}_2, \tag{19}$$

for the polar parts. Now let

$$\mathrm{P} = -\lambda \operatorname{div} p^{-1}\mathbf{E}_2, \qquad \mathrm{Q} = -\gamma \operatorname{div} p^{-1}\mathbf{H}_2, \tag{20}$$

show the connection between P, Q and $\mathbf{E}_2$, $\mathbf{H}_2$. Then, using (20) in (18), (19), we obtain

$$(\lambda\nabla^2 - cp^2)\,\mathbf{E}_2 = p\mathbf{g}_2, \tag{21}$$

$$(\gamma\nabla^2 - \mu p^2)\,\mathbf{H}_2 = p\mathbf{f}_2, \tag{22}$$

showing that polar **E** when free is propagated at speed $(\lambda/c)^{\frac{1}{2}}$ by longitudinal waves, and that free polar **H** is similarly propagated at speed $(\gamma/\mu)^{\frac{1}{2}}$. Call these speeds u and w. These two kinds of longitudinal waves are quite independent of one another. The polar **E** waves have no **H** with them, and the polar **H** waves have no **E** with them.

Given any initial state of **E** and **H**, and no **f**, **g**. In an unbounded medium the result is automatic division into *three* sorts of waves, the circuital or Maxwellian at speed $v = (\mu c)^{-\frac{1}{2}}$, the polar **E** at speed u, the polar **H** at speed w. Nothing is left behind.

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To have remanent **E** and **H**, we require **f** and **g** respectively. If $\mathbf{g}_1 = \text{curl}\,\mathbf{h}$, we see by (16) that $\mu\mathbf{h}$ may be regarded as the density of the intrinsic magnetisation. Its effect is known. It produces, when steady, a circuital state of magnetic induction without electric displacement. Intermediately, it produces both. Or we may regard $\mathbf{g}_1$ as impressed electric current. Similarly, if $\mathbf{f}_1 = -\text{curl}\,\mathbf{e}$, then **e** may be regarded as impressed electric force, or $c\mathbf{e}$ as intrinsic electrisation, or $\mathbf{f}_1$ as impressed magnetic current. It produces ultimately, when steady, a state of circuital electric displacement without magnetic induction, though both intermediately.

Lastly, we come to $\mathbf{f}_2$ and $\mathbf{g}_2$, and now we can represent stationary electrification and its analogue. To show this plainly, let

$$\mathbf{g}_2 = \lambda\nabla\,\text{div}\,p^{-1}\mathbf{E}_0, \tag{23}$$

where $\mathbf{E}_0$ is polar, say $= -\nabla P_0$. Then (18) becomes

$$0 = cp\mathbf{E}_2 - \lambda\nabla\,\text{div}\,p^{-1}(\mathbf{E}_2 - \mathbf{E}_0), \tag{24}$$

or, which is equivalent,

$$cp^2\mathbf{E}_2 = \lambda\nabla^2(\mathbf{E}_2 - \mathbf{E}_0). \tag{25}$$

Here it is $\mathbf{E}_0$ that is to be regarded as impressed arbitrarily. Now, if it is steady, or becomes steady after varying anyhow, (25) shows that $\mathbf{E}_2 = \mathbf{E}_0$ is the final state assumed. That is, P_0 is the electrostatic potential, so that

$$-\nabla^2 P_0 c = \rho, \tag{26}$$

if ρ is the electrification.

Similarly, if

$$\mathbf{f}_2 = \gamma\nabla\,\text{div}\,p^{-1}\mathbf{H}_0, \tag{27}$$

we have

$$\mu p^2\mathbf{H}_2 = \gamma\nabla^2(\mathbf{H}_2 - \mathbf{H}_0); \tag{28}$$

and if $\mathbf{H}_0$ is steady, the final result is $\mathbf{H}_2 = \mathbf{H}_0$, a polar state of **H** indicating stationary magnetification σ, according to

$$-\nabla^2 Q_0\mu = \sigma, \qquad \text{if} \qquad \mathbf{H}_0 = -\nabla Q_0. \tag{29}$$

It is to be observed also that ρ and σ, or P_0 and Q_0 equivalently, need not be steady. This shows a striking difference from Maxwell's scheme, in which **E**, **H**, $\mathbf{f}_1$, $\mathbf{g}_1$ settle the state of induction and displacement. A knowledge of the electrification, and also of its analogue, is included, for that div **B** is zero in reality is a special experimental datum. But in our present system ρ and σ must be independently given, and may be varied.

As regards conductivity, turn cp to $k + cp$, and μp to $\mathbf{g} + \mu p$ in (14) and (15), if k is the electric and g the magnetic conductivity, which is specialised to be zero in actual fact. So we may write

$$\text{curl}\,(\mathbf{H} - \mathbf{h}) = (k + cp)\mathbf{E} - \lambda\nabla\,\text{div}\,p^{-1}(\mathbf{E} - \mathbf{E}_0), \tag{30}$$

$$-\text{curl}\,(\mathbf{E} - \mathbf{e}) = (g + \mu p)\mathbf{H} - \gamma\nabla\,\text{div}\,p^{-1}(\mathbf{H} - \mathbf{H}_0); \tag{31}$$

or, equivalently, in terms of ρ and σ,

$$\text{curl}\,(\mathbf{H} - \mathbf{h}) = (k + cp)\mathbf{E} - \lambda\nabla\,\text{div}\,p^{-1}\mathbf{E} + \lambda\nabla p^{-1}\rho/c, \tag{32}$$

$$-\text{curl}\,(\mathbf{E} - \mathbf{e}) = (g + \mu p)\mathbf{H} - \gamma\nabla\,\text{div}\,p^{-1}\mathbf{H} + \gamma\nabla p^{-1}\sigma/\mu, \tag{33}$$

where ρ and σ are arbitrary as well as **e** and **h**.

To illustrate, if it is given that there is no **E** or **H** initially, and no **e**, or **h**, or σ, at any time later, but merely ρ, then the solution will express the result of introducing ρ. If it is a steady point source, amount q, then

$$\mathrm{D} = \frac{q}{4\pi r^2} \tag{34}$$

is the displacement at distance r from q finally. But at time t, although this is the solution still, it is only valid within the sphere of radius ut. Outside this sphere there is no disturbance. On the boundary is a state analogous to condensation, a longitudinal or normal wave, in fact. The total condensation in this wave increases uniformly with the time.

If q acts from time $t = 0$ to t_1 and then ceases, the result is a shell of depth ut_1, which goes out to infinity. On the outer boundary is a condensational wave, and on its inner boundary a rarefactional wave. The total condensation and the total rarefaction increase uniformly with the time, but their difference remains constant, being proportional to qt_1. Between the waves is the steady state according to (34). If, temporarily, **E** be imagined to be velocity, then fluid is being steadily transferred from the inner to the outer boundary of the expanding shell. Similar remarks apply to a magnetic source σ.

But although we have a scheme which is really Maxwell's, with longitudinal waves of **E** and of **H** (or either alone) added, and have further added the means of exhibiting stationary and steady electrification if required, so that Maxwell's theory can also be imitated in this respect, yet I hasten to add that I have not the least faith in the physical possibility of the extensions. The price to be paid is too great.

To begin with, the representation of electrification by an impressed term may be regarded as objectionable, and open to suspicion. Its only justification would be that it worked out well, and did not lead to embarrassing difficulties. Now, though it is not immediately evident, examination shows that the representation of electrification by an impressed term in the above way cannot be admitted for energetic reasons. To see this, we must examine the activity products.

First put $\lambda = 0$, $\gamma = 0$ in (32), (33), reducing to Maxwell. It is then the same as (16), (17), if there is no conductivity. We may exhibit the equation of activity in two strikingly different ways. Let $(k + cp)\mathbf{E}$ be denoted by **J**, and $(g + \mu p)\mathbf{H}$ by **G**. They are the electric and magnetic currents respectively. Then one form of activity equation is

$$-(\mathbf{gE} + \mathbf{fH}) = \mathrm{Q} + p\mathrm{U} + p\mathrm{T} + \text{div}\mathbf{W}_1. \tag{35}$$

On the left side is exhibited the sum of the activities of **f** and **g**. On the assumption that these vectors indicate the sources of energy, $-\mathbf{f}$ and $-\mathbf{g}$ are impressed forces. The right side expresses the sum of the waste, the time rate of increase of stored energy, and the divergence of the flux of energy, according to

$$\mathrm{Q} = k\mathbf{E}^2 + g\mathbf{H}^2, \quad \mathrm{U} = \tfrac{1}{2}c\mathbf{E}^2, \quad \mathrm{T} = \tfrac{1}{2}\mu\mathbf{H}^2, \quad \mathbf{W}_1 = \mathrm{V}\mathbf{EH}. \tag{36}$$

Now it is a consequence of the circuital equations that **f** and **g** are the sources of disturbances. But it cannot be proved from these equations that they are the sources of energy. The above form of activity equation suits the rotational ether. But in electromagnetics, though **f** and **g** are the sources of disturbances, it is **e** and **h** that are the sources of energy. This is concluded from experimental knowledge. The appropriate form of activity equation, instead of (35), is

$$\mathbf{eJ} + \mathbf{hG} = \mathrm{Q} + p\mathrm{U} + p\mathrm{T} + \text{div}\mathbf{W}, \tag{37}$$

where Q, U, and T are the same, but

$$\mathbf{W} = \mathrm{V}(\mathbf{E} - \mathbf{e})(\mathbf{H} - \mathbf{h}). \tag{38}$$

Equations (35) and (37) are mutually convertible, but differ entirely in the sources of energy and its flux, for the same varying disturbances **E** and **H**. (Compare with §70 and §159, and observe the anomalies pointed out in the latter place.)

Now pass to the more general equations (32) (33). The sources of disturbance are $\mathbf{g}_1$, $\mathbf{f}_1$, ρ and σ. But we cannot conclude from the equations where the energy is taken in. We have the activity equation

$$-(\mathbf{gE} + \mathbf{fH}) = \mathrm{Q} + p\mathrm{U} + p\mathrm{T} + p\mathrm{U}_1 + p\mathrm{T}_1 + \text{div}\mathbf{W}_2, \tag{39}$$

where Q, U and T are as before, whilst there is fresh stored energy

$$\mathrm{U}_1 = \tfrac{1}{2}\lambda(\text{div}\,p^{-1}\mathbf{E})^2, \qquad \mathrm{T}_1 = \tfrac{1}{2}\gamma(\text{div}\,p^{-1}\mathbf{H})^2, \tag{40}$$

and $\mathbf{W}_2$ is given by

$$\mathbf{W}_2 = \mathrm{V}\mathbf{EH} - \mathbf{E}\lambda\,\text{div}\,p^{-1}\mathbf{E} - \mathbf{H}\gamma\,\text{div}\,p^{-1}\mathbf{H}. \tag{41}$$

This form (41) suits the rotational ether, so far at least as it can be applied, for of course the equations are too general for it. For example, if **E** = velocity, then $cp\mathbf{E}$ is the rate of time increase of momentum (per unit vol.), and therefore $-\mathbf{g}$ is ordinary impressed Newtonian force (per unit vol.), and its activity is $-\mathbf{gE}$. This means the rate at which energy is being taken in on the spot.

The above is all very well for consistency, but it will not do in respect to stationary electrification. Thus, by (23) and (26),

$$-\mathbf{g}_2\mathbf{E} = -\mathbf{E}\lambda\nabla\,\text{div}\,p^{-1}\mathbf{E}_0 = -\mathbf{E}\lambda\nabla p^{-1}\rho/c. \tag{42}$$

Apply this to the case of a sphere with constant charge. The activity increases uniformly with the time! This is accounted for by the longitudinal wave (here a spherical wave, of course) at the boundary of the region occupied by the **E** set up by ρ, that is, $\mathbf{E}_0$ ultimately, but practically only $\mathbf{E}_0$ in a sphere of finite radius, and which can never be anything but finite. Similar remarks apply to $\mathbf{f}_2$ and σ. We cannot possibly admit a scheme which requires a supply of energy to keep up an electrostatic field.

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But perhaps the other way will work out better. Guided by Maxwell's electromagnetics, $\mathbf{e}$ and $\mathbf{E}_0$, $\mathbf{h}$ and $\mathbf{H}_0$ should be the sources of energy, although $\mathbf{g}_1$ and ρ, $\mathbf{f}_1$ and σ are the sources of disturbances. On this understanding, the equation of activity takes the form

$$(\mathbf{e}\mathbf{J}_1 + \mathbf{h}\mathbf{G}_1) + (\mathbf{E}_0\mathbf{J}_2 + \mathbf{H}_0\mathbf{G}_2) = (\mathrm{Q} + p\mathrm{U} + p'\mathrm{T}) + p\mathrm{U}_2 + p\mathrm{T}_2 + \operatorname{div}\mathbf{W}_3 \quad (43)$$

where Q, U and T are as before, whilst the new quantities are thus defined. $\mathbf{J}_1$ and $\mathbf{G}_1$ are the circuital parts of the true currents $(k+cp)\mathbf{E}$ and $(g+\mu p)\mathbf{H}$. That is, $\mathbf{J}_1$ and $\mathbf{G}_1$ are the right members of (30) and (31). $\mathbf{J}_2$ and $\mathbf{G}_2$ are the polar parts of the true currents, that is

$$\mathbf{J}_2 = \lambda\nabla\operatorname{div}p^{-1}(\mathbf{E}-\mathbf{E}_0) \qquad \mathbf{G}_2 = \lambda\nabla\operatorname{div}p^{-1}(\mathbf{H}-\mathbf{H}_0). \quad (44)$$

U_2 and T_2 are the new stored energies given by

$$\mathrm{U}_2 = \tfrac{1}{2}\gamma\{\operatorname{div}p^{-1}(\mathbf{E}-\mathbf{E}_0)\}^2, \qquad \mathrm{T}_2 = \tfrac{1}{2}\gamma\{\operatorname{div}p^{-1}(\mathbf{H}-\mathbf{H}_0)\}^2, \quad (45)$$

and, finally, $\mathbf{W}_3$ is given by

$$\mathbf{W}_3 = \mathrm{V}(\mathbf{E}-\mathbf{e})(\mathbf{H}-\mathbf{h}) - (\mathbf{E}-\mathbf{E}_0)\lambda\operatorname{div}p^{-1}(\mathbf{E}-\mathbf{E}_0) - (\mathbf{H}-\mathbf{H}_0)\gamma\operatorname{div}p^{-1}(\mathbf{H}-\mathbf{H}_0). \quad (46)$$

Superficially considered, we have now got rid of the energetic difficulty. If a stationary electric polar field exists, no work is apparently needed to keep it up. The activities of $\mathbf{E}_0$ and $\mathbf{H}_0$ are zero when their fields are established. But, looking closer, the former difficulty turns up in a new shape. Thus, considering a charged sphere. Formerly, the place of activity was the surface of the sphere, and the continuance and increase of the activity were obvious. At present, the seat of activity is the expanding spherical boundary of the radial $\mathbf{E}$. But the activity is existent however far the region of $\mathbf{E}$ may extend.

We must therefore give up the representation of static states by impressed terms in the above way. That is, $\mathbf{E}_0=0$, $\mathbf{H}_0=0$, or $\rho=0$, $\sigma=0$. But when we do this we are no longer able to have stationary electrification in a non-conductor. Not only Maxwell's theory, but older theories, as W. Thomson's, are violated. The cure is to abolish the longitudinal waves, by $\lambda=0$, $\gamma=0$. Then we come back to Maxwell and his purely transverse waves. Good old Maxwell!

The way the transition takes place is worth notice. When λ and γ are reduced to zero the wave speeds u and w are also reduced to zero. Then, even if we do have the above ρ and σ in action, varying anyhow, they do nothing, for no disturbance leaves the sources. This agrees with Maxwell, inasmuch as his electrification cannot be introduced in a dielectric without conduction or convection. Also, if electrification exists, given by $\operatorname{div}\mathbf{D}$, it persists, unless there is conduction or convection.

Lastly, a few remarks about Helmholtz's theory must be added. I made acquaintance with it about 1886, and concluded that it would not do, being fundamentally in conflict with Maxwell's theory. Prof. J. J. Thomson seemed to be of the same opinion, in his Report on Electrical Theories, not being able to harmonise it with Maxwell. Dr. Larmor, too, had a go at it, without success. But Hertz appears to have believed in it, that is, as a possible extension of Maxwell's theory, and certainly Prof. Boltzmann and Dr. Curry have faith in it, as the recent work of the latter testifies.

I think this state of dubiety is principally due to the extraordinary complication of Helmholtz's investigations. There is not only the usual cartesian complication, and the usual 4π anomalies, but an unusual display of constants, and worst of all, the exhibition of results in the form of equations of electric and magnetic force, which are very complicated, and the use of several potential functions. And yet the matter is essentially quite simple, if we look at it from another point of view, employing the simple methods which are coming into general use. Eliminate the potentials; rationalise the formulæ, and put in vectorial language and seek the circuital laws. Then we shall see what we shall see.

Transformed in the desired way, I make Helmholtz's equation of electric force, in my own notation, be

$$\mathbf{E} = -\nabla\phi - \mu_0 p\operatorname{pot}(k+c_1p)\mathbf{E} + \mu_0c_0(1-\kappa)\nabla\operatorname{pot}p'\phi - p\operatorname{curl}\operatorname{pot}\mu_1\mathbf{H} \quad (47)$$

Here understand that μ_0 and c_0 belong to the ether, and μ_1, c_1 are the extra parts due to matter, so that $\mu_0+\mu_1=\mu$, and $c_0+c_1=c$. Also ϕ is a potential, to be explained presently, and κ is a numeric, also to be interpreted. There is another potential ψ, in Helmholtz's equation, but I have put it in terms of ϕ, as in the third term, on the right. I also omit impressed electric force as unessential. There is no impressed magnetic force in the equation.

Operate on (47) by curl, and we get

$$-\operatorname{curl}\mathbf{E} = \mu p\mathbf{H}, \quad (48)$$

the second circuital law, simply. (Compare §65, Vol. I.) Conversely, from (48), by vectorial work we may construct (47), except as regards the ϕ terms.

Similarly, from Helmholtz's equation of magnetic force, we obtain, by curling, another circuital law in the form

$$\operatorname{curl}\mathbf{H} = (k+c_1p)\mathbf{E} - c_0p\nabla\phi. \quad (49)$$

There are, initially, two remarks to be made. First, that the potential term, without further information, merely allows the electric current to have divergence. Next, notice that instead of $cp\mathbf{E}$, as in Maxwell, we have $c_1p\mathbf{E}$. This is a fatal discrepancy. It is not an inadvertent mistake, however, but is intentional. Maxwell's current in a non-conductor is $pc\mathbf{E}$, or $p\mathbf{D}$, the time variation of the displacement. But Helmholtz's is $c_1p\mathbf{E}$, the time variation of the polarisation only, $c_1\mathbf{E}$ being the electric polarisation. It is supposed that ϕ can be adjusted so as to give Maxwell's theory, or a wider theory, by varying a certain constant contained in ϕ, viz., κ in (47).

The next thing to do is to eliminate ϕ. Take the divergence of (49). Then

$$c_0p\nabla^2\phi = \operatorname{div}(k+c_1p)\mathbf{E}. \quad (50)$$

Again, take the divergence of (47). We get

$$\operatorname{div}\mathbf{E} + \nabla^2\phi = -\mu_0p\operatorname{pot}\operatorname{div}(k+c_1p)\mathbf{E} + \mu_0c_0(1-\kappa)\operatorname{pot}\nabla^2p^2\phi, \quad (51)$$

which, by the use of (50) reduces to

$$\operatorname{div}\mathbf{E} + \nabla^2\phi = \mu_0c_0\kappa p^2\phi, \quad (52)$$

or

$$\frac{k+cp}{k+c_1p}\nabla^2\phi = \mu_0c_0\kappa p^2\phi; \quad (53)$$

and therefore

$$c_0\nabla p\phi = \frac{k+cp}{\mu_0c_0\kappa p^2}\nabla\operatorname{div}\mathbf{E}. \quad (54)$$

This gives $\nabla p\phi$ in terms of $\mathbf{E}$. The first circuital law is therefore, by (49),

$$\operatorname{curl}\mathbf{H} = (k+c_1p)\mathbf{E} - \frac{c}{\mu_0c_0\kappa}\nabla\operatorname{div}p^{-1}\mathbf{E} - \frac{k}{\mu_0c_0\kappa}\nabla\operatorname{div}p^{-2}\mathbf{E}. \quad (55)$$

Now put $c/\mu_0c_0\kappa = \lambda$. Then

$$\operatorname{curl}\mathbf{H} = (k+c_1p)\mathbf{E} - \lambda\nabla\operatorname{div}p^{-1}\mathbf{E} - \frac{k\lambda}{cp}\nabla\operatorname{div}p^{-1}\mathbf{E}. \quad (56)$$

This is perhaps the simplest form. Comparing with (9) we see the interpretation of Helmholtz's numeric κ. It is $\kappa = c/\mu_0c_0\lambda$, where λ is, in the rotational analogy, the elastic constant connected with compression.

But no possible legitimate manipulation of κ can reduce Helmholtz to Maxwell. The nearest approach is by $\kappa=\infty$, or $\lambda=0$. Then we make

$$\operatorname{curl}\mathbf{H} = (k+c_1p)\mathbf{E},$$

inconsistent for the reason before mentioned. The speed of propagation is $(\mu c_1)^{-\frac{1}{2}}$, and is only finite in polarisable media. It is infinite in the ether! This comes out of Helmholtz's conception of the current being the time variation of the polarisation instead of the displacement.

Take the case of κ finite, but no conductivity. Then

$$\operatorname{curl}\mathrm{H} = (k+c_1p)\mathbf{E} - \lambda\nabla\operatorname{div}p^{-1}\mathbf{E}, \quad (58)$$

$$-\operatorname{curl}\mathbf{E} = \mu p\mathbf{H}. \quad (59)$$

These indicate transverse waves at speed $(\mu c_1)^{-\frac{1}{2}}$ and normal waves at speed $(\lambda/c)^{\frac{1}{2}}$. *See* (9), (10), (11) above. When the conductivity is finite as in (56), the interpretation is more difficult, but of course still incapable of reduction to Maxwell.

It is important to note that c_0 cannot be equated to zero. If it could be, then $c_0=0$, making $c=c_1$ would reduce (49) to Maxwell in appearance. But this is nonsense. Note also that Helmholtz's theory, being reducible to (48) and (58), is not necessarily a distance action theory. ϕ has gone out. We do not need to have ϕ given to specify the state of the field.

Finally, remember that even if Helmholtz's theory could be reduced to Maxwell's, there would be, in its unreduced state, the electrification difficulties before described.

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CORRESPONDENCE

THE NEW MAXIM LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your letter, I would say that all the reports that have appeared in the American and English Press regarding my experiments with electric lamps have come from a single source. An American newspaper reporter came to interview me. He said he had heard I was doing something with lamps. I said: "It is quite true that I am experimenting, but as yet I have no particulars to give. However, the lamp which is lighting this room, and which has displaced three 16-c.p. lamps, is 42 c.p. When this lamp was made it was found to give a candle-power for considerably less than two watts, whereas the ordinary lamp takes at least four. I did not believe the lamp would last two hours; however, we put it on, and this was a long time ago, and the lamp is still running and is of great brilliancy and quite clean. If I were sure of being able to make lamps like this, in large quantities, the process would be worth a lot of money, but so far I have not advanced far enough to show the lamp to the public. I am running a number of lamps in a large room upstairs, and some have been running 1,000 hours." As to the lamp in question, when it was put on it was 42 c.p.; about two months later it was found to be 52 c.p. However, it has commenced to go off, and when last tested was 41 c.p., which would seem to indicate that it is not going to last for ever after all.

What I have been attempting to do is to produce a lamp in which a very high resistance might be obtained with a short and thick filament, also to produce a filament which will stand a higher temperature than those ordinarily used, as it is well known that a slight rise in the temperature greatly augments the light given in proportion to the current used, but the preparation of the carbon and other materials which form the filament requires a very expensive apparatus. The cost, however, of the finished filament—excepting first cost of plant—is no greater than with the ordinary lamps.

I have tested the new lamps in competition with all the best lamps I could find, and there is no question but what they show a very marked saving in electrical current, and this, of course, is the object aimed at after all. I have not decided as yet whether to keep the process a secret or to patent it.—Yours, &c., HIRAM S. MAXIM.

18, Queen's Gate-place, London, S.W., Oct. 29, 1897.

[The foregoing letter was kindly furnished us by Mr. Maxim, in response to our inquiry about a rumour that had been circulated in the newspapers, to the effect that he had invented a greatly improved form of electric lamp.—ED. *E.*]

TUNNEL ARMATURES.

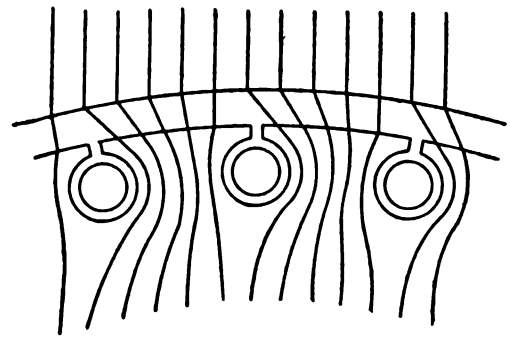
TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have only now seen Prof. Baily's article in your issue of Oct. 15. I cannot accept some of his explanations, which would be in contradiction with some remarks of mine sent to the *Elektrotechnische Zeitschrift* last month. (Their publication has been delayed for editorial reasons, but they will appear shortly.)

In the first place I wish to object to Fig. 1, p. 810, Vol. XXXIX., not only on the practical consideration, already pointed out by Mr. S. Wilson in your last issue, that the conductor is too deep in the iron, but also because that figure is theoretically impossible, for lines of force would cut the conductor when the armature is moved and would therefore generate an E.M.F. without there being any torque, which is, of course, impossible. The case of the conductor being too deep in the iron of the armature is therefore not illustrated by that figure, the real explanation is that the lines of force pass through the iron of the armature *above* the conductors from one pole face to the other.

My second objection, a more practical one, is that the distortion of the lines of force is under practical circumstances but small, for in any good machine the action of the field is much preponderant over that of the armature current, the magnetic field being, so to say, very stiff, so that the required torque necessitates but a small distortion. This point is of importance in considering the influence of a slot cut longitudinally through the top of the tunnel. The annexed figure shows my opinion of the actual diagram of lines of force or lines of induction. For the sake of simplicity I have drawn straight lines in the field magnet and in the air space, their curvature being small and of no importance to the question under consideration. It is obvious that slots cut through the iron above the tunnel will hardly interfere with the lines of force, at least for the part of the armature within the field. When, however, the conductor is in the magnetic neutral zone, the fact of the slot breaking the continuity of the iron around the conductor, will practically prevent circular magnetisation by the current. The advantage of slotted tunnels is, therefore, to avoid the loss of energy which would otherwise result from circular magnetisation round the conductor, directly in the iron or by its reaction on the conductor.

My further objection concerns the point of application of the force in tunnel armatures. If Prof. Baily's Fig. 1 were possible, the result would be only a stress within the iron of the armature. According to my diagram the torque is due to the inclination or distortion of the lines of force, where they pass from the iron of the armature or the pole face in the air space, the force at the circumference of the armature being the sum of the tangential components of the mechanical forces in the direction of the magnetic lines of force. Prof. Baily, however, assumes that forces entirely within the armature will act beyond it, between the armature and the field magnet, for there can be no action (torque) on the armature



without an equivalent reaction on the field magnet. Prof. Baily assumes, therefore, that the lines of force within the iron produce a real action at a distance, which I think is in most flagrant contradiction with the fundamental principle of the lines of force theory.

It seems, moreover, that on this point I am also in opposition with Prof. Du Bois; at all events, in his letter in your last issue he claims Prof. Baily's Fig. 1 as an illustration of his explanation.

That the point of application of the force or drag which acts on the armature and on the magnet is on the surface of the iron seems to me self-evident when we adopt the lines of force theory, for the mechanical force, as calculated from the magnetic lines of force, has only the calculated value at the surface of the iron, and quite another value within the iron. This results only from the mathematical signification of the expression *line of force* or *line of induction*, but has nothing to do with any physical conception ascribed to the *lines of force*, or, rather better in this case, *tubes of force*, for lines are essentially mathematical. I therefore do not agree with Prof. du Bois that on an armature with complete tunnels (not slotted) the drag is "*mainly* exerted on the iron," which, in my opinion, ought to be: "*only* exerted on the iron." Not because the conductors do not experience the action of any magnetic force, for there may be a not negligible magnetic field within the tunnel, causing a very perceptible drag on the conductor, but that will be exerted between the conductor and the wall of the tunnel; the iron around the tunnel experiences the reaction of the action on the wire, not the field-magnet pole-face. It is wholly a question of action and

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reaction, for if the reaction is within the armature it is, of course, evident that the action on the wire has nothing to do with the torque on the armature, and thus that the torque is only due to the action between the surfaces of the armature and of the field-magnet.

The Faraday-Maxwell explanation of the magnetic effect by certain stress and pressure in a medium, determined for a given point by the line of force or of induction at *that* point, is well known. The explanation that the drag on an armature should be considered as if the lines of force were like strings, passing within the iron and held there by friction along their surfaces, so that the points of application of the force are spread over some length of the line, being "in the iron, principally in the part immediately around the conductor," as Prof. Baily says, or that the lines of induction pass through the iron to a conductor within a tunnel so that the drag is partially taken by the iron and partially by the conductor, as seems to be the opinion of Prof. du Bois, is interesting, but I should like to see it a little further developed before I can accept it.—Yours, &c., C. L. R. E. MENGES.

Villa Mar, Scheveningen, Oct. 27, 1897.

ELECTROLYTIC CHLORINE AND BLEACH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We observe that statements have lately been made in the public press, by the promoters of the Rhodin patent process, that bleach could not be made electrolytically at a greater strength than 32 per cent. of available chlorine. We have the pleasure to send you, however, under separate cover, a sample of 38 per cent. bleaching powder, lately turned out by our electrolytic process at St. Helen's, and no doubt you will be interested in seeing this.—Yours, &c., R. SHAW, Secretary.

For the Electro-Chemical Company (Limited).

St. Helen's, Lancashire, Nov. 2, 1897.

ELECTROLYTIC ALKALI AT THE HOTEL CECIL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest the description of the Rhodin electrolytic cell which appeared in your issue of last week. To-day I notice the issue of the prospectus of a company which proposes to pay £90,000 (£60,000 in cash and £30,000 in shares) to Mr. Harvey, the vendor of the Rhodin patent rights. The absence of any details as to where this cell may be seen at work upon a scale of operations greater than those obtaining in mere laboratory experiments, leads me to conclude that the Rhodin cell has not yet arrived at this intermediate stage of its history. This view is confirmed by the report of Dr. John Hopkinson, in which he refers to the results obtained by use of "the small apparatus."

The number of cells and apparatus for the electrolysis of salt solutions that have been patented during the past eight years may be counted by dozens. Every one of these would have made an equally interesting exhibit if shown as a model at the Hotel Cecil; and if accompanied by the refreshment for the inner man for which this hotel is famous, the exhibition would have enabled the inventor, his friends, and the representatives of a select group of London technical and daily papers, to spend an equally agreeable, and from a scientific point of view, equally profitless, half hour together. A room of the Hotel Cecil is no place in which to inspect and test an electrolytic cell for the production upon a commercial scale of caustic soda and chlorine. The very idea is absurd.

Not one of the four electrolytic alkali processes at present working was introduced to the public in such a manner. Experimental trials, conducted upon a scale in some degree approximating to those found in actual manfacture, were made, and the experience gained in trials extending over weeks, months, and in one case years, was obtained before any attempt was made to float the process upon an industrial scale, or to bring it before the investing public. Those who have any knowledge of the construction and operation of chemical plant know well that apparatus for the conduct of operations at a boiling temperature is always more difficult to construct and to maintain in working order than plant for which no external heating is used. The carrying out of the electrolysis at 90° to 100°C. is stated to reduce the required E.M.F. to 3·3 volts per cell. Whether—on a commercial scale of operations—it will pay to heat and maintain a large plant at 90°C., in order to reduce the resistance of the cells, is a question that the Commercial Development Corporation (Limited) has yet to answer. For the benefit of those who are unacquainted with the details of the two most promising electrolytic alkali processes yet in operation—the Castner-Kellner and the Hargreaves-Bird—I may state that the former works with an E.M.F. of 4 volts, and the latter with one of 3·4 volts when producing carbonated alkali. The superiority of the Rhodin cell, which is stated to work with 3·3 volts at 90°C., is therefore not very striking.

In conclusion, I may perhaps add that I am not financially interested in either of the above companies, or in any of the existing electrolytic alkali companies in this or other countries. In the case of the company which is now being floated I regret that the circumstances have compelled me to take up an antagonistic attitude, but as one who has studied and written upon electro-chemical industries for a considerable period, it has appeared to me only right to utter a warning against the investment of money in an apparatus which in my opinion, and also in that of many others, has not been sufficiently tested.—Yours, &c., JOHN B. C. KERSHAW, F.I.C.

Streatham Hill, S.W., Nov. 5, 1897.

EFFECTIVE VALUE OF ALTERNATING E.M.F.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A method of obtaining the effective value of an alternating wave of current or E.M.F. recently occurred to me, which is new so far as my knowledge goes, and is at the same time extremely general, and simpler and briefer than any other I have seen. The method may be extended to any function capable of being expressed as a sum of constants and terms of the first degree in circular functions (excepting the inverse functions). In the electric problem the method is as follows:—

Let the E.M.F. or current be denoted by

$$J = A_1 \sin \omega t + A_2 \sin 2\omega t + \ldots + B_1 \cos \omega t + B_2 \cos 2\omega t + \ldots \quad . \quad . \quad . \quad (1)$$

Squaring, we have

$$J^2 = A_1^2 \sin^2 \omega t + A_2^2 \sin^2 2\omega t + \ldots + B_1^2 \cos^2 \omega t + B_2^2 \cos^2 2\omega t + \ldots + \text{terms of the form } \underset{m,n}{K} \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} m\omega t \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} n\omega t, \quad . \quad (2)$$

where m and n are different. To find the mean value of J^2 we must add together the mean values of all the terms on the right side of the equation. Now,

$$2\sin^2 x = 1 - \cos 2x, \text{ and } 2\cos^2 x = 1 + \cos 2x, \quad . \quad (3)$$

also

$$2 \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} mx \cdot \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} nx = \pm \left\{ \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} (m+n)x \pm \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} (m-n)x \right\}, \quad (4)$$

of which (3) might be regarded as two particular cases. From (3) the mean value of the square of any sine or cosine is equal to $\frac{1}{2}$, since the value of any sine or cosine is zero. Also, for the same reason, by (4), the mean value of every term of (2) of the form $\underset{m,n}{K} \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} m\omega t \cdot \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} n\omega t$ is zero. We therefore have from (2),

$$\text{Mean } J^2 = \tfrac{1}{2}(A_1^2 + A_2^2 + \ldots + B_1^2 + B_2^2 + \ldots), \quad . \quad (5)$$

and

$$(\text{Mean } J^2)^{\frac{1}{2}} = \frac{1}{\sqrt{2}}(A_1^2 + A_2^2 + \ldots + B_1^2 + B_2^2 + \ldots)^{\frac{1}{2}} \quad (6)$$

The usual method (of integrating) becomes virtually identical with that here given when we think of the relation of the integral to a mean value. This, however, would be of no avail to one unfamiliar with the infinitesimal calculus, while the method above described will be readily comprehended by anyone having an elementary knowledge of trigonometry.—Yours, &c., S. J. BARNETT.

Cornell University, Ithaca, N.Y., Oct. 22, 1897.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Oct. 29, 1897.*

Meeting of the American Street Railway Association.—The sixteenth annual convention of the American Street Railway Association was held at Niagara Falls on October 19th, 20th and 21st. It was very largely attended, and was one of the most profitable meetings the Association ever held. Several Papers of deep interest to electric railway men were read. In a Paper by Mr. Maurice Hoopes on the subject of Power Distribution and the Use of Multiphase Currents Transmission for Ordinary Street Railways, that gentleman stated that, while the majority of cases may be best handled by direct-current distribution, there are many instances of need for a distribution system where only the alternating-current system is applicable. Where water powers are used they are almost always so remote from the centre of load that very high potentials must be used for economical transmission. Long inter-urban roads operating so few cars that the load is large enough for only one power station, bring a condition where distribution must be accomplished by sub-stations on the alternating system. The use of alternating currents for ordinary street railways is limited to the rotary converter system he stated. This is due to the fact that alternating-current motors in their present state of development are not adapted to the needs of such railways. Alternating motors have the disadvantages of limited torque and a tendency to synchronism. This makes them poorly adapted for the uses of any line but one having long runs at practically uniform speeds and few stops. These conditions are those of a through express service between cities. The ideal system has been thought to be one composed of a generating station containing large multiphase generators, with lines distributing current at a potential high enough to require but a comparatively small amount of copper; static step-up transformers, and motors that may be regulated throughout at all desired variations of speed by merely changing the impressed E.M.F., with a controller dependent upon the use of various ratios of transformation. There seems to be little possibility, he thought, of an early solution of the problem of adopting the alternating motor to the intermittent work of a street railway.

One of the most interesting Papers was that of Col. N. H. Heft, electrical engineer, of the New York, New Haven and Hartford Railroad Company, who discussed the subject of the application of electricity to railroads now operated by steam power. Col. Heft reviewed the work of his Company in introducing electric power on its Nantasket Beach line, and on the branch line between New Britain and Hartford, Conn. In referring to the practical operation of the electric system, he stated that it had been found beneficial to blow out the motors several times during the day by means of a blast of air from a hose pipe connected with the air-brake reservoir. This was for the purpose of providing ventilation, which provision had been sacrificed by manufacturers in order to obtain waterproof machines. The danger to station and car apparatus from lightning discharges is avoided in the third-rail system, since the third rail is so close to the ground that it is practically a lightning arrester itself throughout its whole length. The problem of braking is solved by the use of the Westinghouse air-brake system, but instead of steam air compressors, electric motor compressors are used, controlled by an automatic regulator, which has given excellent satisfaction. The Company's experience with the third-rail and return circuit was then briefly discussed. The third rail has a potential of 600 volts, and it frequently happens that water accumulates 2in. or more in depth over the ties. Naturally under these conditions it would be supposed that the line would be directly short-circuited between the third and service rails through the water, the distance being about 2ft. each way. The Company has, however, been able to operate the road without the slightest difficulty under such circumstances, and nothing unusual has ever been noticed at the station, nor has the the electrical output, as registered by the recording wattmeter, been abnormal. In one instance, on the Berlin-Hartford line, the tracks were submerged in two places, 10 miles apart, during a heavy rainstorm, and a leakage under these conditions was found to be imperceptible when both cars on the line were at rest and their air-pumps out of circuit. At that time the wattmeter was standing still. The Company's aim is to so connect its third-rail lines and the service rail return as to have a practically complete metallic circuit of extremely low resistance, and as far as possible insulated from the ground. In spite of the fact that the general conditions of operation do not point to a low cost of power, because neither station on the Berlin line is worked at anywhere near full capacity, Mr. Heft thought that his Company was, as a matter of fact, producing power more cheaply than can be done in any power station in the country using coal as fuel. The reason for this, he stated, was the fact that they were burning "sparks," which are the half-consumed coal dumped from the extension fronts of locomotives at the Company's various round-houses. There is a great deal of steam-generating value in these sparks, and they are being carried on the Company's cars to the stations at Berlin, Nantasket and Stamford, and charged to the electrical operation at the cost of freighting, plus the cost of loading and unloading—a total of 70 cents (about 3s.) per ton delivered. Some changes in furnace arrangements are necessary, of course, to enable the combustion of these sparks. At the Berlin station the cost of fuel, using coal, has been 9 mills ($\frac{9}{10}$ of 1 cent) per horse-power-hour, or 12 mills per kilowatt-hour. Using sparks as fuel, this cost has been reduced to 3 mills per horse-power-hour, or 4 mills per kilowatt-hour.

Mr. A. E. Lang, of Toledo, Ohio, was elected President of the Association for the coming year. There was a large number of exhibits of electric railway apparatus of every imaginable kind, and although there were no particular novelties shown, deep interest was manifested by the visitors.

Incandescent Lighting at 25 Cycles per Second.—The general belief among electric light men that a current at 25 cycles per second is useless for lighting has been disproved by the Niagara Falls Power Company at Niagara Falls, N.Y. That Company has been lighting its offices and power-house with such a current for the past two years, and has recently installed a set of transformers at the village of Echota to illuminate it by Niagara power. The Company installed three 50-kilowatt transformers to provide a current at 112 volts for lighting the switchboard structures, wheel pit, offices and draughting rooms in the building, and for heating purposes. The current for the lighting of the town of Echota, which is 7,000ft. distant from the power-house, is delivered to two 50-kilowatt transformers built especially for a low rate of alternations by the Stanley Electric Manufacturing Company. From these transformers a system of secondary mains has been run along the alleys which pass in the rear of each row of houses. At frequent intervals along these mains have been placed circular iron junction-boxes, from which branches are tapped-in and led off, these in turn being tapped by the service wires. No trouble from flickering has been experienced with 16-c.p. lamps, and no flickering has been noticed by the employés of the power company who have been using this light during the past two years. The system has given excellent satisfaction. The currents generated at the power house for this service are two-phase alternating.

The Accident on the Hudson River Railway.—The sad accident which occurred on the New York Central and Hudson River Railway last Sunday morning, by which a train was thrown into the Hudson River, a few miles north of this city, resulting in the drowning and killing of a score of people, had peculiar interest to the electrical fraternity, owing to the fact that many of the delegates were returning home at that time from the Niagara Falls Convention. There were several electrical people on board the ill-fated train, but fortunately they all escaped with their lives, and in only one instance was any injury suffered, and that very slight.

The Longest Trolley Line in the World.—It may interest your readers to know what is supposed to be the longest possible continuous trip in the world on trolley roads. The total length of the lines is 124 miles, and the territory covered is in the eastern states. The route of this long trip is from

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Fairhaven, N.H., through various cities in the eastern states to Boston and then back to Nashua, N.H., by different roads. The only break in the line is at a place near Fall River, where it is necessary to cross a bridge by means of a coach. Just how long it takes ordinarily to make this trip is not stated, but no doubt it would be extremely tiresome at the best.

DIRECT SPANISH TELEGRAPH COMPANY.

On the invitation of the Marquis of Tweeddale (Chairman of the Direct Spanish Telegraph Company) a dinner was given in the Empire Hall, Trocadero Restaurant, London, on Monday last, to celebrate the twenty-fifth anniversary of the establishment of the Company. Those present included the Marquis of Tweeddale, Mr. J. Denison Pender, Mr. F. W. Blunt, Mr. W. F. Bradshaw, Mr. W. H. Burman, Mr. J. H. Carson, Mr. R. M. Cunningham, Mr. Ch. Gerhardi, Mr. R. K. Gray, Mr. J. G. Griffiths, Mr. W. W. Howell, Señor N. Jauralde, Mr. J. F. Mills, Señor Don Urbano Montejo, Mr. F. C. C. Nielsen, Mr. F. T. Preddle, Mr. G. Von Chauvin, Mr. Fred. Ward, and about thirty other gentlemen.

At the conclusion of an excellent dinner the CHAIRMAN, after a cordial reception had been given to the usual loyal toasts, read messages which had been received from the Company's staffs at the different stations, wishing prosperity to the Direct Spanish Telegraph Company. He then referred to the changes which had recently occurred in the directorate of the Company, owing to the lamented deaths of its late Chairmen (Sir James Anderson and Sir John Pender) and of Mr. Etlinger, and also to the death of the Company's representative in Spain, Mr. Aparicio. The Direct Spanish Company, after experiencing to the full the difficulties and troubles peculiar to the early telegraph companies, had now emerged into the smooth waters of permanent success. The prosperous condition of the Company was shown by the considerable growth of traffic and revenue which had been the feature of the last few years' work. This growth of traffic had resulted in an income at the present time, from an average of 300,000 messages, of £30,000 per annum. The credit of this success was unquestionably due in large measure to the great ability displayed in the conduct of the Company's affairs by their manager (Mr. Charles Gerhardi), who gave them the benefit of an experience of no less than 44 years in the telegraph service, and who had been associated with the Direct Spanish Company from its establishment on November 8, 1872. (Cheers.)

Mr. CH. GERHARDI thanked his Lordship and the assembled guests for the cordiality with which the toast of his health had been received, and feelingly referred to the losses which he, personally, in common with the telegraph service, and the Direct Spanish Telegraph Company in particular, had suffered by the deaths of Sir James Anderson, Sir John Pender, Mr. Etlinger and Mr. Aparicio. He made amusing reference to the troubles which attended the management and early work of a submarine cable company, and graphically described the dangers which he had himself experienced during the early Carlist wars in Spain, when engaged in that country on behalf of the Direct Spanish Company. Mr. Gerhardi's description of the methods adopted in the early days for circumventing the machinations of those who were, from various causes, opposed to the introduction of the telegraph into Spain, were listened to with interest, and recalled to the memories of many present the schemes and devices which had many times been found necessary under circumstances similar in character to those which Mr. Gerhardi described. The speaker referred to the assistance which had always been cheerfully rendered by the staff at home and abroad in the work of the Company, which had not always been as free from anxiety, financial and otherwise, as, under the presidency of the noble chairman, he was pleased to say was the case at the present time. (Cheers.)

In reply to the toast of "The Chairman," the MARQUIS OF TWEEDDALE briefly responded, and the toast of "The Guests" having been given by Mr. J. DENISON PENDER, and responded to by Señor Don URBANO MONTEJO and Mr. G. VON CHAUVIN, an extremely pleasant evening's proceedings terminated. The music discoursed during the evening, both vocal and instrumental, was of a high order.

Under the presidency of the Superintendents at the Company's stations dinners were given to the staff at which the leading officials of the Governmental Telegraph Departments in the several countries were present.

BOOKS RECEIVED.

"Taschenbuch für Monteure Elektrischer Beleuchtungsanlagen." By S. Freiherr von Gaisberg. (Munich: R. Oldenbourg. Price 2·50 marks.)

"Handbook to the Workmen's Compensation Act." By M. Roberts-Jones. (Cardiff: *Western Mail*.)

"The Dynamo." By S. R. Bottone. Tenth Edition. (London: Swan, Sonnenschein and Co.)

"Official Gazette of the United States Patent Office." Numbers 4, 5, 6, 7, 8 and 9, Vol. LXXX. (Washington: Government Printing House.)

"*Proceedings* of the Royal Society." No. 380. Vol. LXII. Price 3s. 6d.

LEGAL INTELLIGENCE.

Commercial Development Corporation (Limited) v. Castner-Kellner Alkali Company (Limited).

In the Chancery Division on the 6th inst. Mr. Justice Byrne heard an *ex parte* application for an *interim* injunction restraining any publication of a circular-letter of the defendants' solicitors and the opinion of counsel annexed.

Mr. TERRELL, Q.C., for the plaintiffs, said the Company was incorporated last month with the object (*inter alia*) of purchasing Mr. J. G. A. Rhodin's patent for an improved electrolyser or electrolytic apparatus. The prospectus of the plaintiff Company and forms of application for shares were issued to the public on or about the 3rd inst., and copies of the same were sent to all the leading London and other provincial newspapers to be advertised on the 5th and 6th inst., the time for application closing on the 8th inst. at 4 p.m. The plaintiffs that morning discovered that on Thursday evening, the 4th inst., the defendants' solicitors had sent the circular-letter in question to the newspapers, which stated in effect that the process for the electrolytic production of alkali and bleaching powder which the plaintiff Company were about purchasing from Mr. Rhodin would be an infringement of their patent rights. This letter and the opinion of counsel appeared in *The Times* on the 5th inst. The plaintiffs' solicitors wrote to the defendants' solicitors threatening proceedings if the counsel's opinion should appear in print, and the publication in the other papers was prevented. The Court would always grant an injunction against a person whose act would result in great damage to other persons. The circular complained of was not a circular to assert the defendants' rights, but to prevent people from subscribing to the plaintiff Company. It was a circular threatening that they would take action as soon as the plaintiffs began to manufacture.

Mr. ASTBURY, Q.C., also asked his lordship to hold without hesitation that this was not merely a caution to the trade generally, but that there was also a definite intention on the part of the defendants to issue a writ having regard to the plaintiffs' prospectus. In other words, what the defendants did was to wait until the prospectus was in the hands of the public, and then issued this circular, which could only be of benefit to them in stopping the subscriptions. This, he maintained, was an illegal act on the part of the defendants. All they were entitled to do was to bring their action, and he repeated that they were not entitled to try and prevent the plaintiff Company from obtaining subscriptions for the working of the apparatus, providing they could do it legally. He contended that, whether it was an infringement of the defendants' patents or not, it was an illegal act of the defendants to attempt to stop the promotion of this Company.

His LORDSHIP refused the injunction, and said that parties were entitled, if they instituted proceedings with due diligence, to give fair warning to all the world that they intended to take proceedings against persons for what they considered to be an infringement of their patent rights.

Mr. TERRELL subsequently, on the same day, appealed from Mr. Justice Byrne's decision to the Court of Appeal, and submitted that it did not matter whether Mr. Rhodin's patent was vested in the plaintiff Corporation or not. The way in which the threat of the defendants was used showed it was not a *bonâ fide* one. It was not a threat for the purpose of enforcing the defendants' patent rights, because they might have brought the action a long time before. The learned counsel said that the circular in question was issued simultaneously with the prospectus. The defendants made an allegation that what the plaintiff Company was going to do was an infringement of their patent.

Lord Justice CHITTY: Any person might do that, provided it is done honestly.

Mr. TERRELL: It had been laid down that a patentee had no right to sit down and encourage people to spend money on a process, and then to bring actions against them. By the circular they threaten to do that which the Courts have always held to be unfair. A threat to bring an action against anybody infringing is a warning to the public not to infringe, and for that purpose the threat is honest. What I submit the defendants are doing is not a threat to stop people from infringing, but to stop people from subscribing to our Company, which is illegal. Even at common law it is not a *bonâ fide* threat, because it is for an improper object.

Their Lordships ultimately refused to grant the injunction on an *ex parte* application, but said that the learned counsel must move on notice to the other side.

The application was accordingly refused.

The Queen (Ducket and Others) v. Calvert.

This case came before the Queen's Bench Division in Dublin on Monday on a motion to make absolute a writ of *certiorari* to quash certain surcharges made by Mr. Calvert, Local Government Board auditor, in respect of payments made for the electric lighting of the town of Killarney. Mr. Meredith, Q.C., who appeared for the appellant Commissioners, said that there had been a contest for the lighting of the town between the Gas and Electric Lighting companies. It was alleged that the Commissioners had entered into contracts with the Companies, and judgment was obtained by both against the Commissioners for light supplied. The Local Government Board auditor surcharged some of the Commissioners in respect of the payments made on account of the electric-lighting contract, on the ground that the gas contract was in existence for the same purpose. The appellent Commissioners contended that the contract for gas was never sealed or properly authorised.

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Mr. Bourke, Q.C., on behalf of Mr. Calvert, pointed out that the first contract for gas was sufficient for the town and the contract for electricity was absolutely unnecessary. The County Court judge's decrees, involving the establishment of the legality of both contracts, did not affect the duties of the auditor. The latter, whose duty was to safeguard the interests of the ratepayers, and to whom it was open, notwithstanding any decree given against the Commissioners, to declare the contracts to be unfounded and unnecessary as between the Commissioners and the ratepayers.

The Court reserved judgment.

Ward Electrical Car Company (Limited).

On Wednesday, in the High Court, before Mr. Justice Wright, a petition was presented by Mr. E. R. Evans, a shareholder, for a compulsory order to wind up the above Company. Counsel for the petition stated that the Company was formed in 1888, but had never done any business, never owned any omnibuses, nor had any commercial existence. There being no opposition, his Lordship made the necessary order for the winding-up of the Company.

Taylor v. Sax.

Mr. Justice Mathew heard an action last week, brought by the plaintiff to recover damages for breach of a commission agreement. The defendant paid £100 into court, but did not appear, nor was he represented by counsel. Plaintiff's case was that in 1895 the Lambeth Vestry obtained an electric lighting provisional order, and several persons were desirous of securing a transference of the order, amongst others defendant, Mr. Charles William Sax, electrical engineer. It finally resolved itself into a question whether Mr. Sax should secure the transfer or the County of London and Brush Provincial Company. Mr. Sax employed a Mr. Gomer, who had some knowledge of various members of the vestry and some influence, to assist him in obtaining the transfer, and in the formation of a company to carry out the works which the order involved. In January, 1896, the defendant wrote to Mr. Gomer undertaking to pay him £500 in shares of the proposed Company in consideration of his doing his best to assist him in the matter. The Vestry decided to transfer the order to Mr. Sax, but the Board of Trade declined to allow it to go to an individual, and instead of the order being transferred to Mr. Sax, and from him to the Company, it was transferred direct to the Company. The commission note was afterwards legally assigned by Mr. Gomer to the plaintiff. The shares of the Company which was formed (the South London Electric Supply Corporation, Limited) were of £5 each, with £2 paid, and they stood at par.

Judgment was given for the plaintiff for £400, in addition to the £100 paid into court, with costs.

M'Lauchlan v. Manchester Edison-Swan Company.

At Salford, William M'Lauchlan claimed £37. 10s. from the Manchester Edison-Swan Company as commission upon a contract for the electric lighting of the Prudential Buildings, Manchester, being 5 per cent. on £750. Counsel for defendants said that prior to December, 1896, they paid the plaintiff commission upon orders directly brought by him. In November, 1896, it was resolved to wind up the Company voluntarily, and this was confirmed on December 24. On December 14 they paid plaintiff £30 in full settlement of commission to date, and terminated all commission arrangements. Since then plaintiff had ceased to have any business with them, and the contract in dispute was secured altogether apart from him in January last. Plaintiff admitted there was an understanding he was not to have commission unless by special agreement, and failed to produce evidence proving a special agreement in regard to the Prudential buildings lighting. The jury found for defendants, and judgment was given accordingly with costs.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. *New Edition now ready.* These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

Notice.—There will shortly be ready a cheaper Edition of these popular "Notes and Forms," for the use of students at the Polytechnics and other teaching institutions throughout the country. The price of the new forms will be 2d. net, post free, or 2s. per dozen assorted forms.

"THE WORK OF HERTZ AND HIS SUCCESSORS": Being a Description of the Method of Signalling across Space without Wires by Electric Waves. —By Dr. O. J. Lodge, with many original illustrations. Price 2s. 6d. net.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins can be supplied, price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS." — A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS." — By J. Elton Young. *Ready shortly.*

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book for the electrical trades desires to contradict a rumour which he learns is in circulation that the issue of this work is to be discontinued. The Directory and Handbook for 1898 is already in course of preparation, and the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced.

Tenders Invited.—Tenders are invited for plant and works in connection with the scheme for the conversion of the Blackpool Corporation electric tramways to the overhead trolley system. Tenders, addressed to the Chairman of the Electric Lighting and Tramways Committee, must be delivered to Mr. Robert C. Quin by 10 a.m. of Monday, the 22nd inst.

——— The Blackburn Corporation Tramways Company invite tenders for eight tramcar bodies, with trucks, motors, controllers, trolley poles, &c. Further particulars appear in our advertisement columns, and drawings, plans of route, &c., may be inspected at the office of the engineer (Mr. E. M. Lacey), 10, Delahay-street, Westminster, London, S.W. Tenders must be sent to the secretary of the Company (Mr. J. W. Baker), Railway-road, Blackburn, by noon of Saturday, the 27th inst.

——— The Corporation of Burnley require tenders for the supply and delivery of lead sheathed, armoured underground cables.

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Tenders to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, by the 17th inst.

Tenders Invited.—The Bradford Guardians require tenders for wiring the nurses' home at the union workhouse. Tenders to the Clerk, 22, Manor-row, Bradford, by Tuesday next.

——— The Midland Railway Company require tenders for stores for 1898, including telegraph instruments, telegraph stay rods, bolts, &c., telegraph and signal wire, indiarubber goods, brass engine fittings, and a large variety of general stores. Tenders have to be in by 9 a.m. of the 16th inst.

——— The North Eastern Railway Company invite tenders for telegraph apparatus, wires, and line stores for the six months to June 30, 1898. Tenders to the Secretary of the Company, York, by the 22nd inst.

——— The Postmaster-General invites tenders for the purchase of old telegraph stores, including about 26 tons of gutta-percha, 40 tons copper (wire, plates, &c.), and a quantity of other metals, india-rubber-covered wire, &c. Tenders by 10 a.m. on Tuesday, the 23rd inst.

——— The General Direction of Spanish Posts and Telegraphs invite tenders for the supply of 25,000 porcelain insulators. Tenders to Madrid by 21st inst.

Tenders Accepted.—On the recommendation of the Asylums Committee, the Durham County Council have accepted the tender of the Corlett Electrical Engineering Company for the installation of the electric light in the Winterton annexe and the superintendent's house at £2,285.

——— The Cheltenham Town Council have accepted the tender of the Tudor Accumulator Company for the supply and maintenance of a battery of accumulators at the electricty works for £1,000.

——— The Salford Town Council have accepted the tenders of the British Insulated Wire Company for high and low-tension cables at £2,351, and for one mile of concentric high-tension cable at £150; of Messrs. Mather and Platt for motor transformers at £692; Messrs. Nalder and Hilton for switchboard at £189. 11s. 6d.; and the Tudor Accumulator Company for the supply of accumulators at £186.

Tenders Received.—We mentioned last week that seven tenders had been received by the Glasgow Corporation for the electrical equipment of the Springburn-Mitchell-street tramways, and that tenders had been sent in only by American firms or their representatives in this country. This statement, however, is not quite in accordance with the facts, as we believe that at least two tenders were sent in by British contractors for the supply of electric railway and tramway plant.

Telephone Contract.—The Private Wire and Telephone Installation Company, of 110, Cannon-street, E.C., have obtained the contract to fit up Guy's Hospital with telephones. Magneto instruments will be used, and the wiring will be on the inter-communication system.

Sale by Auction.—Messrs. Fuller, Horsey, Sons and Cassell notify in our advertisement columns that, by order of Mr. Justice Vaughan Williams, they will offer for sale at the Waverley Typewriter Works, Handforth-road, Clapham, London, S.W., on Thursday and Friday, Dec. 2 and 3, at 11 o'clock each day, a costly collection of modern machine tools, including screw-cutting and other lathes, milling machines, a 6 H P. Otto gas engine, a complete electro-plating plant (including two dynamos, two plating backs, tanks, polishing lathes, &c.), as well as the office furniture, stock and stores, consisting of about 250 Waverley typewriters, &c. Catalogues, when ready, may be had of the Receiver, Mr. James Harris, F.C.A., 8, Old Jewry, E.C.; Messrs. John H. Mote and Son, solicitors, 11, Gray's Inn-square, W.C.; and of the auctioners, 11, Billiter-square, E.C.

Appointment Vacant.—The Urban District Council of Llandudno require a clerk of works to supervise, under the consulting engineer, the erection of the electric lighting plant and other works in connection therewith. Salary £3. 10s. per week. Further particulars are given in an advertisement elsewhere, and applications must reach the clerk to the Council (Mr. A. Conolly), Municipal Offices, Llandudno, by 10 a.m. on the 22nd inst.

Vacancies.—An electrician is required to take charge of a gas-driven installation of about 300 H.P. See advertisement elsewhere.

Business Notices.—Mr. P. M. S. Brodie, the Bradford district agent for the India Rubber Company, has been appointed agent of the Company at Glasgow.

——— The Norwegian Mica Company has started business at Christiania, and will work mica mines in Norway.

——— Mr. F. A. Butler, mica and talc merchant, has removed from 68, Grosvenor Park-road, to the East London Mica Works, 6, Comby Bank-road, Hoe-street, Walthamstow, London, E.

——— Messrs. H. Binko and Co. announce that, in consequence of increase of trade, it has been decided to turn the business into a limited company, under the style of Binko, Ridsdale and Co., combining the two old-established businesses of H. Binko and Co. and Ridsdale and Co. The capital has been privately subscribed, and the new arrangements will involve no alteration in the management of the business.

Business Notices.—The General Electric Company, of London and Manchester, have added a Dublin branch to their business, under the management of Mr. Fletcher. Premises have been taken at 9, William-street, where a stock of the Company's goods will be kept.

Bankruptcies.—John Orme, trading as J. Orme and Co., electrical and scientific apparatus manufacturers, 6, Cross-street, Finsbury (late of 65, Barbican, E.C.), has been adjudicated bankrupt. The first meeting of creditors will take place on the 16th inst. at Bankruptcy-buildings, Carey-street, W.C., and the public examination on Dec. 17 at the same place.

——— The failure of Messrs. Paterson and Cooper, electrical engineers, of European Works, Pownall-road, Dalston; Princes Chambers, Victoria-street, S.W., and 137, Regent-street, Glasgow, was in the London Bankruptcy Court list of applications for discharge on the 5th inst. It was stated that the assets were in course of realisation, and consequently it was decided to ask the permission of the Court to postpone the hearing of the application until the realisation had been completed, as the result would doubtless affect the Court's decision. Mr. Registrar Brougham ordered the application to be adjourned until Jan. 28 next.

——— Arthur Bagshawe, engineer, 4A, Upper Thames-street and Queen Victoria-street, E.C., was publicly examined at the London Bankruptcy Court last week. The accounts showed total liabilities £40,460. 12s., of which £36,129. 12s. 7d. was expected to rank, against assets valued at £50,121. 12s. 5d., after allowing £278 for preferential claims. The examination was adjourned.

——— At the Westminster Palace Hotel, London, on Wednesday, the adjourned meeting of the creditors of New and Mayne (Limited) was held to receive a report of the Committee of Inspection recently appointed. The Committee reported that between £60,000 and £70,000 had been advanced by Mr. Rucker, who holds debentures for between £50,000 and £60,000. On the advice of experts a valuation had been made of the works at Woking, but the Committee refrained from giving any figures as to the real value of the plant, &c. The books of the firm had been very badly kept, and the management had been, in the Committee's opinion, very inefficient. Mr. Rucker had consented to reduce his first mortgage debenture claim of £53,000 to £25,000, and to allow that amount to rank with the claims of ordinary creditors. The Committee recommended that this offer be accepted, as in that case it was probable the creditors might get something, which was unlikely if the Company was wound up by order of the Court. It was proposed that the Company should give up manufacturing and contracting altogether, and direct its energies to the development of its inventions and patents. A resolution that Mr. Rucker's offer be accepted, in view of an early reconstruction of the Company, was approved, it being explained that the resolution was merely formal, and might serve to induce the Court to sanction some scheme for carrying on the business.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 3 to Nov. 9, with the ports of destination:—

Argentina—Buenos Ayres, £153 (including £13 telegraph material). *Australasia*—Adelaide, £44 (including £20 telegraph material); Auckland, £630; Launceston, £19; Lyttelton, £24; Melbourne, £601 (telegraph cable); Sydney, £1,105; Wellington, £3,196 (including £2,470 telegraph material). *Belgium*—Antwerp, £81. *British Guiana*—Demerara, £15. *Canada*—Montreal, £93. *Ceylon*—Colombo, £20. *China*—Shanghai, £155. *Denmark*—Copenhagen, £29. *France*—Marseilles, £31. *Germany*—Hamburg, £70. *Holland*—Amsterdam, £230. *India*—Bombay, £238; Calcutta, £328; Madras, £12. *Italy*—Naples, £450. *Japan*—Hiogo, £57. *Madeira*, £140. *Portugal*—Beira, £55. *Siam*—Bangkok, £44. *South Africa*—Cape Town, £248; Durban, £371; Port Elizabeth, £1,006 (including £180 telegraph material). *Straits Settlements*—Singapore, £114. *Sweden*—Gothenburg, £60; Stockholm, £1,662 (including £612 telegraph material). *United States*—Philadelphia, £183. Total, £11,464, against £8,861 in the corresponding week last year (Nov. 4 to Nov. 10).

A Battery Hydrometer.—The Electrical Power Storage Company, 4, Great Winchester-street, London, E.C., are introducing a new form of hydrometer, known as the "Hurst Enclosed Hydrometer." It has been specially designed to facilitate the testing for specific gravity of liquids in cells which are contracted in dimensions, or where otherwise the electrolyte is difficult of access, and where also it is desirable to test the density at various parts of the cell. This hydrometer consists of a glass tube, filled at its top end with a collapsable india-rubber bulb, and at its lower end with a flexible tube. Within the glass tube is enclosed an ordinary bulb-pattern hydrometer. In use the flexible tube is inserted in the electrolyte, and the bulb is used to suck up the liquid into the tube containing the hydrometer, which,

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therefore, is floated alone by liquid from the region of the cell where the end of the flexible tube has been placed.

Falcon Works Engineering Society.—The inaugural meeting of the fourth session of this Society, which is formed of the staff and employés of the Brush Electrical Engineering Company, was held at the works at Loughborough on Thursday, the 4th inst., when Mr. Percy Sellon delivered an address reviewing the history of the Society and of the Falcon Works, and explaining the extensions which the Company are carrying out and have in contemplation at the works.

Fire.—A fire occurred at the Woolwich works of Messrs. Siemens Bros. and Co. on Saturday last. The conflagration broke out in the roof of the joiners' shop, about 30ft. from the west end of the premises, and was discovered at four in the afternoon. The fire brigade was at once called by telephone, and the engines arrived from half-an-hour to an hour later, but in the meantime the fire was dealt with by the firm's own firemen and workmen, who, in some instances at considerable personal risk, got at it from the stairs and back and front of the building. The fire, however, gained upon their efforts up to about five o'clock, when it was mastered, although it was not finally subdued until about two hours later. We regret to say that three of the men who were assisting during the fire were injured (one badly, but not dangerously) and had to be taken to the hospital. The damage by fire was entirely confined to the top floor of the building, but the contents of the other two floors were considerably injured by water. The amount of the loss (which is covered by insurance) has not yet been ascertained, but is estimated roughly at between £3,000 and £4,000—possibly nearer the latter figure, a large stock of seasoned mahogany, value about £1,500, having been quite destroyed.

Commercial Intelligence.—In the monthly circular issued by the British Chamber of Commerce in Paris a statement of the replies given by the Chamber to the questions put by the Commercial Intelligence Committee of the Board of Trade is published. We observe that the tenour of these replies is in effect that of the recommendation made in *The Electrician* some months ago, that the consular, colonial and similar reports received from our representatives abroad should be summarised into "Trades and Industries;" and there cannot be any doubt that, if this method is adopted and carried out in an efficient manner, shorn of all unnecessary details but amplified by particulars at the command of the department, these reports may be made to serve an extremely useful commercial purpose. The British Chamber in Paris is of opinion that the reports at present keep too much in the same groove, and that the information given should be much simplified. On the subject of the appointment of special commercial agents in the British colonies the Chamber approves of this suggestion, and, as an alternative, recommends that existing Chambers of Commerce should be asked to supply the information under a subsidy from the home Government. A further recommendation is the establishment of a commercial inquiry office and a museum of samples. The monthly circular of the Chamber for October is of more than usual interest.

Motor Cars in the Lord Mayor's Show.—The directors of the Elieson Lamina Accumulator Company, towards the end of Oct. last, communicated with the Lord Mayor and Sheriffs' Committee of the City of London offering to provide one of their electric motor cars for use in the procession which took place on Tuesday. This offer was respectfully declined, on the ground that no motor car of any kind would be included, but on the 5th inst. the Company received a circular setting out the police instructions as to the time and place for "your motor carriage" to join the procession. Having received the first notification the directors concluded that the latest letter was intended for some other firm, and naturally feel that they have been treated very unfairly. The action of the Committee in declining the Company's offer seems to require some explanation, seeing that several motor cars formed part of the procession.

A Correction.—In our issue of the 29th ult. we stated that the Consolidated Telephone Construction and Manufacturing Company were the oldest established firm of telephone and telephone apparatus manufacturers in existence. Messrs. Cox-Walker point out that the statement is erroneous, and that telephonic apparatus has been manufactured by their senior partner continuously since 1878. In 1880 Mr. Cox-Walker entered into partnership with Mr. Harrison, and the firm, as we now call to mind, was established in that year as Harrison, Cox-Walker and Co. The list of telephone companies established since 1878, for whom this firm have manufactured apparatus, includes the majority of those which have, by absorption or otherwise, passed out of memory.

"Automotor and Horseless Vehicle Journal."— No. 2, Vol. II., of this journal will be ready on Nov. 16th, and will contain articles on "Motor Cars for Heavy Traffic," the Official Conditions and Rules for the 1898 Competition and the Self-Propelled Traffic Association, "The Parsons Motor," "Maxim's Automotor," and other matters connected with the automotor industry.

Cassier's Magazine.—The November issue of this magazine contains articles on "Geological Knowledge in Mining"; "Discharging and Storing Grain at British Ports"; "The City of the Future"; "The Compound Locomotive in the United States"; "Systematic Boiler Construction"; "High Temperatures Aboard Ship"; and "Engineering Experience." A Biographical Sketch (with portrait) of Mr. Alfred F. Yarrow is also given.

Aberdeen.—The Harbour Board has now definitely adopted the scheme set out in our last issue for the electric lighting of the quays and harbour.

The extensive premises of Messrs. Campbells (Limited), in Bon Accord-street, are being wired for the electric light by Messrs. Shirras, Laing and Co.

Acton.—The District Council recently issued circulars to the ratepayers, asking the amount of support likely to be accorded to their proposed electric lighting scheme. Over 600 circulars were sent out, and of these 383 approve of the proposal, and will probably take current; 105 approve but will not at the outset take current, and 120 reply negatively.

Asylum Lighting.—The London County Council, on Tuesday, discussed a report involving an expenditure of £112,000 for the erection of an asylum at Horton, the lighting of which will be entirely electrical. The laundry machinery and ventilating fans will also be worked by electricity.

Bradford.—The Tramways Committee have decided to recommend the Council to accept the offer of the Eccleshill District Council to construct and maintain tram lines from the Mechanics' Institute, Eccleshill, to join the proposed Bradford line on the city boundary at Bolton, on a 21 years' lease, the Corporation providing the electric cables and working the trams in connection with the proposed electric tramway extension from Great Horton to Bolton, in consideration of a payment to the Corporation of an annual rental equivalent to 5 per cent. on the first capital outlay of the District Council. The length of the proposed line is about three-quarters of a mile. Councillor W. C. Dixon, who was chairman of the Gas and Electricity Committee until November, 1896, will be again appointed to the position.

"Britannia" Motor Cars.—At a meeting of shareholders of the Britannia Motor Carriage Company, last week, the Chairman stated that in the course of the next few weeks the Company would have completed a number of motor carriages manufactured under their patents. He also stated that the Company had been trying several electric batteries for use with their cars, and had recently succeeded in getting one which appeared to give much more favourable results than had hitherto been found possible.

Bromley (Kent).—The Bromley Electric Lighting Company, recently formed for establishing electric light works in this district, has decided to adopt a differential scale of charging. The charge will be 7d. per unit for the maximum demand, and 4d. per unit afterwards.

Colchester.—The Electric Light Committee reported at the meeting of the Town Council, on Tuesday, that they had considered the correspondence relating to the draft contract with the Electric Construction Company for the supply and erection of electric lighting plant and machinery, &c., and they had ascertained that the Company declined to undertake the execution of the work unless a general arbitration clause were inserted in the agreement, and consequently the agreement with the Company would lapse. Messrs. Siemens Bros. and Co., however, stated that they now found that by deducting the estimated cost of street work and modifying the engines and dynamos as suggested by the Council's consulting engineer, the amount of their original tender could be reduced to about £10,800. They would be willing to carry out the work on the terms of the draft agreement, provided the necessary guarantees could be arranged with the engine makers, and would hand over to the Corporation one-half of the net profits of the first two years' working, provided that, in the improbable event of there being any loss, they should be repaid the amount out of the first profits made by the Corporation after they had themselves taken over the running of the works. The Committee therefore recommended that, as the Electric Construction Company had declined to undertake the works, the Council should accept Messrs. Siemens Bros and Co.'s offer, the amount of their reduced tender being only £34. 13s. in excess of that of the Electric Construction Company, and that the contract with Messrs. Siemens be sealed accordingly. After discussion this recommendation was adopted.

Dorking.—Mr. F. J. Warden-Stephens has submitted his report on the proposed erection of electricity supply works to the District Council.

Dublin.—A special meeting of the Municipal Council was held on Wednesday for the purpose of considering the memorial and proposed draft Order-in-Council for the construction of new electric lines and the alteration of existing lines of the Dublin United Tramways Company. After some discussion a resolution was passed approving the Company's proposals.

The Annesley Bridge-Dollymount section of the electric tramway was opened yesterday (Thursday).

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Dudley.—A Local Government Board inquiry will be held on Saturday into the application for powers to construct electric tramways in this district. The Town Council insist upon electric current being taken from the Council's projected supply station, but the promoters object to this stipulation.

Dundee.—The accounts of the Electricity Department of the Corporation, for the six months ended Oct. 31st, show gross receipts of £1,594. 5s. 11d., an increase of £210. 14s. 8d. over last year.

Durban (Natal).—The Town Council have received a proposa for the improvement of the tramway service and for the introduc' tion of electric traction throughout the entire system. The matter is under consideration.

Electrical Trades Union (Bradford Branch).—We are asked to state that the meetings of this Union will be held to-morrow at Lockhart's Coffee Tavern, Briggate, Leeds, at 8 p.m., and on Wednesday, 17th inst., at the headquarters of the Dyers' Union, Bradford.

Exhibition.—The electrical exhibition which is being promoted by the Sunderland Exhibition Company will be opened on the 22nd inst. by the Marquis of Londonderry.

Fredrikstad (Norway).—This town is now completely lighted by electricity, current being conveyed by overhead wires. Steam generating plant is used.

Hackney (London).—As the result of a further debate on the electric lighting question the Vestry have appointed a joint committee of the Public Health and Electric Lighting Committees to consider the question of the transferring the Hackney Provisional Order, and to report fully as to the advisability of establishing joint electricity supply and refuse destructor works.

Huddersfield.—In the annual statement presented to the Town Council on Tuesday it was announced that the capital expenditure to date on electric lighting works and plant was £65,917. The report of the electricity supply department was of a most satisfactory character. There are at present 544 consumers, an increase of 188 over the previous year. The equivalent number of 8-c.p. lamps connected was 38,600, against 11,600 in 1896. Extensions of the works were in progress, and would increase the capacity of the station by another 10,000 8-c.p. lamps. The Engineers' Strike had, however, unfortunately retarded the progress of the extensions. Still further additions to the plant would be required for next season. 9,580 yards of new mains had been laid during the year, and the demand for current for electric motors and for cooking and heating purposes was steadily increasing. The profit on the year's working was £434.

Lewes.—Mr. F. J. Warden-Stephens' report on the electric lighting of the town has been adopted by the Electric Lighting Committee, and, as already announced, the Corportion have decided to apply for a Provisional Order next session.

Leyton.—At the last meeting of the District Council the electrical engineer (Mr. H. C. Bishop) asked permission to at once proceed with the work of laying electric light mains on the Abbotts Park Estate, instead of waiting the sanction of the Local Government Board to borrow the necessary money. If permission were given current would be supplied on the estate within a fortnight. The matter was urgent, as the local gas company had started laying their mains. After discussion the matter was referred to the Electric Lighting Committee, with power to act. The electricity department has at present 66 customers, with an equivalent of 3,839 8-c.p. lamps connected.

Light Railway Schemes.—At a meeting of the Sussex County Council, sanction was asked for applications for Orders under the Light Railways Act for the construction of light (electric) railways and tramways. These applications were from (1) the British Electric Traction Company for *Brighton*, *Hove* and *Steyning East*; (2) the Hastings, Bexhill and District Light Railways (Electric) Company for the construction of light railways from *Hastings* through *St. Leonard's* and *Bexhill*, and (3) from Mr. C. G. Champion, solicitor, acting for a company who intend to apply for an Order to construct a light railway from *Berwick* to *Berling Gap*. All the applications were referred to the Railway Committee for consideration and report.

At the meeting of the *Coatbridge* Town Council on Friday, it was resolved to oppose an application made by the British Electric Traction Company for power to construct a light electric railway through the streets of the burgh. The Council are already in negotiation with the New General Traction Company for the construction and equipment of an electric tramway in the town.

The Tynemouth Town and Whitley and Monkseaton Urban District Councils have decided to oppose the application of the British Electric Traction Company to the Light Railway Commissioner for authority to construct a network of light railways in *North Shields, Tynemouth and District*. The Northumberland County Council have referred the consideration of the matter to the Roads and Bridges Committee.

The Ealing District Council have unanimously resolved to oppose the project of the British Electric Traction Company for the construction of a light (electric) tramway from *Acton* to *Ealing* and *Hanwell*.

Llandudno.—A special meeting of the District Council was held on Monday for the purpose of sanctioning an application to the Board of Trade for a Provisional Order for the construction of tramways in the district. In the course of the discussion it was stated that it was proposed to employ electric traction throughout the entire system. The proposal was adopted by 16 votes to 2.

The Light Railway Commissioners will hold an inquiry to-day (Friday) into the application for an Order to construct a light (electric) railway between Colwyn Bay, Llandudno, and Deganwy and Llandudno.

Maidstone.—The Town Council have decided to take steps to put the terms of their Electric Lighting Provisional Order into force.

Mile End (London).—A loan of £5,000 has been granted by the London County Council to the Guardians of the Mile End Old Town to defray the cost of the electric lighting installation at the Board's premises in Bancroft-road, E.

Municipal Honours.—The list of Mayors for 1897-8 contains the names of the following gentlemen associated with electrical and engineering enterprises: Mr. James N. Paxman, J.P. (Colchester); Mr. Moses Tunnicliffe (Messrs. Taylor, Tunnicliffe and Co.) (re-elected at Hanley, third year); Alderman William Potter, Chairman of the Electric Lighting Committee (Taunton); Mr. T. Speight, Chairman of the Gas and Electricity Committee (re-elected for Bradford); Mr. George Franklin, Chairman of the Sheffield Electric Light and Power Company (Lord Mayor of Sheffield); and Sir William Henry Crundall, Chairman of the Dover Electricity Committee (Dover).

New Heseldon (Durham).—This village is lighted electrically, current being supplied by the South Hetton Coal Company to seven 16-c.p. incandescents!

Paisley.—It is authoritative'y stated that steps are about to be taken to introduce electric traction on the local tramways. A new Company is to be formed for the purpose of acquiring the present tramways and constructing new lines, and electric traction will then be adopted throughout the entire system.

Provisional Order Notices.—The Urban District Council of *Barnes*, the *Bermondsey* (London) Vestry, the Urban District Council of *East Stonehouse*, and the *Hereford*, *Maidenhead*, and *Rochdale* Town Councils give notice of their intention to apply for Provisional Orders. Mr. James de Lara Cohen notifies his intention to apply for a Provisional Order authorising the supply of electricity for public and private purposes within the area known as Friar's Place Estate, *Acton*, Middlesex. The Peterborough Electric Light and Power Company also intimate their intention of applying for an Order for *Peterborough*.

Self-Propelled Traffic Association.—The second session of this Association will be opened on the 26th inst., when Mr. W. Worby Beaumont will deliver an address (with lantern illustrations) upon "Self-Propelled Vehicles, 1896-97," at the Liverpool Royal Institution.

Sheffield.—A discussion took place at Tuesday's meeting of the City Council on the tenders sent in for the electrical equipment of the Nether Edge-Tinsley section of the tramways. The report of the Tramways Committee stated that after further consideration of the offers submitted, and acting upon the advice of Dr. J. Hopkinson, the Committee recommended the acceptance of the tender of Messrs. Siemens Bros. and Co. for the supply and erection of engines, dynamos, switchboards, and underground conductors, for £11,732, and the tender of the British Thomson-Houston Company for the cars, trolley wires, poles, &c., at an approximate cost of £20,690, subject to an adjustment in the price of the poles if another pattern were adopted. It was also recommended that further tenders be obtained for the boilers, condensers, steam pipes, and electric storage batteries. When this report came up for discussion Alderman Clegg, Chairman of the Committee, explained that they wished to withdraw the recommendation for the acceptance of tenders as it was undesirable to have two sets of contracts. The reason given for adopting this course was that the question of dual responsibility might arise, and the Committee were anxious to safeguard themselves against this contingency. A lengthy discussion ensued, in the course of which several members pleaded for the "encouragement of local industries." In reply, Alderman Clegg said that he had always shown, and should always show, the greatest consideration for local firms; but if conditions were not equal, and they could not satisfactorily compete with outside firms, then it was against the principles of economy to confine themselves to local firms. The Council would remember that when the very first tender was given out by the Committee he publicly expressed his

tender for those contracts. The section about to be laid down was the most important one, and it was absolutely essential that they should have the best work on it. The report was then referred back, as desired by the Committee.

Shoreditch (London).—At the last meeting of the Vestry the Electric Lighting Committee reported that they had carefully considered the engineer's report and estimates for the supply and erection of the new engines and boilers and for the extension of the mains, &c., and they recommended that an expenditure not exceeding £20,000 be authorised. At the previous meeting it was agreed to expend £6,000 for additional plant, but there were other large items of expenditure to be considered, and the Committee thought it best to ask for the increased amount. The total expenditure to date was £105,000. The recommendation was agreed to.

South Africa.—The *British and South African Export Gazette* contains the following:—

"The contract with Messrs. Siemens and Halske, of Berlin, for the extention of the electricity supply works in Johannesburg, has been executed. The scheme aims at the extension of the electric light mains throughout the various districts of Johannesburg within the jurisdiction of the Sanitary Board. The fresh efforts made to induce the Raad to reconsider its recent decision on the question of the electric tramway concession have failed. The Tramway Company are thus secure from opposition.

"The contract for the electric lighting of Krugersdorp has been signed.

"For the projected electric light installation at Bloemfontein seven tenders have been received, but no decision has yet been come to.

"The Durban Town Council have decided to bond the rails of their projected tram line so that the line may be worked electrically at any future time.

"Further additions to their electrical plant are contemplated by the Directors of Moodie's Gold and Exploration Company, Barberton.

"The Directors of the Rand Central Electric Works propose to increase the capacity of their plant from 2,100 to 3,000 H.P.

"An order will shortly be given out for electric lighting plant for the Tebeque gold mine, Selukwe district, Rhodesia.

"Two generators, of 250 H.P. each, have been supplied to the Violet gold mine by Messrs. Crompton and Co.

"Messrs. Davey, Paxman and Co. have received an order from the Natal Government Railways, through their Johannesburg representative, for two direct-coupled engines and dynamos."

Taunton.—The Town Council have received a communication from the Light Railway Commissioners to the effect that they have refused the application recently made by the West Somerset Electric Railways and Tramways Company for the construction of electric tramways in the town, owing to want of jurisdiction.

Telephones for Warships.—The new battleship "Cæsar," which is completing for commission at Portsmouth, has been fitted with Graham loud-speaking telephones. Tests were made on Wednesday in the presence of the Commander-in-Chief of the Portsmouth Station and other naval men, and a further severe test is to be made when the ship is commissioned for the Channel squadron.

The Strike.—Rumours were prevalent during the early part of the week that a common ground for negotiations between the contending parties in the engineering strike and lock-out had been found, and that the prospects for a conference on the basis of a revised draft proposal of the Board of Trade were decidedly promising. These reports were confirmed later in the week, and there is now every prospect of an early meeting to discuss the Board of Trade proposals to bring the strike and lock-out to a speedy conclusion. This good news was announced by Lord Salisbury at the Guildhall Banquet on Tuesday, and was the most important announcement made upon that occasion. Lord Salisbury referred to the judicious and pertinacious efforts of Mr. Ritchie, the President of the Board of Trade, and congratulated that gentleman on the success of his efforts. The "amended draft" submitted for the consideration of the parties is to the following effect:—

The Federated Employers, while disavowing any intention of interfering with the legitimate action of trade unions, will admit no interference with the management of their business. The trades unions, on their part, while maintaining their right of combination, disavow any intention of interfering with the management of the business of the employers. The notices demanding a forty-eight hours week served on the Federated Employers in London, without previous request for a conference, are withdrawn. A conference between representatives of the Federated Employers and the trades unions concerned in the dispute shall be held forthwith. The arrangements for the conference shall be made between the chairmen or other selected representatives of the parties. Failing an agreement as to the chairman, each side to have its own chairman. The conference to consider and determine—(*a*) The best means of giving practical effect to the declarations set out above. (*b*) The best means of avoiding, as far as possible, future disputes; and arrangements for the mutual discussion of questions in the settlement of which both parties are concerned. (*c*) Hours of labour. As soon as the conference arrives at a settlement work to be resumed.

It is expected that the preliminary conference to discuss these proposals will take place to-day (Friday), at the Westminster Palace [illegible] when the chairman of the conference will probably be appointed. The men will, it is thought, submit the names of Lord Rosebery and Lord James of Hereford. The employers are stated to adhere to the stipulation that chairmen shall be selected to represent each side, and that the final negotiations shall be conducted through these gentlemen.

Tramway Provisional Orders.—The Cardiff Corporation have published a plan of the routes of the proposed tramway extensions, powers for the construction of which are to be sought next session. The lines will run to Penarth, Llandaff, Whitchurch and Roath Park, and electric power will be employed. The scheme will work with the existing tramways when those are acquired by the Corporation, and electric traction has been substituted for the present system. Some of the lines are, however, dependent upon the enlargement of the borough boundaries. With the exception of short lengths, the lines will be double.

The Huddersfield Town Council propose to apply for powers to construct about two miles of additional tramways, the greater portion of which will be double lines. Electricity will be the motive power, and the gauge will be 4ft. 8½in.

The Dublin United Tramways Company propose to apply for sanction to increase the speed of the cars authorised by their Acts of Parliament on the Southern sections of their lines.

Walsall.—The Town Council have decided to apply to the Local Government Board for sanction to borrow a further sum of £7,000 for the purpose of putting down additional plant at the electricity generating station. Owing to the rapidly-increasing demand for current it will be necessary to increase the capacity of the station plant before next winter.

Wolverhampton.—The annual report of the Lighting Committee, presented at the meeting of the Town Council on Tuesday states that, owing to an increasing demand for electric current, extensions of the plant at the station will be necessary.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or, where complete specifications accompanies application an asterisk is suffixed.*

October 13, 1897.

23,623. C. HOWARD and R. MAYER. London. An improved process of manufacturing electric incandescent lamps.

23,625. A. J. WHEATLEY, J. M. JAMES, and T. B. BROWNE. London. An electrical time-switch.

October 14, 1897.

23,680. J. E. LIARDET. London. Improvements in and relating to dynamos and electric motors.

2,3681. G. MARTINEZ. London. Improved mechanism for operating or controlling electrical motors at a distance.

23,705. C. B. CALLOW. London. Improvements in electric motor engines.

23,713. R. FABIAN. London. Improvements in dynamo electric machines.

23,717. W. WEBBER. London. Improvements in or connected with prepayment meters for gas or other fluid and electricity.

October 15, 1897.

23,792. F. W. SCHNEIDER. London. Improvements relating to the electric propulsion of vehicles.*

October 16, 1897.

23,858. C. T. A. HENSHAW. Edinburgh. A method for winding flexible electric wires.

23,877. E. SCHOEPKE. London. Improvements in ink reservoirs for Morse telegraphic ink writers and writing machines generally.

23,886. F. O'CONNOR PRINCE. London. Improvements connected with electric motors, and in the manner of connecting batteries to same.

23,896. F. PROCTOR. London. A high and low-water alarm (electrical).

October 18, 1897.

23,914. G. M. MINCHIN. Staines. A receiver for electric oscillations.

23,979. J. BOOTH and S. HOBDAY. Birmingham. Improvements in or relating to switches for controlling electrical currents.

23,987. M. H. ROBINSON and H. R. SANKEY. London. Improvements in dynamo electric machines.

23,988. H. H. PERRY. London. Improvements in apparatus especially suitable for grinding and polishing the commutators of electrical apparatus.

23,999. S. Z. DE FERRANTI. Lancashire. Improvements in electricity meters.

24,000. S. Z. DE FERRANTI. Lancashire. Improvements in electricity meters.

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1897.

1,756. BYNG AND BELL. Double-contact switches especially adapted to telephones.

6,243. COWX. Protection and support of underground electric conductors, principally applicable for electric railways and tramways.

18,230. PITT. (Société Sautter Harlé et Cie.) Apparatus for electrically actuating and controlling ships' rudders or other mechanism.

18,552. HARRIS. Electric controllers for railway vehicles.

18,934. VANDEVELDE. Automatic electric alarms.

19,230. FREED. System for the electrical protection of safes.

19,518. SPENCER. Electric arc lamps.

COMPANIES' MEETINGS AND REPORTS.

West India and Panama Telegraph Company (Limited).

The 41st ordinary general meeting of this Company was held on Wednesday at Winchester House, Mr. William Andrews (the Chairman) presiding.

The MANAGER and SECRETARY (Mr. R. T. Brown) having read the notice convening the meeting, and the minutes of the preceding one,

The CHAIRMAN said: I am very sorry, as you may imagine, to be in the place I am occupying to-day. The melancholy and sudden death of our late Chairman, Mr. Earle, was a source of great sorrow to all of us, because we had been connected with him for so many years in the management of this Company. Mr. Earle devoted himself very thoroughly to the shareholders' interests. No trouble was too great for him. He was always doing something to benefit you, and up to the very last he was engaged in the most indefatigable manner, in conjunction with the associated companies, in an endeavour to bring about a somewhat acceptable arrangement for carrying out the Bermudas-Jamaica cable, and his visits to the Colonial Office were numerous. I do not know what may be the feeling of the shareholders in the matter, but I think if, before we separate, the shareholders would pass some vote of sympathy with the family, and regret at the loss they have sustained in the death of our late Chairman, it would be a graceful thing to do. Now I will go on to the business. The gross receipts for the half-year were £38,209, and for the corresponding half-year £42,317. Then there was a diminution of £3,124 in traffic receipts as compared with the corresponding half-year. The expenses for the last half-year were £21,426, against £22,280, an apparent reduction of some £800. I say apparent reduction, because it simply arises from an adjustment of the depreciation account. Our expenses, in fact, have been brought so low, and are consistently and constantly kept so low, that I do not think we are likely to be able to effect any more savings for you. Our revenue would have been still less, but it so happened that the French cable was broken, and that that brought us in a certain amount of additional revenue. You all know the reason for the small business the Company transacts is the wretched state of things in the West Indies. They have been going from bad to worse. Business is becoming more and more restricted, and the position has at last reached such a point that the Government, as you all are aware, appointed a Commission to see if anything could be done. No doubt that Commission consisted of able public men, and they have made their recommendations. They seem to have gone very searchingly into all the different businesses that might be created, and that exist at the present time in the West Indies, and they have come to certain conclusions. But you know that what they recommend are, after all, not remedies, but merely palliatives. The only member of the Commission, it seems to me, who has a certain amount of logic about him was the gentleman who recommended that the only way to meet the sugar bounties was by the adoption of countervailing duties. We have been allowing the bounty-fed sugars to come in practically free of duty, until everybody interested in the sugar industry in our colonies is going to the wall. That is not the case in Jamaica only, but in all the West India islands belonging to Great Britain, and in recent years we have witnessed the almost complete disappearance of the sugar refiner. At one time that was a big industry, but it had now practically gone. Of course, these causes have restricted our business. They have made it shrink to almost insignificant proportions. It was never very big, as you know, and now at last we have got to face real competition besides. We have been threatened for a good many years, but it is only within recent years that that competition has been established, and it is only just now, I think, that we really begin to feel its effects. The West India islands have among them, unfortunately, two French colonies, and of late years the idea seems to have been formed by the French Government that France had improperly neglected her communications with her outlying territories and colonies. The French Government took up the question, and they determined to connect those islands with their own territory by an independent system of French cables, manufactured by French companies, and, therefore, to that extent, encouraging French interests. Well, of course, we have nothing to say against that. They are quite within their rights. If they chose to establish a system of National cables why should they not? Now, this French cable connects Martinique and Guadeloupe with the United States. Previously they used to connect up with other systems. Now, they have a direct line of their own to the United States, and a portion of their system is to consist of a new cable, to be laid direct from the United States to France. Well, on the establishment of this system some years ago, as you will remember, we lost our subsidies from the French islands, which amounted to £4,000 per annum. That sum was taken away from us, and given, not unnaturally, perhaps, to their own countrymen, and the islands, to a very large extent, followed suit with their business. In other words, the French people sent their business to the French cables, which again was not an unnatural thing. This French Company has subsidies amounting to £36,000 a year, and they have, besides, guarantees of traffic and other advantages from Hayti, Curaçoa and French and Dutch Guiana. Of course, these gross amounts are only payable when the communication has been established and opened throughout. But that is not all. It is bad enough as it is, but the British Government comes in with a subsidised cable and insists on low rates for that cable. Of course, that again will compete with the systems already established and tend to the starvation of the telegraph companies doing business with these islands. The line which is to be subsidised by the British Government was originally projected for Imperial purposes to connect Bermuda and Halifax, but the Imperial purposes, as you see, owing to tariff stipulations, have become mixed up with commercial purposes. Therefore, we shall find ourselves also competing with this new cable, which will have a subsidy of £16,100 a year for connecting three stations only, whereas we, for connecting the whole of the West Indies, including Barbados, Trinidad, Demerara, Jamaica, and other islands, receive nothing whatever from the British Government. We have tried over and over again, on account of the services we have rendered, to obtain some acknowledgment from our own Government in the shape of a subsidy, but you see we were already on the spot, and had committed the error of going there before getting a subsidy. To crystallise all this, we have three competitors working for a traffic which has never been sufficient decently to support one. I do not know that I have anything more to say with regard to the business, but I am sorry to add that I think circumstances point to the probability of our having to make rather a large renewal. Our chord line has failed, and although we have attempted many times to repair it, so soon as we get it near the top it breaks. We have had our ship employed a long time upon it, and we have done our best to get it to the surface, but it parts before quite reaching there, and consequently we shall have to abandon it, or a large portion of it. It is not a very agreeable thing to have to recommend that we should spend money out of our reserve for making good this line, seeing the unsatisfactory results we are getting out of the cables; but, at the same time, we must either do that or see our business leave us. However inadequate the business we do may seem in our minds, I think we should do all we can to maintain our revenue, and also that we may continue to render the important services to the country and the Government that we have been enabled to do up to the present time, because I happen to know that, owing to certain circumstances, the services we have been at times able to render have been almost invaluable to the Government and to the country. If, hereafter, notwitstanding our efforts, the continuance of our system should be imperilled owing to the competition of these cables subsidised by the French Government and our own Government, then my opinion is that Mr. Chamberlain is not the man, nor our Government a government, to allow our important system to go under for want of support similar to that which the Government has accorded to the other Company I have referred to. It will be our duty to do our best to obtain such support. Hitherto we have always been able to go on. We have been threatened in this way ever since 1882, and in view of the falling-off in business in the islands, and increased competition and other causes of that sort, I think you will admit that we have been enabled to carry on the affairs of the Company very well. I may tell you we have mapped out our policy, and I think we shall be able to pursue it with success. We are not going to give in, as you may imagine. Threatened men live long, and we believe we shall, after all, be able to hold our own. Of course, if a revival of business occurred in the West Indies, everybody would benefit, and none of us, probably, would be complaining. What has really been at the bottom of all this up to the present time has not been competition. That I feel bound to say. What may be at the back of it by-and-bye may not be competition. The whole explanation is to be found in the miserable condition of the islands that we serve. Business is, as it were, gone, and unless something is done to remedy this, the cable companies relying on it cannot look for much improvement in their traffic. I now beg to move—

"That the Directors' report and accounts to June 30th, 1897, submitted to this meeting, be, and the same are hereby received and adopted; and that, as recommended by the board, dividends of 6s. per share on the first preference shares, 6s. per share on the second preference shares, and 1s. per share on the ordinary shares, the last free of income tax, be, and the same are hereby declared."

Mr. HENRY HOLMES seconded the resolution.

Mr. VEARS thought the Chairman might have avoided speaking of misfortunes until they occurred. The directors of this company had, in his opinion, always done their best, and he believed they would continue to do so.

Mr. LEA-SMITH asked what was the probable cost of repairing the chord cable.

The CHAIRMAN: That all depends on the mileage we may ultimately find it necessary to renew. I am afraid, however, that it will dip rather largely into our reserve fund.

Mr. VARLEY inquired the age of the cable?

The SECRETARY replied that it was 22 years old.

Mr. NEWTON asked who manufactured the cable?

The CHAIRMAN: Hoopers.

Mr. LEA-SMITH remarked that trade in the French West India islands was good. The French Government would not allow their colonies to be ruined by bounty-fed sugar.

Mr. GRIFFITH, after paying a tribute to the memory of the late Mr. Earle, said he thought the British Government ought to be severely censured for having done nothing to relieve the suffering in the West Indies, and secondly, for using the Imperial power in such a way as to ruin a

private trading concern by granting a subsidy to another company which should compete with it.

The CHAIRMAN, replying to a further question, said the reserve fund stood at £179,000, but he did not at all think the cost of repairing the chord cable would cost half that amount.

The resolution was then agreed to.

On the motion of Mr. NEWTON, seconded by Mr. GRIFFITH, the Secretary was instructed to send from the meeting an expression of sympathy with the widow and family of the late Mr. Earle.

A vote of thanks to the Chairman concluded the proceedings.

NEW COMPANIES, STATUTORY RETURNS, &c.

BEESTON MOTOR COMPANY (LIMITED).—This Company was registered on Nov. 3, with a capital of £110,000, in £1 shares, to acquire the business of motor carriage and machinery manufacturers now carried on by the New Beeston Cycle Company (Limited), and to carry on the business of manufacturers of motor and auto-propelled carriages, carts, vans and other vehicles, electricians, engineers, and machinists. The first directors are: Rowland Hill, C. W. Iliffe, and S. Gorton (managing).

ELECTRIC REDUCTION COMPANY (LIMITED).—This Company was registered on Nov. 5th, with a capital of £40,000 in £1 shares, to enter into an agreement with the Anglo-Continental Gold Syndicate (Limited), to work and develop certain processes for the electrolytic reduction of ores, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, electrical apparatus manufacturers, and workers of electrolytic processes. The first directors are:—A. W. Berry, A. Larsen, and E. Pears; and W. A. Williams and William T. Gibbs (managing).

POWER AND TRACTION (LIMITED).—This Company was registered on Nov. 8 with a capital of £10,000, in £1 shares, to carry on the business of an electric traction, power and lighting company in all its branches, electricians, mechanical engineers, electrical apparatus manufacturers, tramway proprietors, carriers, &c. The first directors are: Robert A. Smith and Arthur Hopkins.

PREMIER ELECTRIC LAMP SYNDICATE (LIMITED).—This Company was registered on Nov. 8th, with a capital of £30,000, in £5 shares, to enter into an agreement with Mr. Jacob Atherton, of Singleton, Huyton, Lancs., and to carry on the business of manufacturers of and dealers in lamps, wires, lines, and electrical apparatus of all kinds, electricians, mechanical engineers, suppliers of electricity, and the general business of an electric light company. The first subscribers are: James B. Atherton (manufacturer), Charles Petrie, J.P., Lloyd Higginbottom (engineer), Jacob Atherton (manufacturer), D. L. Chalmers, F. J. Leslie and A. E. Haptie.

WEYMERSCH ELECTRIC BATTERY SYNDICATE (LIMITED).—The annual return to Sept. 6 has been filed. The whole nominal capital of £20,000, in £5 shares, has been taken up, and 3,000 have been issued as fully paid. The full amount has been called and paid on the remainder.

WHITE, JACOBY AND CO. (LIMITED).—The statutory return to Sept. 17 has been filed. The capital is £4,000, in £1 shares. 2,357 shares have been taken up, and 2,350 have been issued as fully paid. No calls have been made on the others.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26⅝d. per oz. (Nov. 11). Consols (2¾ per cent.) 112⅜—112⅝ for money, 112 1/16—113 1/16 for account; 2½ per cent. 105¼—105⅜ (Nov. 11). Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Days, Nov. 24 and Dec. 13; Ticket Days, Nov. 25 and Dec. 14; Pay Days, Nov. 26 and Dec. 15; Mining Share Carry-over Days, Nov. 23 and Dec. 11.

BERLIN ELEVATED AND UNDERGROUND RAILWAY COMPANY (LIMITED).—The prospectus of this Company has just been issued, inviting subscription for 12½ million marks (the nominal capital) at 15 per cent. premium (less 4 per cent. interest to Jan. 1, 1898). The Company has taken over from the firm of Siemens and Halske the construction of an elevated railway in Berlin. We understand that the capital was promptly subscribed.

CALIFORNIA EXPLORATION (LIMITED).—Applications have been invited this week for £100,000 Seven and a-Half per cent. Cumulative Priority shares of £1 each in this Company. The total share capital of the Company is £500,000, in £1 shares. In May last the Company took over as a going concern the undertaking of the California Exploration Company, of San Francisco, U.S.A., and one of the contracts entered into by that Company was with the Blue Lakes Water Company, by which the latter undertook to erect a large electric power plant on the Monkelumne River. Under this contract the California Exploration Company has for 30 years the exclusive monopoly of furnishing power in Calaveras county from this source. The formal opening of the power station took place in August last, and the plant capacity is equal to over 6,000 H.P. Electric power is transmitted for a distance of 19 miles, 12 miles of which (the property of the Exploration Company) is already constructed. Two towns are now lighted from the station, and the prospectus states that the contracts for lighting will more than cover the running expenses of the whole of the plant. The Company also possesses extensive mining properties, to which electric power is to be supplied. Sir C. Rivers Wilson is a Director. The list closes to-day (Friday) at 4 p.m. for both town and country.

COMMERCIAL DEVELOPMENT CORPORATION (LIMITED).—We learn that letters of allotment and regret in the recent issue of this Company's shares have been posted.

DIRECT WEST INDIA CABLE COMPANY (LIMITED).—Letters of allotment and regret in the recent issue of this Company's shares and debentures have been posted.

ELECTRICAL OMNIBUSES.—Very little has been heard of late of the London Electric Omnibus Company. Reference was, however, made at a meeting of the Colonial Assets and Investment Company (Limited) on Wednesday to the effect that the latter owned a one-sixth interest in the Ward accumulator, and it was stated that the Company, which has been formed in London (the London Electric Omnibus Company) for the purpose of working this accumulator has completed the construction of three omnibuses, but its Directors have decided that, until the Company has a sufficient number to run on the streets, it will not commence a regular service of electric omnibuses.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company in October, 1897, were £24,400, and the total receipts from Jan. 1 to Oct. 31, £228,000, against £237,600 and £261,600 in the corresponding months of 1896 and 1895 respectively.

HEADLAND'S PATENT ELECTRIC STORAGE BATTERY COMPANY (LIMITED).—The capital of this Company has been increased from £15,000 to £20,000 by the creation of 5,000 new shares of £1 each.

MASCHINENFABRIK OERLIKON.—This Company has declared a dividend of 20 per cent. for the year 1896-97, compared with 17½ per cent. in the previous year.

RAND CENTRAL ORE REDUCTION COMPANY (LIMITED).—A satisfactory report is issued by the Directors of this Company for the year to 30th June last, in which a net profit of £21,273. 7s. 8d. is shown. After writing off nearly £11,000 for depreciation and putting nearly £3,500 to reserve a dividend of 10 per cent. on the ordinary shares is declared. The Company are closely identified with the "Siemens" ore reduction process which was recently formed into a limited company under the name of the Gold Patents Company (Transvaal), Limited. The success of this process is described in the report as having far exceeded expectations.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have appointed Wednesday, the 17th inst., a special settling day for the provisional certificates for £150,000 Five per Cent. registered "B" Debentures of the Tramways Union Company (Limited), and have ordered these securities, as well as the further issue of 5,000 shares, Nos. 45,001 to to 50,000, of the Company, to be quoted in the official list. Application has also been made to the Committee to appoint a special settling day in, and to grant a quotation to, the provisional certificates for 8,000 Ordinary shares of the Chelsea Electricity Supply Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Nov. 5 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,739.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Nov. 6	3,511	+388	...	...	...
Bristol Trams & Carriage	„ 5	2,545	+616	18	48,574	+6,663
City & South London Ry.	„ 7	1,041	+ 5	19	17,580	− 167
Dover Tramways	„ 6	103	...	9	1,140	...
Dublin United (Southern)	„ 5	489	+ 47	18	13,316	− 560
Liverpool Overhead Rly.	„ 7	1,341	+276	19	27,430	+3,763
Sheffield Tramways	„ 7	936	+133	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Nov. 3.		Price Wednesday, Nov. 10.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 6.	
								£ s. d.		Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.								
£12,126	£10	3/0	Central London Ordinary	9⅝	10¼	9⅝	10¼	2 17 2	June and December	..	..
143,906	10	1/3	Do. (6 paid)	5⅛	5	5⅛	6	3 0 0	„ „	5⅛	..
£500,000	Stock	2	City and South London Railway Con. Ordy.	69	71	69	71	2 12 10	January and July	70⅛	69⅛
8,419	£10	5%	Do. 5% Perpetual Preference	15½	15⅝	15½	15⅝	3 4 6	„ „	..	..
£128,701	Stock	4%	Do. 4% Perpetual Debenture	137	139	138	140	2 17 2	May and November	..	..
64,000	10	1/4⅔	Waterloo and City Ordinary	12⅜	13½	12½	13	2 6 1	June and December	..	..
25,000	10	3	Liverpool Overhead Railway Ordinary	11⅜	11½	11½	11⅝	2 11 7	February & August	..	..
10,000	10	5%	Do. 5% Preference	16	16½	16	16½	3 0 7	„ „	..	..
150,000	Stock	4%	Do. 4% Debenture	110	113	110	113	3 11 6	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 3.		Price Wednesday, Nov. 10.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 6.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£923,960	Stock	14/0	Anglo-American	57	59	57	59	4 13 3	Feb., May, Aug., Nov.	..	..
£3,038,020	Stock	23.0	Do. Preferred	104	105	104	105	5 6 6	" "	105	104
£3,038,020	Stock	5/0	Do. Deferred	12	12¼	12⅜		..	" "	..	12⅜
£137,400	£100	4%	*African Direct Telegraph (Red)	101	105	101	105	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	5½	6¼	5½	6½	..	" "	..	..
130,000	10	5,0	Brazilian Submarine	16	16½	16	16⅛	4 4 10	Mar., June, Oct., Dec.	16⅜	15⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	114	118	114	118	4 5 10	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	183	183	185	190	4 4 3	Jan., Apr., July, Oct.	187	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105	107	105	107	3 14 9	" "	106⅜	105⅞
16,000	10	8/0	Cuba Submarine	8½	9½	8½	9½	8 8 5	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18½	19½	18½	19½	5 2 7	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10½	10⅝	10½	10⅝	5 12 8	Jan., Apr., July, Oct.	10⅛	10⅝
400,000	£10	2,6	Eastern	16⅜	17¼	17	17⅜	3 14 4	" "	17⅛	17
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18	19	18	19	3 3 8	" "	18⅛	18⅛
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	130	133	131	134	2 19 9	May and November	132¼	131½
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 14 9	February & August	..	..
250,000	10	2/6	Eastern Extension	18	18½	18	18⅛	3 17 9	Jan., Apr., July, Oct.	18⅜	18⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	130	134	130	134	3 0 0	February & August	133	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	100	104	100	104	4 17 4	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	100	104	100	104	4 17 4	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103	106	103	103	3 15 8	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	109¾	112¾	108¾	111¾	3 12 1	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	11½	12	11½	12	3 15 0	Jan., Apr., July, Oct.	11⅞	11⅝
180,042	10	6%	Do. 6 per Cent. Preference	17	17⅛	17	17½	3 8 7	" "	17⅝	17½
150,000	10	5/0	Great Northern of Copenhagen	26½	27½	26	27	3 14 1	January, April, July	26⅛	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	102	105	102	105	4 15 3	March & September	..	..
17,000	25	12/3	Indo-European	53	56	53	56	4 9 3	May and November	53½	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	107	110	107	110	5 9 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	107	110	107	110	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	136	141	136	141	4 5 1	" "	137½	..
15,609	10	6/0	West African Telegraph	4½	5½	4½	5½	5 0 0	.. ..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 14 4	March & September	105½	104½
30,000	10	2/0	West Coast of America	¾	1¼	¾	1¼	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	103	106	108	3 14 10	June and December	..	..
88,321	10	-/6	West India and Panama	¾	1	⅝	⅞	..	May and November	..	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½	10½	9½	9⅜	6 3 6	" "	10	9½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	9¼	9⅜	9	9½	3 3 0	May and November	9⅝	9½
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	8	7½	7⅜	3 17 4	" "	7⅝	7½
33,129	7½	1/6	Do. Deferred Ordinary	2¼	2⅜	2	⅞	..	" "	2½	2⅜
£387,250	..	4%	Do. 4 per Cent. Debenture Stock	106	109	105	109	3 14 1	June and December	106	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	103	107	103	107	6 10 10	Feb., May, Aug., Nov.	..	..
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3½	3⅞	3½	3¾	5 6 8	August	..	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	..	..
484,597	5	3/0	National	6½	6⅝	6½	6⅝	4 14 1	February & August	6½	6 7/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 10 7	" "	16	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	15	17	14	16	3 15 0	" "	14 5/16	14½
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6	6½	6	6½	3 16 11	" "	6½	6 7/16
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104	109	104	109	3 5 0	June and December	106½	104
171,504	1	0/4	Oriental	1/16	1/8	1/16	1/8	4 2 4	April and October	⅛	..
58,000	5	5/0	United River Plate	3¾	4¼	3¾	4¼	5 17 8	July	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	107	102	107	4 14 4	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.								
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	12	..	12	..	..	March	..	..
£50,000	5	..	Do. (New Issue) £3. 10s. paid					..	..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	25	26	25	26	2 13 10	February & August	25½	25
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17	18	17	18	3 6 8	January and July	17⅞	17 5/16
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131	134	131	136	3 14 3	June and December	..	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12	13	12	13	2 0 0	February & August	12 7/16	..
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 6 8	" "	6⅞	6½
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)						January and July	..	..
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	10	10½	10	10½	3 11 5	March	10½	10⅜
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	110	113	110	113	3 19 8	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	12⅜	13½	12⅜	13½	..	..	12 5/8	12⅜
20,000	£10	6%	Do. 6% Cumulative Preference	15½	15⅞	15½	15⅝	3 16 2	March & September	15⅝	..
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9	9½	9	9½	..	..	9¼	..
10,000	£5	7%	Do. 7 per Cent. Preference	10¾	11¼	10⅜	11½	3 2 1	March & September	10 7/8	..
111,000	£5	..	London Electric Supply Ordinary	2	2¼	2	2⅛	..	..	..	..
48,050	£5	..	Do. Preference	4⅜	5	4⅜	5⅛	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	17½	18½	17½	18½	2 19 6	April and October	..	..
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	17	18	17	18	..	" "	..	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119	123	119	123	3 13 6	June and December	..	..
6,452	10	8/0	Notting Hill Electric Ordinary	15	16	15½	16½	2 8 2	March	15½	15⅝
275,000	1	..	Rand Electric	1½	1⅝	1 1/16	1 3/16	..	..	..	..
£125,000	Stock	..	River Plate Elec. Lt. Tr. ct'n, Ltd., 5% 1st Mor. Deb.	93	98	93	98	..	..	..	..
150,000	$100	..	Royal Electric Company of Montreal Shares	148	150	148	150	..	..	105	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	103	105	103	105	4 5 9	April and October	..	..
19,980	5	3,6	St. James and Pall Mall Electric Ordinary	16	17	16	17	3 7 8	February & August	16⅝	16 7/16
20,000	5	3/6	Do. 7 per Cent. Preference	6½	10½	9½	10½	3 6 8	" "	..	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	103	106	103	106	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	14½	15½	14½	15½	3 4 0	March & September	15	14 13/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	1/6	Brush Electrical Engineering	1½	1⅝	1½	1⅝	..	..	1⅝	..
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	1 7/8	2⅛	1⅛	2⅛	..	..	2	1 15/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	107	111	107	111	4 1 8	February & August	109½	109
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	98	102	98	102	4 9 7	June and December	..	..
10,000	£10	..	British Aluminium Ordinary					..	..	..	..
20,000	10	..	Do. 7% Cumulative Preference					..	..	..	..
20,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7	8	7	8	3 15 8	June and December	..	..
£99,000	Stock	4½	Do. 4½% Mort. Deb. Stock	108	113	103	113	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½	1⅝	1½	1⅜	..	..	..	..
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	..	1½	..
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	89	94	89	94	5 6 5	January and July	..	..
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½	2⅝	2½	2⅝	6 0 0	February & August	2 5/16	..
17,139	5	2/9½	Do. (£5 paid)	4	5	4	5	5 10 0	" "	..	..
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101	103	101	103	3 17 8	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2	2⅛	1⅞	2⅛	4 13 10	February & August	2	..
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3⅝	3½	3⅝	4 3 4	August	2 5/16	..
91,196	1	10/0	Elmore's Patent Copper Depositing	½	½	½	½	..	..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	19½	20½	19½	20½	4 15 3	February & August	20½	19½
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 12 0	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 10	" "	113½	..
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21⅝	21½
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	103	107	3 14 9	March & September	105	..
37,350	12	12/0	Telegraph Construction and Maintenance	36	39	36	39	4 12 4	March and July	36½	..

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NOTES.

Prof. E. B. Rosa, of America, commences in our issue this week a description of his electric curve tracer, an instrument which captivated Section A at the recent meeting of the British Association at Toronto. Of the numerous devices for graphically representing or recording alternating-current wave-forms and allied electromagnetic periodic functions, we do not think that any surpass Prof. Rosa's automatic tracer in regard to promptness combined with accuracy of record. Others there may be that are more accurate, but these do not make a permanent record, but only a transient luminous trace of the varying function; while others, again, which are designed to produce a permanent diagram, are objectionable on the score that they necessitate hand adjustments, requiring too much time, and thereby they prolong the operation of plotting a complete curve and increase the risk of its being inaccurate. In a later portion of his article Prof. Rosa will give a number of examples of curves plotted by his automatic tracer, and these will be found interesting, not only in relation to the process of drawing them, but also because they teach some useful lessons about the machinery by which the waves that are recorded were generated.

An interesting and suggestive Presidential Address was given on Wednesday by Mr. J. Sinclair Fairfax before the Society of Patent Agents, on "The Classification of Patents in Relation to a Preliminary Search for Novelty and Patent Law Reform." After reviewing and comparing the British and American systems of procedure in granting patents and in their classification, Mr. Fairfax showed that although, perhaps, the United States system of instituting an official search before granting a patent is theoretically the ideal one, practically it is rapidly becoming unreliable, as affording to an inventor a false criterion of the validity of his claim. In consequence of the vast accumulation of records with which the Office has to deal, unless the system is soon modified in some restrictive manner it is probable that it must ultimately break down under its own weight. Meanwhile, the sense of security hitherto felt in the possession of a United States patent must be shaken. It seems better, therefore, to content ourselves with our own system, with its advantages and admitted disadvantages, rather than to adopt a less practical one. Mr. Fairfax advocates the institution of an index museum of models, in which devices performing similar functions would be placed together, no matter to what use applied; and he further suggests that, "if, by a reform in law and procedure, the Patent Office were to assign an invention to one or more special classes, and the patentee allowed to restrict his invention to the same, or even to a special subdivision of a particular class, it would relieve him from much of the danger involving patents"; and, further, "if it should enact that a new manufacture is one that has not been worked or freely published during the last 25 years, it would probably lead to a revival of many industries"—which would, indeed, justify the granting of a monopoly, restricted as it would be to the special application of the revived invention.

It has been resurrected—that wonderful scheme of bygone years to generate electrical energy on the coalfields and distribute it instead of coal! The General Power Distributing Company, having negotiated with the British Thomson-Houston Company, has given notice of its intention to apply to Parliament for power "to find a market for the product of an almost untapped inland coalfield by the manufacture of electricity." The project is in reality being got up by a number of colliery proprietors and coal-owners. With "the north-west corner of the parish of Warsop" for centre, and at a radius of 25 miles, the Company proposes to describe a circle within which it will supply electric power generated in its central station. Particulars are not yet forthcoming in regard to the precise conditions of generation and

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distribution. As regards costs and the prospects of success, these are largely a question of coal *versus* copper. The project has been likened to the Niagara utilisation scheme, but there is a vital difference between them. At Niagara, if the power were not converted into electricity on the spot, it could not be utilised at all at a distance, say, at Buffalo; whereas the electric energy obtained from a central station on a coalfield may have to compete at the far end of the line with coal freighted by rail or canal from identically the same coalfield. It remains to be seen whether the General Power Distributing Company can sell its energy at a profit under such conditions. We sincerely hope it can, for the general outline of the project is decidedly moderate and reasonable in tone, and wears none of that ambitious impracticability of former schemes—such, for example, as that which proposed to supply all London with electric power generated in the Midland counties.

In the years which are following the great rush for electric traction in America a healthy progress and a notable extension of the industry are being shown. From a detailed table recently published by the *Street Railway Journal*, of America, we gather the following data, which may serve to indicate in a general way the progress made during the past year. At the end of 1896 there were 916 electric roads in the United States and 30 in Canada, representing 12,133 and 450 miles of track respectively. At the end of last October there were 953 electric roads and 13,765 miles of track in the United States, and 32 roads and 498 miles of track in Canada; figures which represent an increase of 13·4 per cent. and 10·1 per cent. respectively in the total mileages of track. These increments to a considerable extent arise from the conversion of cable and horse lines into trolley and other electric lines. Thus, the mileage of cable lines in the United States has declined 10 per cent., from 599 to 540 miles; while the mileage of horse lines has decreased from 1,219 to 947, or as much as 22 per cent. It may be of interest to state that there are now 29,659 motor cars on the United States electric roads.

Corresponding improvement is shown by the financial statistics of these concerns, of which we may cite a few examples. At the end of last year the United States electric railways and tramways represented a capital stock of £157,000,000, a funded debt of £118,100,000, and capital liabilities amounting to £275,100,000; whereas the capital stock at the present time represents £169,400,000, the funded debt has swelled to £126,600,000, and the aggregate of existing capital liabilities is £296,000,000. These capital increments, taken as aggregates, seem to be quite healthy, although no doubt the average healthiness has been lowered by the sickliness of some few individual concerns. Thus, as regards the question of capital and liability *per mile of track* it is satisfactory to find a decline, slight though it be, in each of the totals under the three heads enumerated.

In our issue this week will be found the first of a series of descriptive and critical articles, from the pen of our Special Correspondent, who recently made an extensive tour through the United States and Canada on behalf of this paper. Our correspondent deals in his initial communication with the Boston tramways subway, and we are sure that readers who have followed our notes on the subject will be glad to have the connected and well-illustrated account of this characteristic piece of American engineering which his article affords. There is a notable difference between the subways and tunnels of American cities and those in this country, the cause of which largely lies in the essential difference in the favourite modes of city and suburban travel. On our side of the Atlantic the problem of convenient and rapid transit in cities has been solved by the railway train; in America by the tramcar. Naturally, when a system of tramways must be put underground, the tunnel is built as close as possible to the surface; while for regular trains, stopping only at fixed points, a deeper level is permissible. In future articles our correspondent will deal with several interesting examples of engineering work, and it is intended that these articles, taken as a whole, shall form a comprehensive survey of typical American practice.

Plotting curves has been hitherto an occupation more commonly practised by the engineer and the scientist than by the accountant, at any rate on this side of the Atlantic. In some American engineering works we have visited every item is duly plotted in its appointed curve, and the progress of details—whether of financial or technical affairs—may be seen at a glance. The advantage over columns of figures lies in the possibilities of the glance, possibilities unknown even with the best dissected figures; but, like most advantages, it is purchased at a sacrifice, for diagram accounts cannot carry that absolute accuracy which occurs in well-kept figures.

Advocates of diagram accounts, however, do not generally desire that these should supplant the day-books and ledgers and other entries of revenue and expenditure, but that they should serve as a graphic supplement to them. It is so much easier for the head of a department or a member of the firm to see where his business is drifting, and to compare the drift with past history, when a set of curves comprising the fluctuations of every detail confront him. Not one-tenth of the people who watch the barometer reports in the newspapers would do so if, instead of curves, merely a table of half-hourly readings were printed. The case for diagram accounts in engineering works has recently been ably stated by Mr. J. Jameson, in a Paper read before the Institution of Mechanical Engineers, an abstract of which we reprint this week.

The development of the electrolytic soda industry seems to be proceeding with satisfactory rapidity. Attention may be directed to the measure of success attained by the Castner-Kellner process, and to the approaching flotation, on a large industrial scale, of the Hargreaves-Bird process at Middlewich, in Cheshire. We also note the formation of a French company—the "Société des Soudières Electrolytiques"—with a capital of 3,000,000 francs, and head offices at Grenoble, which purposes working the Hulin process for the electrolytic production of alkalies and chlorine. This process has been working for a considerable time upon a small industrial scale at the paper works of MM. Matrussière fils et Forest,

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at Modane, in Savoy, and this 120-H.P. plant has been sufficiently successful in operation to justify the commencement of operations upon a still greater scale. The Hulin process is dependent upon the use of fused lead as cathode, and of fused salt as the electrolyte. It is a modification of a process known as the Vautin process, which was tried experimentally a few years ago in this country near Manchester. The works that are now being built by this French company are to derive their electrical energy from a water-power of 5,000 H.P., and they are expected to be in operation in the early part of next year.

Obituary.—We regret to announce the death, at seventy-seven years of age, of Sir Henry Doulton, head of the well-known firm of Messrs. Doulton and Co., of Lambeth.

British Association.—Sir William Crookes has been elected President of the British Association meeting to be held at Bristol next year, commencing on September 7th.

Helium.—A lecture will be delivered next Tuesday evening at 8:30, at the Royal Victoria Hall, S.E., by Prof. W. Ramsay, F.R.S., on "The Gas Helium, and How it Was Discovered."

Royal Institution Christmas Lectures.—A course of six lectures, specially adapted to young people, on "The Principles of the Electric Telegraphs" will be delivered by Prof. Oliver Lodge at the Royal Institution. The first lecture is fixed for December 28th next, and the rest of the series will be on December 30th, January 1st, 4th, 6th and 8th, 1898.

The Central London Railway.—We are informed that the British Thomson-Houston Company have acquired the English patent rights for the gearless motor invented by Prof. S. H. Short, and that they intend to use this type on the locomotives of the Central London Railway. This spring-suspended gearless motor has been used during the last two years on the electric locomotives of the Baltimore and Ohio Railroad.

Dover.—In connection with the scheme for improving the mail service between London and Paris, it has been decided to erect electric and steam cranes at Dover and Calais for the purpose of expediting the transfer of mails and baggage to and from the steamers. The London, Chatham and Dover Railway Company and the Dover Harbour Board propose to build a large joint station at an estimated cost of £100,000. To carry out the scheme a portion of the line of the Dover electric tramway will have to be diverted.

Cable Interruptions and Repairs.—

	Date of Interruption.		Date of Repair.
Obidos—Parintins	Dec. 7, 1896	...	—
Hong Kong—Macao	Sept. 28, 1897	...	Nov. 9, 1897
Cayenne—Pinheiro	Sept. 29, 1897	...	Nov. 17, 1897
Otranto—Vallona	Oct. 11, 1897	...	—
Santarem—Alemquer	Oct. 21, 1897	...	—
Paramaribo—Cayenne	Oct. 25, 1897	...	—
Cadiz—Teneriffe	Oct. 26, 1897	...	—
Santiago de Cuba—Guantanamo	Oct. 29, 1897	...	Nov. 9, 1897
San Thomé—Loanda	Nov. 8, 1897	...	—

Wiring Rules.—The last number of the *Bulletin de la Société Internationale des Electriciens* contains a collection of the wiring rules of different countries. The regulations of the Verband Deutscher Elektrotechniker for high and low-tension are given, the regulations of the Austrian Electrotechnical Society, the Belgian rules for electrical installations in mines, the "National Electric Code" in force in the United States, and finally our Board of Trade regulations, the St. Pancras Corporation's rules relating to wiring, and finally, the new rules recommended by the Institution of Electrical Engineers. A set of French rules has been submitted to a commission of engineers and electricians chosen by the Minister of Posts and Telegraphs, but these official rules have not yet been published.

Water-power Utilisation in Norway.—A waterfall of considerable size, and hitherto unexploited, has been discovered in Norway for our enterprising contemporary the *Zeitschrift fur Elektrochemie*. It compares favourably with some other Scandinavian natural sources of power, such as the Sarpsfoes, where 10,000 H.P. are used by the Kellner-Partington Co., and 20,000 H.P. by Schuckert and Co., and Trollhätten, some 50 miles from Gothenburg. The newly announced fall is on the Flekke Fiord, at the south-west corner of Norway, and is immediately accessible to ocean-going ships; a saving in freight as compared with the water-power at Sarpsfoes and Trollhätten would thus be secured. About 30,000 H.P. is said to be available.

The New Brest—St. Pierre Cable.—We much regret to learn that the c.s. "Silvertown" has been compelled to return to Calais, and that there is no likelihood of this cable (which is being laid for La Compagnie Française des Câbles Telegraphiques) being completed this year. A portion of the cable has already been successfully submerged, and the "Silvertown," with the remainder of the cable on board, proceeded to splice on to the cable already laid and complete the work. Everything possible was done to successfully carry out this operation, the work extending over a period of about three weeks, but the vessel has, we are informed, unfortunately been compelled to abandon the work for the present. With winter upon us, we much fear that no further operation can be attempted until the spring. This must be a great disappointment to France and to the Compagnie Française.

The Use of Batteries on Trolley Circuits.—An interesting exhibit at the Convention of the American Street Railway Association, at Niagara Falls, N.Y., was made by the Electric Storage Battery Company, for particulars of which we are indebted to the *Western Electrician*. This exhibit was designed to show the application of storage cells at the end of a feeder on a trolley line, and 55 Chloride accumulator cells had been installed on a model feeder system at 110 volts, together with the necessary measuring ammeters for indicating the variation of current in the battery, feeder and trolley circuits. With a variation in the demand of the latter of from zero to 200 amperes the variations in the feeder were less than 70 amperes. The advantages accruing from this system in the way of regulation of pressure, possibilities in extension of lines and saving in feeder copper were, it is stated, appreciated by many street railway men who inspected the exhibit.

Refuse-Destructor Work in America.—The *Engineering News* of New York is responsible for the information that the five-year refuse destruction contract for Chicago has been placed at £50,054 per year, and that it is reported that the English type of refuse-destructor, "with provision for utilising the heat," similar to the Shoreditch Vestry plant, is to be installed. The report is also given of the Committee of the American Public Health Association on the Disposal of Garbage and Refuse. The concluding paragraph of this report is as follows:—"The experience and results now before your Committee indicate that the English pattern of cell furnaces with sloping ante-chamber for a preliminary drying and heating of the garbage gives more economical results than the large and level American furnaces. It also plainly indicates that a skilful construction of the entire plant and skilful operation, requiring special training of the firemen, are prime requisites to obtaining successful results."

The Heilmann Locomotive.—A successful trial trip was made by the Heilmann electric locomotive on Friday last, on the railway between Paris and Mantes. The train was composed of 12 first and second class carriages and a luggage van. About 250 persons were in the train, which weighed about 150 tons. The object was not to make a trial of speed. Such trials are to be made later on, and are to be combined with a progressive increase in the weight of the train. The train went at the low speed of 18 miles an hour, but the electric locomotive will shortly be called upon to draw trains of 200 tons at a speed of 25 or 30 miles an hour, and then of 225 tons at a speed of 37 or 43 miles an hour, with the object, it is stated, of finally reaching a weight of 300 tons with a speed of 62 miles an hour. This latest experiment has unquestionably demonstrated the ease and regularity of the movement of the Heilmann system of drawing a train. There was a very appreciable and agreeable diminution of jolting and rocking, and much less noise.

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Telegraph Experiments in India.—The Administration Report of the Indian Telegraph Department gives the following particulars of some experiments in simultaneous Morse and vibrator working on a single wire:—

The experiments of simultaneous Morse and vibrator working over a single wire are still going on. A considerable step in advance was made towards the close of the year by an ingenious system devised by Mr. C. P. O'Reilly, sub-assistant superintendent in charge of the Agra telegraph office. By this arrangement the vibrator currents were enabled to actuate an ordinary relay, instead of a telephone, and so, not only can the operator's attention at the distant end be at once attracted, but the messages can be written down from audible signals on an ordinary sounder, without its being necessary, as heretofore, to hold a telephone to the ear for the purpose. A large number of messages were transmitted between Agra and Delhi by this system towards the end of the year without interfering with the ordinary traffic on the wire; the results are very promising of further success in the future. It was also discovered that when a wire along which these vibratory currents were being sent was actually broken the currents were still received with scarcely diminished force if there were other wires on the posts, since, by their peculiar inductive action on neighbouring wires, the gap was effectually bridged over without the slightest interference with the legitimate currents passing along those neighbouring wires.

Brave Telegraphers and the Bombay Plague.—The following extract from a report on the plague—so far as it affected the working of the Central Telegraph Office, Bombay—by the Superintendent in charge of the office, is taken from the Administration Report of the Indian Telegraph Department:—

From the end of August to the end of the year under report Bombay has suffered most severely from an outbreak of the bubonic plague, and I cannot speak too highly of the way in which the whole signalling and clerical staff, with the exception of a few Goanese clerks, have stuck to their work, and carried out their duties cheerfully. This is the more meritorious as many of the signallars and clerks are living in the most infected areas, with plague all around them and at their very doors, and many of them have lost several near relatives from the prevailing disease, so that it would have been excusable if they had given way to panic. I regret to have to report that two signallers, viz., F. Murray and R. D'Souza died from the disease, and many of the peons and menials, my own personal peon among the number. Every care has been taken to keep the disease actually out of the office buildings and signallers' quarters; once a week the whole of the buildings have been thoroughly washed with a solution of phenyl, and chloride of lime placed in pans at short intervals. The only case that has occurred was the assistant messman, who was taken ill in the signallers' quarters, and was removed to the hospital, where he died. During the month of January considerable inconvenience was felt owing to the death or desertion of many of the delivery peons.

Another Italian Three-Phase Traction Plant.—An American contemporary states that a three-phase railway system will be installed between Varese and Luino, in Northern Italy, near Milan, by the French Thomson-Houston Company. The distance between the two places is 16¾ miles, with a branch of 3·1 miles. There are two main grades—a long one of 4½ per cent. on which a speed of 21¾ miles per hour is called for, and a shorter grade of 7½ per cent. up which the cars must travel at 12·4 miles per hour. There will be one central station, containing three-phase generators directly connected to the turbines. The line voltage will be 6,000, with a frequency of 45 cycles, which will be stepped down by stationary transformers placed on the poles, to the usual railway voltage of 550, at which pressure it will be fed to the twin trolley wires and track. Eight trains composed of three cars will be run, which will have a total weight of 26 tons, including two 70 H.P. iron-clad three-phase motors, which will be guaranteed to meet all requirements. The contract allows about a year for completion, and all machinery will be manufactured by the General Electric Company at its Schenectady works.

An Electrically-Driven Tea Factory.—We learn from the *Indian and Eastern Engineer* that the British Darjeeling Tea Company is the first tea factory to introduce electric power for driving their plant. The Thurbo Tea Estate, which is owned by the Company, covers over 3,000 acres, extending from the Mechi river (one of the Nepal boundaries) to the Rungbong river. The factory is situated at one mile from the latter river, at an elevation of 4,000ft. The water, taken from the Rungbong river, is led by a substantial waterway of masonry to a point where a fall of 56ft. is obtained; from this point 16in. steel pipes convey the water to a 40 H.P. Jonval turbine built by Messrs. W. Gunther and Co. To this turbine is connected, by belt and pulley, a Mather and Platt "Manchester" dynamo capable of generating 70 amperes at 320 volts. The current is transmitted by overhead copper wires to the factory, where it drives a Manchester motor capable of developing 24 B.H.P. The machinery driven comprises two tea driers, two tea-leaf rollers, one tea packer, two tea sifters, and one tea cutter. The electric lighting is effected from the same mains. Our contemporary points out that, owing to the stringency of the Forest Department, firewood is difficult to obtain in the Darjeeling district, and coal has to be brought from afar and is dear.

A Novel Electric Boat Propeller.—We had an opportunity last Wednesday of seeing a new development in the design of electrically-propelled pleasure craft, which has been given the name of the "Nymph." Briefly, the "Nymph" is an attachment to an ordinary pleasure boat, sailing ahead of it but rigidly connected to it, the boat containing the accumulator cells and the switch-gear by which is controlled the motor in the body of the swan-shaped tug. The craft is guided or steered by two reins attached to the head of the "swan," and these reins actuate by gear the ordinary rudder. A regulator situated close to the right-hand of the driver enables him to control the speed of the motor and propeller in the "swan," and to go at full or half-speed, ahead or astern. There are 16 chloride cells of 17 plates each, and these, for starting and low speeds, are connected to the motor in two parallels of 8 cells each, all the cells being used in series for full-speed. The total electrical capacity of the battery is about 300 ampere hours, and this is equal to propelling the boat at a speed of eight miles an hour for six hours, or a total distance of about 50 miles, with six people on board. No resistances are used, and neither the field nor the armature is divided up in any way to regulate the speed. The vibration of the boat is perceptibly less than in one containing the motor. Although the arrangement lends itself to graceful design, there is probably considerable loss of efficiency as compared with the usual stern propeller. The inventor of the "Nymph" is Mr. Bowick.

"Spark Telegraphy" in Germany.—Prof. Slaby delivered a lecture on "Spark Telegraphy" before the German Society for the Advancement of Industry on November 1st. In the first instance he objected to the terms "telegraphy without wires," "radiator" and "coherer"—to the latter two because they were words of foreign origin. He used "spark-telegraphy" as the title of his lecture, and proposed the "good German words" Strahlapparat (ray apparatus) for radiator, and Fritter or Frittröhre for coherer. Prof. Slaby then described large-scale experiments he had made himself near Potsdam over distances of from one to two miles, and others over a distance of 13 miles between Schöneberg and Rangsdorp. From his systematic experiments he found that obstacles such as trees, buildings and hills considerably hinder the propagation of the waves, and are especially disturbing when in the neighbourhood of the transmitter or receiver. Contrary to Capt. J. N. C. Kennedy's experience (see *The Electrician* of October 29th, p. 22), the Professor finds that the length of the wires at the terminal stations is all-important, and that the height to which they are led is, within certain limits, of secondary importance. The lecturer stated that he had found that the dust in the air also tended to impede transmission, for whereas on the English coast signals were transmitted over distances 200 times as great as the length of the charged wire and at Spezia 500 times, this figure only reached 70 to 100 in dusty Brandenburg. Prof. Slaby also found that he obtained better results if, instead of Marconi's fairly thick wire, ending in a flat sheet or cylinder of copper, he used quite thin insulated wire of low electrostatic capacity, ending quite freely in the air. In the 13-mile transmission above referred to, a 4mm. wire with thick cotton insulation and 330 yards long, attached to a captive balloon, was successfully employed after unsuccessful trials had been made with a two-wire telephone cable of the same length. Prof. Slaby also mentioned the disturbing influence of atmospheric electricity. Finally, he stated that wires running in the same direction as the waves very considerably increase the possible distance of transmission, and he showed an experiment in which he used the same wire for simultaneous wave and current telegraphy.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

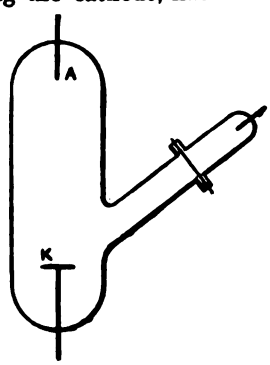
Resistance Determined by Screening Effect.—According to J. J. Thomson, the screening effect produced by a layer of electrolyte introduced in the path of electric waves is proportional to the thickness of the layer, and to the conductivity of the electrolyte. J. A. Erskine has employed this law to determine the specific resistances of various electrolytes. The oscillator, consisting of a ring with two gaps, of 1mm. and 2cm. respectively, was immersed in an evaporating dish filled with petroleum. The dish was surmounted by another dish with a flat glass bottom, containing the similarly-constructed resonator immersed in the electrolyte to be studied. The screening action was observed, not by observing the sparks of the resonator, but by inserting a small demagnetising coil in the small gap of the latter, and observing the demagnetising action of six successive sparks traversing the coil upon a test needle, as indicated by a magnetometer deflected by it. The waves used were 170cm. long in petroleum. The resistances were all referred to a NaCl solution of density 1·109 at 18deg. The resistances thus found are practically the same as those found by Kohlrausch for continuous currents. They range from 0·26 (arbitrary units) for HCl of density 1·049 to 3·41 for $NaC_2H_3O_2$ of density 1·051. A layer of water 1·2cm. thick produced no discernible screening action.

[Erskine, *Wied. Ann.*, No. 11, 1897.]

Screening by Luminous Gases.—That luminescent gases absorb the radiations which make them glow is rendered *a priori* probable by the fact that whenever an electrodeless tube is excited to luminosity it is just those parts nearest the source which glow most intensely, the other parts being screened by the luminous layer. But E. Wiedemann and G. C. Schmidt have demonstrated the existence of this absorption in more well-defined cases. They placed an exhausted vacuum tube against the terminal condenser plates of a Lecher wire system, and provided it with electrodes to carry a continuous current from a high-voltage battery. They found that in many cases where the tube without the current failed to screen another small electrodeless tube from the exciting action of the waves, the small tube was completely screened on passing the current through the larger. The dark space next the cathode did not screen, but the positive light column did. The authors next tried whether flames exercised a similar screening action. A fish-tail burner and a Bunsen burner, dark or glowing with Na or Li salts, were tried, but no screening effect was obtained from them. It was found, on the other hand, that luminous gases in a vacuum tube are capable of screening the knob of an electroscope from the influence of a rubbed glass or ebonite rod. This effect is probably due to charges on the glass walls produced by "transverse currents" or partial discharges across that part of the potential gradient between the rod and the knob which lies inside the tube.

[Wiedemann and Schmidt, *Wied. Ann.*, No. 11, 1897.]

Canal Rays.—Goldstein's first cathode layer, obtained as distinct "canal rays" by perforating the cathode, has been studied with improved apparatus by E. Wiedemann and G. C. Schmidt. Instead of endeavouring to fit the perforated cathode tightly into the tube, they fused two tubes together end to end, with a piece of wire gauze or grating stretched across between them as a partition. On using this grating as a cathode, and an electrode at the end of one of the tubes as an anode, canal rays were obtained in the other tube. Or, better still, two successive partitions were made, and two anodes were mounted at the ends, thus obtaining the canal rays in the space between the two partitions. This space, when filled with canal rays, was found to possess peculiar properties. Like the glowing gas referred to above, it screens other sensitive tubes from the action of electric waves. The canal rays also reduce the discharge potential between the two cathode gratings, as was proved by mounting a spark gap in parallel with them. This reduction also takes place when canal rays impinge upon the front of the cathode. This can be shown by means of the apparatus shown in the diagram, which produces canal rays impinging upon K_1 and reducing the spark potential between K and the anode A. Canal rays also facilitate transverse discharges across the thickness of the tube, whether proceeding from an influence machine or from a battery.



[Wiedemann and Schmidt, *Wied. Ann.*, No. 11, 1897.]

Ionisation and Osmotic Pressure.—J. Traube advocates some rather daring and revolutionary ideas with regard to electrolytic dissociation and the kinetic theory of liquids. He starts from the law for which he has already furnished the experimental basis: "The contraction undergone by a substance during its solution in water is proportional to the concentration of the solution, and is nearly independent of the nature of the dissolved substance. It amounts to about 13·5c.cm. for every gramme-molecule of an insulator dissolved, or for every gramme-ion of an electrolyte." The contraction is, according to his theory, accompanied by intermittent "bindings" between water molecules and molecules of the substance, and the number of water molecules so bound is, in dilute solutions, the same for every non-conductor, but in the case of electrolytes it increases in proportion to the degree of ionisation. By means of this hypothesis, an interesting relation may be established. Boyle's law for liquids has the form $K\phi = RT$, when K is the internal pressure of the liquid, and ϕ the molecular co-volume. If one litre of the co-volume contains N gramme-molecules, the pressure is $22{\cdot}38 \times N$ atmospheres, as in the case of gases. In the case of a sugar solution divided from pure water by a membrane, and containing *n* molecules of sugar for every N of water, the 'osmotic pressure" produced by their binding with water molecules is 22·38 *n* atmospheres. This is equivalent to van't Hoff's important law that the osmotic pressure is the same as the pressure that would be exerted by the dissolved body at the same temperature in the gaseous state. The author then goes on to establish a close relation between Faraday's laws of electrolysis and his own law of molecular contraction, or, in other words, the contraction of 13·5c.cm. and the transportation of 96,540 coulombs. He concludes as follows: "The contraction of 13·5c.cm. stands apparently in the same ratio to the quantity of electricity of 96,540 coulombs as does Nernst's 'solution pressure' to the E.M.F. We have here cause and effect. To the contraction wave (if I may so express it) corresponds the equal electric waves, and the possibility would be furnished of interpreting the electrostatic charges of the ions in the sense of the recent theories as wave motions in the ether." The Paper is well worth reading in full, especially in view of recent English discussions of the same subject.

[Traube, *Wied. Ann.*, No. 11, 1897.]

A Magnetic Test for Iron.—Since W. Duane discovered the true source of his "new magnetic effect" in the presence of extremely minute admixtures of iron to the specimens of sulphur and other dielectrics, he has been endeavouring to make this source of error a highly sensitive reaction for the presence of iron, rivalling spectroscopy itself in that respect. Instead of measuring the damping factor, he now suspends the specimen to be tested by a quartz fibre in a glass tube, and introduces it into a rotating magnetic field produced by electromagnets rotating bodily. The deflection of the specimen indicates the presence of iron. Whereas in the former method a certain specimen showed a hardly perceptible damping factor of 0·00009, it now gave a deflection of 17·6cm. at a distance of one metre.

[Duane, *Wied. Ann.*, No. 11, 1897.]

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THE ZEROGRAPH.

It seems to be *de rigueur* that a fantastic name should be given to new instruments destined to be brought to the attention of the general public. The zerograph does not merely write cyphers, but is capable of transmitting the same number of letters and symbols as any other type-printing telegraph. However, a fancy name seems essential in this case, for to call the instrument the Kamm type printer, when one of its most important claims to attention is the absence of clockwork, would have been a comical error.

The general appearance of the instrument is shown in Fig. 1. Its overall dimensions are approximately 18in. by 20in. by 17in. high. The keys, 36 in all, are not arranged in alphabetical order, but those most often required, *i.e.*, those letters placed near the centre of a type-writer keyboard, are put at the extreme left, the figures and stops which are less frequently used being at the right-hand side. The reason for this will be explained presently. The most interesting part of the instrument is, as usual, the synchronising device, and its action will be gathered from the following description, and a reference to Fig. 2. The keys A, of which one is shown in the diagram, are connected to vertical pins B arranged in the arc of a circle at right angles to the plane of the paper. The centre of this circle is the axis of an arm D, termed by Mr. Kamm the synchronising arm. Normally this arm is held at a fixed starting position to the left of the arc of pins by a catch, and when the catch is released the arm is

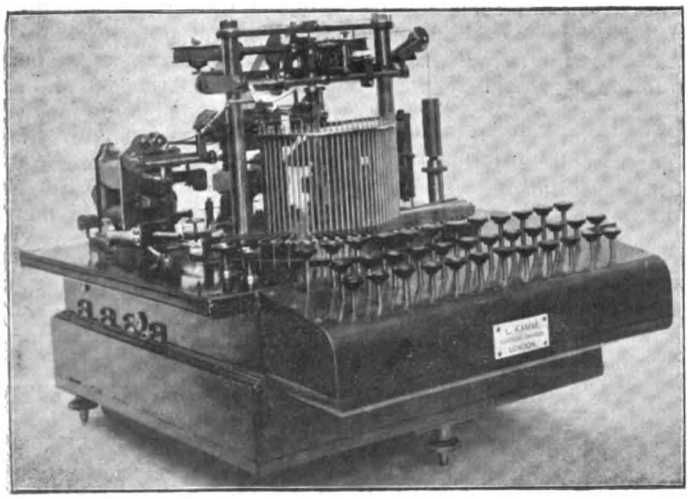

Fig. 1.—The Zerograph.

capable of swinging through the arc of a circle just above the pins already referred to until it is stopped by one of these rising. The impulse is given to the arm by a dropping weight connected to it by a cord passing over a pulley. The instruments at the two ends have exactly similar weights and synchronising arms, a screw adjustment being provided; by this means the space through which the impulse-giving weight drops can be varied, so that the speed of rotation at either end of the arm can be slightly altered if it is not in exact agreement with the other end. The weight acts on the spindle through a pawl so that it only acts during the forward swing of the synchronising arm. Two current impulses are sent to line, the first releasing the catch and starting the synchronising arm, and the second stopping the arm when the letter comes in a position for printing. The types are mounted on flat springs in the arc of a circle corresponding to that of the pins and fixed to the same spindle as the synchronising arm, and the printing is effected by a plunger pushed forward by the printing magnet, which presses the type against the paper tape. An ink ribbon is employed in the usual manner, this being continuous and passing over two ink pads on the circumference of two rollers.

The arm D carries two projections F and G moved by the magnet marked "synchronising magnet" in Fig. 2. The projection G is arranged to engage with any pin B as soon as this is raised by depressing the corresponding key A. The other projection F engages with a hook, C, attached to the armature of the "starting magnet," and this catch holds the synchronising arm in its initial position until the magnet is energised. On depressing any key A a contact at H is made as the key moves down, closing the circuit of the starting magnet and allowing the synchronising arm to start on its journey. The lever attached to the key also makes a contact between K and L, and the starting magnet closes a contact at J; it will be seen that these two contacts connect the line battery to line. The line current passes through the synchronising magnet at the other end, the armature M is attracted, F is released, and the synchronising arm at that end also starts. When the synchronising arm at the sending end reaches the pin B of the letter required it is stopped by the pin, and closes another local circuit energising the "second contact magnet" and the printing magnet. The former of these lifts its armature, making a contact at O, and sending another current impulse to line. This second current

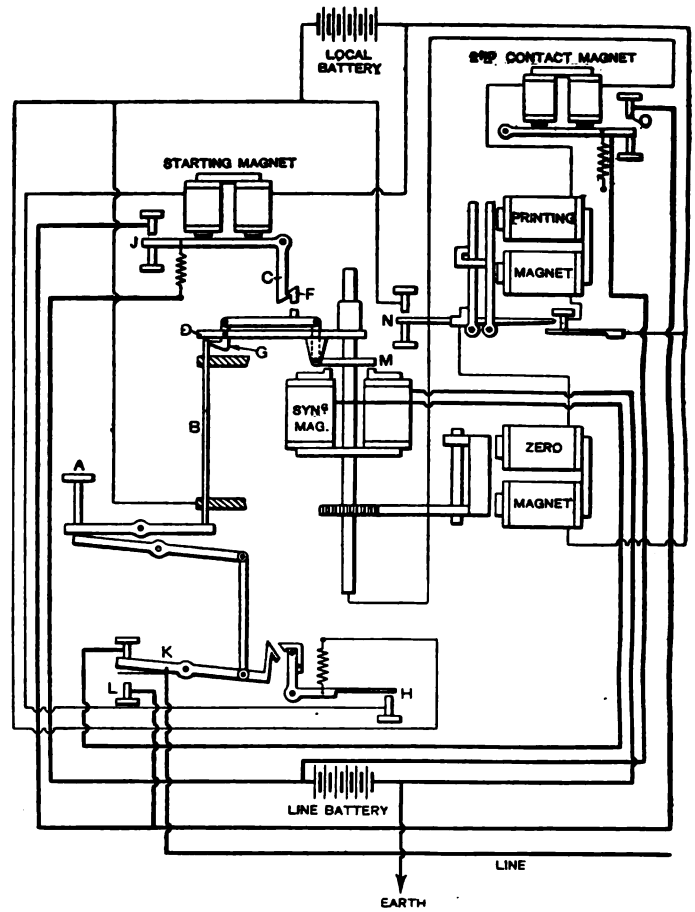

Fig. 2.—Diagram of Connections in the Zerograph.

again energises the synchronising magnet at the other end, the armature of which moves the projecting fang G, so as to stop the synchronising arm at the nearest spring-pin. This pin must correspond to that at the sending end of the line, if the two arms move with equal velocity. The same local circuit at each end is therefore closed, and the printing magnets press the type against the paper. At the same time the paper is fed by the usual mechanism, and the circuit of the "zero magnet" is closed at N, this magnet returning the synchronising arm to its initial position. We believe that an arrangement of condensers and resistances are connected across the contacts in the local circuits, to diminish sparking.

In point of speed the zerograph, although not competing with the Hughes type-printer, is, it is seen, far beyond instruments of the step-by-step type, of which latter the "telescriptor," described in our issue of November 5th, is a good example. The synchronising arm takes but half a second to swing to the limit of its travel and back, and as

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the letters most frequently used are placed to the left, at the first part of the range of the synchronising arm the average time per letter is but a very small fraction of a second; in fact, it is claimed that the instrument can transmit 25 words a minute. As evident from the description, however, everything depends on the accuracy with which the speed of the two synchronising arms agree, and although the spindles are mounted on jewels, and the instrument shows most careful and workmanlike finish, time only can decide whether in this important respect no trouble is likely to be experienced. We understand that experiments have been made on long artificial lines, but no actual trials on long telegraph lines. The synchronising magnet is very sensitive, and a 12 milliampere current suffices to work it, but we should expect that on long lines with considerable distributed capacity some method of curbing will be found necessary to ensure the first current impulse being completely wiped out before the second occurs. It is essential that each impulse should take the same time to reach the other end, but the time elapsing between successive impulses varies with each letter.

Mr. Kamm has also devised a "column printer," in which paper of a certain width is used instead of tape. To commence a new line a key is pressed which is not connected to any of the circle of pins, and the synchronising arm swings right to the end of its travel, closing a contact there which completes the local circuit of an extra electromagnet. This magnet moves the paper forward, and at the same time brings it back to the commencement of the line. This type of instrument is, however, not beyond the experimental stage, so that a detailed description of it would be out of place now.

ACCUMULATOR TRACTION ON RAILS AND ORDINARY ROADS.*

BY L. EPSTEIN.

While electric traction on the trolley system has proved, on the whole, an unqualified success, both from a technical and financial point of view, traction by means of accumulators could, until quite recently, only be pronounced a failure, and all that even its most ardent advocates can plead for is the substitution of the term "qualified success." However, at the present time signs are not wanting that promise at last success for accumulator traction. The progress made in the manufacture of secondary batteries, and the experience gained with regard to the best mode of using them, not only warrant that belief, but, what will no doubt prove more convincing, relatively good results have already been obtained. It will be remembered that ever since accumulators were produced on a commercial scale attempts were made from time to time to use them for traction purposes, but all these experiments up to a short time since—although frequently hailed with great enthusiasm—only led to disappointment, from a commercial point of view. An investigation of the causes which militated against success might prove useful, and will show that they may be divided into two classes—viz., inherent defects in the accumulators themselves, and mistakes in the mode of their application.

Dealing with the method of working, first, it will be seen, on analysing the expenses, that, apart from the cost of repairs and renewals, a heavy expenditure was incurred by the handling of the batteries; and, in view of the success of trolley traction, it is natural that the remedy should suggest itself to imitate, as far as possible, the latter system—that is to say, to employ accumulators in such a manner that they require a minimum of attendance and handling. It was, as we all know, the common practice to sub-divide the battery into a number of groups, each contained in a tray; and the connection between one tray and the next, as well as at the terminals, both on the cars and in the lifts for charging, was most imperfect. Sliding contacts were generally used, which were open to attack by the acid spray, necessitating almost incessant cleaning and repairs. Again, the pulling out and pushing in of these heavy trays was not always done with the requisite care, much to the detriment of the batteries, cars, and lifts. A further considerable source of waste consisted in the electrical leakage when charging, especially as many tiers of the cells were underground, and therefore out of sight, whilst they were not easily accessible, and were thoroughly saturated with acid spray.

These difficulties and losses can be obviated by adopting a system which will allow of the batteries being treated as a mechanically and electrically well-connected whole, either by being placed in the cars or preferably slung to the frame, or carried on a separate car—apart from the sub-division in groups for coupling in parallel or series during discharge. Where the conditions of working render it desirable, the motor, or motors, could also be fixed in the battery car, which would then assume the character of an electric locomotive; but in any case, whether carried in the car itself or slung to the frame, or carried on separate wheels, the battery should not be sub-divided and handled in the old way, but should always be treated as an indivisible unit. The obvious advantages gained by this method are the absence of lifts or similar contrivances, good connection between cell and cell, no corroding contacts, no loss of current through leakage, less wear and tear of the batteries and consequently easier management and reduced expenditure. The importance of obviating the exchanging of batteries has been fully recognised on the continent, and the methods of working in Hanover and Paris offer interesting illustrations of how this object has been attained.

In Hanover, as is well known, a combined system of trolley and accumulators is in use. The batteries are charged from the trolley *en route*, and an additional charge is given to them on their return to the car shed. This installation is on a sufficiently large scale to render the financial results of commercial value, and it is gratifying to see from the official report that the results for the year 1896 were pronounced to be in every respect satisfactory. The cost of maintenance is said to have been accurately ascertained, and found to average per car and month 40s., which, at an average mileage of 90 per car and day, corresponds with 0·177d. per car mile. The directors anticipate that this cost will be increased somewhat, but they are also confident that it will in no case exceed 60s. per car and month (which amounts to 0·266d. per car mile) even in those years when the quicker deterioration of the plates will occur. It must be understood that the cost of maintenance includes renewals of plates to keep the latter always in good condition, so that the additional depreciation is reduced to a rate not higher than that of the renewal of other parts of the machinery. Based on the actual experience gained, this rate has been fixed at 6 per cent., and with an accumulator car covering between 31,000 and 34,000 miles during the year on this mixed system, accumulator traction incurs an additional expenditure of 0·4d. per car mile, as compared with the trolley. Taking into account that in the absence of the accumulators the trolley system would have to be installed throughout the whole line at an outlay of £2,000 per mile of track, and further considering the maintenance of the overhead system and the saving in the wear and tear of the trolley, which is, of course, at rest while the accumulators are supplying the current, it is computed that even on the most unfavourable assumption the extra cost of the combined system compared with the overhead system alone does not in Hanover exceed 0·2d. per car mile. It may be of interest to mention here that the running expenses of the electrical system, including driver, amounted to 2·22d. per car mile.

This system, although so far satisfactory, is open to certain objections, the foremost being the dead-weight of the accumulators carried on the trolley wire section. It might be found more advantageous to place the batteries in a frame slung to the car, or in dummy cars, either of which could be picked up at the end of the trolley section, while the charging of the accumulators could still be effected in the same manner from the trolley wires, the only difference being that the charging would take place at fixed points instead of *en route*.

A different system is employed in Paris, where the Société des Moteurs have installed and are working a line about 12 miles long at the same cost, including depreciation, as horse

* Paper read before the Institution of Electrical Engineers, Nov. 11, 1897.

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traction. Here the plan has been adopted of charging the batteries at the stopping places, the time of charging varying ordinarily between 8 and 10 minutes, and the charging is effected not, as is usual, at constant current, but at constant potential, consequently very high current densities are applied at the beginning of the charge. Six feeder circuits are projected, of which three are working at present. These circuits are underground, and, although of different lengths, are all of uniform resistance. I am not aware that any figures showing the actual cost of working are available.

It will be seen that, however different these two systems may be in detail, they have the following points in common:

1. The batteries are dealt with as a whole.
2. The batteries are once for all installed in the cars where they are charged and discharged.
3. Each of the two systems permits the use of batteries of less weight than if the old practice had been followed of charging them either at the journey's end or at constant current.

Never losing sight of the object in view, viz., to approach in the mode of working as far as possible the overhead or conduit system, the special method to be adopted will depend upon local circumstances. While in one case the batteries may be advantageously carried in or slung to the car, in others it will be found desirable to place them in dummies, which latter might also carry the motors, as an alternative to the motors being fixed in the cars. A dummy with a battery sufficient to propel a 52 passenger car for about eight hours will weigh, complete, about three tons, the dummy itself, with axles and wheels, weighing about three quarters of a ton. As each ton propelled under normal conditions incurs an expenditure of about 0·4d., the extra weight of the dummy would increase the expense by about 0·3d. per car mile. It is, however, obvious that this increase represents only a small fraction of the expenditure which is incurred when the accumulators are handled in the old manner, apart from the saving in wear and tear of the cars and of the batteries.

There are many lines on which the traffic varies considerably, not only as is usual during the different hours of the day, but perhaps in a much more marked degree, during different seasons of the year, such, for example, as tramways in market towns or seaside places. By the use of dummy cars the exigencies of a varying traffic can most effectively be dealt with, as they may be attached to one or more trailers, provided the batteries have the required qualities, and may safely be discharged at high rates.

However excellent the method of using the battery may be, it will avail but little if the battery itself be lacking in the necessary qualities, and it may safely be asserted that the success or failure of accumulator traction will be decided by the merits of the accumulator. In order to lend itself satisfactorily to traction purposes, an accumulator must, in addition to all the good points possessed by a successful lighting cell, present special features of its own. Although lightness may not be the main consideration, yet it is a very important one. Again, the cell must not only be able to withstand jolting without shedding of material and high discharge rates without buckling, but, moreover, it must not decrease in capacity while in use, as this would necessitate alterations in the time-table relating to the charging of the batteries, and interfere with the general arrangement. The battery, furthermore, should not require frequent overhauling, and the repairs should be neither more numerous nor more costly than those of any other part of the machinery. We all know that in the past batteries left very much to be desired. Some of the positive plates deteriorated much sooner than others, and this led first to the practice of replacing them by less damaged plates taken from other cells, and finally to that of converting part of the negative sections into positives. After some time the original array had dwindled down to a small fraction consisting of the least injured remnants, which were occasionally referred to as a proof of the long life of the type they represented. As a battery naturally consists of a large number of cells, and each cell again consists of a large number of plates, the overhauling and repairing proved a very serious item—in fact, in many cases the heaviest item of expenditure.

The nearest approach to an ideal cell for traction purposes will probably be one in which the positives are of the Planté type, with a large extent of surface, the layer of active material relatively thin, but in most intimate contact with the metallic lead out of which it has been formed. As is well known, while the capacity of a plate is determined by the volume of active material, the rate of charge and discharge depends upon its surface, and as it is quite feasible by means of ribs or protrusions, without unduly interfering with the mechanical strength of the plate, to extend its area to about ten times that of the plane surface, it follows that the current densities obtainable will be increased in the same ratio. It is further essential that the acid should have free access to all parts of the active material, and such is naturally much more the case with a Planté plate offering a largely extended surface with a thin coating of peroxide than it would be in a plate with a plane surface, where the active material forms a relatively thick layer. Not only is the contact between active and conducting parts less perfect in the pasted plate, but, in addition thereto, as the acid in the pores of the active part is liable to become exhausted, especially with heavy discharge currents, while the interstices are too narrow to allow of a quick diffusion of the electrolyte, the electric action may be seriously interfered with, although there may still be a sufficient quantity of undischarged active material.

As regards good negative electrodes, positives of the above description, after having been reduced, may be employed with advantage, or lead oxides or salts may be used, as the finely reduced lead is a much better conductor than peroxide of lead; but care should be taken to secure the best possible contact between such material and its support, and so to select the materials intended to become active that they will, after full formation, produce a layer of the highest possible porosity consistent with mechanical coherence. It has been found by experiment that the exhaustion of a positive plate or section of a cell effects a gradual falling in the E.M.F., while as soon as the negative electrode is exhausted the E.M.F. falls very rapidly. For this reason, and as it is obviously advantageous to have as little variation in the E.M.F. of the battery as possible, I would suggest, for traction purposes, to use negative sections of higher capacity than that of the corresponding positive sections.

In the interest of economy the formerly much-recommended overcharging must not be too freely indulged in. Such overcharging can easily be guarded against by using recording instruments, or by other suitable means, while when charging at constant potential the battery will itself guard against overfeeding by effectively opposing, at the proper time, the charging current. The recommendation to overcharge the cells *occasionally* may, however, be followed with advantage, the beneficial result consisting not so much as was formerly supposed in the actual improvement of the electrodes, but in the thorough mixing of the electrolyte, which is liable to vary in S.G., being densest at the bottom of the cell and decreasing towards the surface, thus leading to unequal action in different parts of the plate. Another device for equalising the action over the whole surface consists in making the electrodes taper towards the bottom, with the object of compensating for the higher density and better conductivity of the electrolyte there by increasing the distance between electrodes of opposite polarity.

We are now, however, confronted with the all-important question of the cost of depreciation of the batteries. If we consider a battery in a car for 52 passengers with an average running weight of about 12 tons and an average mileage of 100 per day, equal to 1,200 ton miles per day, we find that at the rate of 80 watt-hours per ton mile the daily electrical expenditure is 96 units, or, if working at 400 volts, 240 ampere-hours. It is, of course, immaterial for our calculation what the voltage is, as the cost of renewal of either a small number of large electrodes or a larger number of small electrodes will be practically the same for the same watt-hour capacity. The cost of renewing the positive section of a cell of such capacity should not exceed, including manufacturers' profits, 10s., and, assuming two discharges or their equivalent a day, we may reasonably expect a useful lifetime extending

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over 1,500 discharges. The battery doing work, therefore, during 750 days and covering 75,000 car miles, the cost of renewing the positive sections in 220 cells, will amount to £110, or 0·35d. per car mile. That this estimate errs on the safe side is borne out by the experience gained in Hanover, although it seems that the batteries used there are of greater weight than is necessary.

Given a good battery, and having adopted a system best suited to the conditions of a given line, and in any case obviating the necessity for handling the batteries, we should arrive at a working cost approximately the same as on the trolley system, the extra expenditure caused by the greater weight of the self-contained car being balanced, as is shown in Hanover, by corresponding advantages gained.

While on tram lines accumulator traction must prove its superiority over rival systems in order to be adopted, there is another large field in which the use of batteries is a matter of necessity. I refer, of course, to traction on ordinary roads. The tractive force on ordinary roads is naturally subject to much greater variations than that on rails. I think, however, that on good roads paved with asphalt or wood, and in fairly good condition, the tractive force of vehicles as hitherto built should, on the level, not exceed 60lb. The weight of an electrical vehicle to carry from two to four passengers, with motor and battery complete, will be about 30cwt., which includes a battery with a weight of 9cwt. A battery of such weight ought to be sufficient to supply current for a four to five hours' run, at an average speed of eight miles on the level and four miles up a gradient of 1 in 24. The power on the driving axle will be about 2 effective H.P. in the former case, and about 3 effective H.P. in the latter; and, assuming a combined efficiency of motor and gearing of 65 per cent., the battery will have to furnish discharges at the rate of 2,208 watts and 2,812 watts respectively. With a battery efficiency of 70 per cent., the charge to supply one hour's actual run requires about 8 units, which, at an estimated cost of 2d. per unit (a sum that should certainly not be exceeded, whether the current be generated at the company's own stations or taken from a public supply), corresponds with a cost of ¾d. per mile. It may therefore be anticipated that electric carriages plying for public hire should be able successfully to compete with horse-drawn vehicles for a similar purpose, provided that the wear and tear of the accumulators is not excessive. The favourable financial results would not be impaired even if the cost of maintaining the accumulators should exceed the rate of 10 per cent. per year, said to be quoted by some manufacturers. The time during which such accumulators have been at work is probably too short to prove whether the batteries can be maintained at such a remarkably low rate.

Reliability of the battery, obviating the necessity for frequent examinations and tests and for remedying partial defects, is again of much higher importance than—within reasonable limits—the lifetime of the whole battery, as will become evident from the following consideration. Assuming the average mileage made with one charge to be 40, and estimating the cost of renewing the positive section at 10s. per cell, or £20 per battery of 40 cells, the cost of renewal per mile run would be as follows:—

If renewed in	8 months	=240 days,	after	9,600 miles,	0·5d.	per cab mile
,,	12 ,,	=360	,,	14,400 ,,	0·33d.	,,
,,	16 ,,	=480	,,	19,200 ,,	0·25d.	,,
,,	24 ,,	=720	,,	28,800 ,,	0·166d.	,,

If the average cost of a battery be £60, and if it should become necessary to renew all the positive sections—even after as short a time as 12 months after having run 14,400 miles—it is true that the cost of renewals (£20) will equal 33⅓ per cent. of the first cost, but this only equals one-third of a penny per cab mile. On the other hand, even with batteries having a longer life but necessitating supervision and slight repairs, the wages incurred and the cost of material would, judging from the experience gained in tramway work, certainly amount to a much larger sum than the cost incurred in renewing the positive sections, even in a comparatively short time. Besides, in such case more sets of batteries per car would become necessary, increasing not only the first outlay but the charge for interest and depreciation, and thus considerably swelling the total cost.

Lightness of batteries for ordinary roads is of much more importance than it is on tram-lines, not only on account of the heavier energy expenditure which is necessary to propel a given weight, but the more so as the battery will represent a larger portion of the total weight of the vehicle as compared with tramcars. In large towns it would be an advantage to use batteries which are interchangeable, and to make arrangements with public supply companies to charge the batteries and always keep a number ready for use. The drivers would then be able to exchange the batteries at the nearest station instead of being compelled to return to the one station, which may be a long distance off; time would thus be saved, and the earning-capacity of the electric carriages increased.

The figures relating to tramways contained in this Paper are the results of my own tests; but such is not the case with those having reference to traction on ordinary roads. I should have preferred to submit data, based on personal observations on a motor car which I am making, and which I think embodies several improvements tending to reduce the necessary tractive force. But, unfortunately, as is often the case with new constructions, the completion of that car has taken longer than anticipated, and, although I endeavoured to postpone my Paper until I should be in a position to bring something which might have the charm of novelty before this Institution, yet, wisely or otherwise, I gave way to the request to read a Paper on electric traction at the beginning of the session. If—as I fear—I have failed to bring anything very original or interesting before you, this must be my excuse.

ELECTRIC LIFTS AND CRANES.*

BY H. W. RAVENSHAW, ASSOC.M.INST.C.E.

The object of this communication is to direct attention to the electrical and mechanical problems which present themselves in the application of electric motors to working lifts and cranes; and to describe the methods by which they have been solved in particular cases which have come under the notice of the author.

Electric Lifts.

The simple gearing and slowly-moving mechanism necessary where hydraulic power is available afford many advantages. With the electric motor, however, the current varies with the work developed, while with the usual form of hydraulic motor the quantity of water used is as great with a light as with a heavy load. The greater simplicity of the hydraulic lift would therefore probably be an insufficient advantage to justify its introduction in places where electricity was already available, and where no hydraulic installation existed.

Motor.—The class of electric motor generally employed does not call for special description. Any good commercial machine can be used, a principal necessity being that it should require little attention. The machines should be sparkless under wide variations of load, the brushes self-adjusting for wear, and the direction of rotation reversible. The bearings should also be self-lubricating. The efficiency should be high at all loads; but a comparatively small machine can be used, as in most cases the maximum load is of short duration, the machine standing idle for at least half the time. Series motors have been used in some cases, but they are not suited for this work, as the speed varies excessively with a varying load. Shunt motors are remarkably self-regulating, if the potential is constant, and they are now almost always used, series coils of a few turns being sometimes added to enable the motor to be started quickly and with a reasonable current. A distinctive characteristic of the electric motor is the comparatively high speed of rotation of the armature. It is possible to make a motor that will run at a very low speed, but the large size and heavy first cost of such a machine make it more convenient to employ a mechanical method of reduction.

* Paper read before the Institution of Civil Engineers.

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Gearing.—In the earlier electric lifts, belts were generally used to transmit the power from the motor to the winding-drum, and in many cases the motor ran continuously. Reversing, starting and stopping were effected mechanically. This arrangement is, however, cumbrous, and positive gearing is now generally used—the motor being started, stopped and reversed as required. Double helical spur-gearing is perhaps the simplest and most efficient method of reducing the speed, but the noise inseparable from it prohibits its use in most places where lifts are required. Worm-gearing is more expensive and less efficient; but on account of its compactness and silent running it is almost universally adopted. The arrangement does not admit of wide variation. A quick pitch for the worm, ball, or collar bearings to take the thrust, and the worm and wheel running in an oil-bath, form the principal characteristics. The older form of slow-pitched worm-gear had the advantage of being self-holding; but in an efficient worm-gear the wheel will drive the worm, so that no reliance can be placed on its holding power. When once the wheel and worm have worn themselves to a good bearing surface, the gear gives little trouble. The ball-bearings run well, if the ball-races are made of good steel and are ground true after being hardened. When ball-races are made of unsuitable materials and are not properly hardened, the wearing surfaces become pitted, and much friction and noise occur. Notwithstanding the silent running of good worm-gear, a certain amount of vibration is always transmitted to the worm-wheel shaft; it is therefore usual to drive the rope-drum through intermediate pads of india-rubber, otherwise an unpleasant vibration is sometimes felt in the lift-cage.

The power is generally transmitted from the worm-wheel shaft to the cage by wire ropes wound on a grooved barrel. A modified arrangement, used by Messrs. Easton, Anderson and Goolden, is shown in Figs. 1-3. In this case, one end of each cage rope is fastened to the balance-weight. On the shaft of the worm wheel is keyed a drum having twice as many grooves as there are ropes. The latter pass half round the drum over a guide-pulley and half round the drum again, the balance-weights being sufficient to give the necessary friction between the pulley and the ropes. A number of ropes on a high lift can thus be used with the advantage of a comparatively narrow drums.

The principal exception from the usual practice of reducing the speed by worm-gearing is the Sprague lift, which is extensively used in America. In it a screw is driven by the motor, directly or through gearing. Travelling on this screw is a nut which carries a pair of sheaves, over which the ropes pass in a similar manner to the ordinary hydraulic jigger. The nut forms virtually a ball-bearing, the balls returning through a race in such a way that they follow in a continuous stream. In the event of a ball jambing, the nut, which is held by friction-plates, revolves with the screw, and the travel of the lift is arrested.

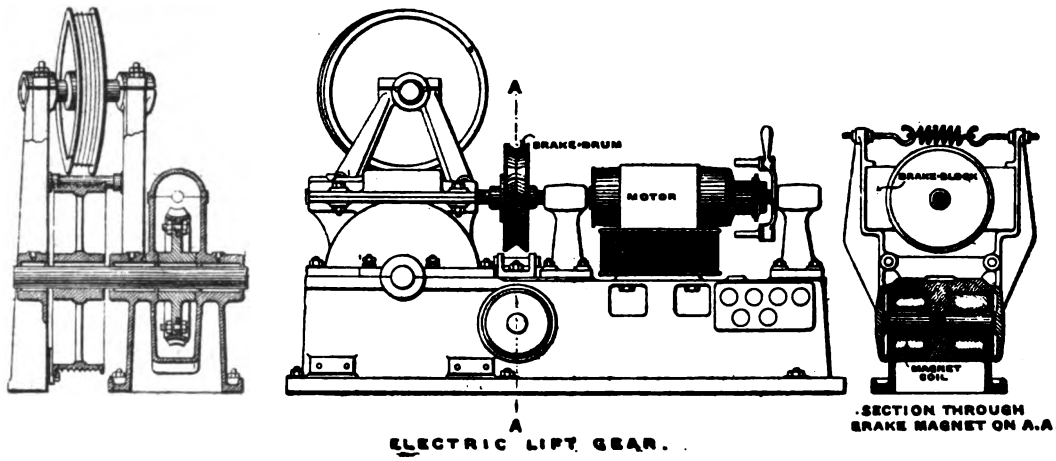

FIG. 1.—Scale: ½-inch = 1 foot.

Starting and Regulating Gear.—The driving-gear presents few difficulties, seldom showing variation from a uniform pattern. The requirements of the regulating-gear are:—Prompt starting, stopping, reversing and ease of being worked by unskilled persons; absence of sudden jerks or jumps at starting, due to rushes of current; minimum current consumption, and regular speed with varying loads.

Automatic lifts are not largely used in Great Britain, a skilled attendant being generally employed, and the usual hand-rope adopted. A small reversing motor, or a pair of magnets or solenoids controlled by a switch in the cage, may be used to actuate the regulating-gear. The current has, however, to be carried from the cage, either by hanging wires or by sliding contacts; and where a rope is used the simplest arrangement is obtained. When a motor is running, the current in the armature is that resulting from the difference between the electromotive-force of supply and the back electromotive-force of motor. If the machine is switched on while it is standing, there is no back electromotive-force, and the current is that due to the full electromotive-force of supply, the resistance of the armature and circuit being constant. As in a good motor the back electromotive-force is only about five per cent. less than that of the supply, the current, on starting without added resistance, would be nearly 20 times as great as the working current, being practically equivalent

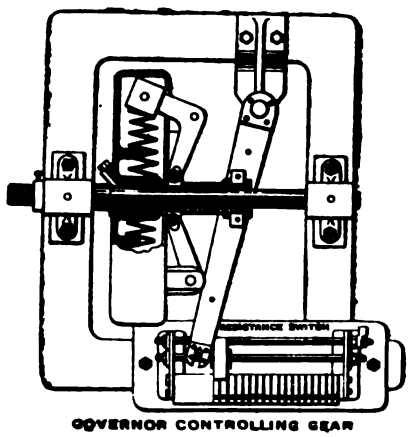

FIG. 2.—Scale: 1 inch = 1 foot.

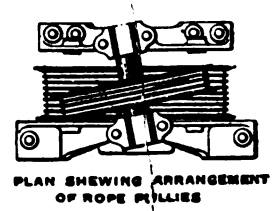

FIG. 3.—Scale: ½-inch = 1 foot.

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to a short circuit. This would cause a great fluctuation in the supply of electromotive-force in the adjacent circuits and an enormous turning effort in the motor, causing it to start with a jerk. Indeed, the fuses would be melted, as such a rush of current would be dangerous, and could not be tolerated. In order to start smoothly and without a great rush of current, resistance must therefore be inserted in the motor circuit. It is usual to provide a switch so arranged that a resistance is inserted in series with the armature. This resistance allows only sufficient current to flow to enable the motor to start, and is afterwards cut out by a further movement of the switch-handle. The switch is sometimes worked entirely by the attendant, who switches on slowly, giving the motor time to start. With a lift in which a hand-rope is used, there is no indication of the position of the switch, and an unskilled person might suddenly switch out all the resistance, causing almost as great a rush of current as if there were no resistance in use. Various arrangements of dashpots have been used to prevent the rope from being pulled suddenly down; it should, however, require a very small effort to work it, and an arrangement which automatically cuts out the resistance is more satisfactory. The following arrangement has been adopted by the Otis Elevator Company. When the hand-rope or other starting-gear is actuated, the current is switched on in the right direction, and the brake is released; a switch arranged to automatically cut out the resistance is also released by a cam, but its action is retarded by a dashpot and a solenoid, which does not release the switch until the current has fallen below a certain limit. This has been largely used, and works well.

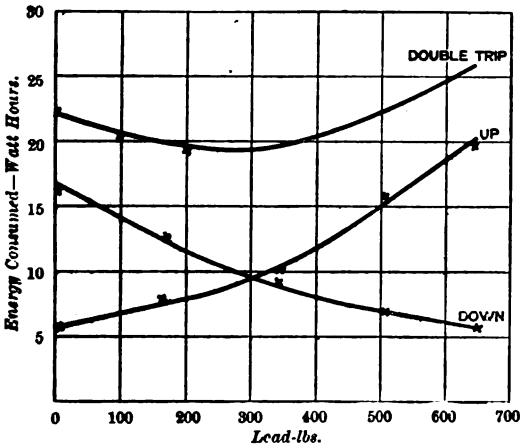

Fig. 4.—Otis Lift Curves showing Energy Consumed at Different Loads.

Another form of gear designed by the author is shown in Fig. 2. It consists of a centrifugal governor driven from the motor-spindle, and controlled by a spring, so that the travel of the switch which it actuates is nearly proportional to the speed of the motor. This switch is arranged to decrease the resistance in the main circuit as the speed of the motor increases, all the resistance being cut out just before the motor attains its maximum speed. Sufficient resistance is inserted to allow the motor to start with its maximum load; but if the motor is over-loaded or any of the gear is jammed, the resistance is not cut out, and only the ordinary starting current continues. When fitted with this starting-gear, an electric motor behaves in almost exactly the same way as a steam-engine, and is specially applicable to winches and cranes, as it is impossible to overload the machine. A similar gear has been used by Messrs. Siemens and Halske.*

When lifts are supplied with energy from a central station, the authorities generally specify that current shall not be switched on in steps of more than, say, 10 amperes. The reversing switch, which is driven by a hand-rope, is therefore generally fitted with a certain number of resistance contacts if the starting current for the motor exceeds the specified limit. This resistance is also of use with fast-running lifts, where unskilled persons are liable to hold the rope too long and reverse the motor suddenly. The governor gear, however, in such a case at once promptly inserts the resistance. A gear having an almost similar effect has been designed by the author. It consists of a solenoid, wound with fine wire and connected across the brushes of the motor. This actuates a resistance switch, and is controlled by a spring or weight. When the motor is standing, only a minute current flows through the solenoid; but directly the motor starts, the potential at the brushes increases, and causes the solenoid to gradually cut resistance out. This gear is convenient in some cases, but has the disadvantage that current is always flowing through the solenoid while the motor is running, thus diminishing the efficiency of the system.

The Brake.—It is important that a lift should stop promptly when required, and some form of brake is always employed. This may be worked from the hand-rope, but an automatic magnetic brake is generally used, it being important that the rope should not require much effort to work it. For this purpose the ordinary bar electro-magnet is generally adopted, as a magnet of reasonable dimensions can be made to give a pull of one ton through a distance of half-inch. The magnet can be arranged to release the brake when the current is switched on, the cage being automatically stopped when the circuit is purposely or accidentally broken. For this reason the magnetic is far safer than the mechanical brake. The shunt coils of the motor and the magnet are controlled by the starting switch, a resistance, wound to have little self-induction, being fitted to prevent sparking when the magnet-circuits are broken. This resistance is inserted by the switch just before the magnets are cut off, and is left in circuit with them while they remain disconnected. The author's usual practice is to make this of the same resistance as the magnet-coils with which it is connected. By this arrangement the circuit of a magnet weighing several tons can be broken without an injurious spark.

Indicator.—Although the main current may be switched off, the hand-rope can be left in such a position that the brakes and field-magnets are still in circuit. In the lifts designed by the author an electric vibrator or "buzzer" is connected in parallel with the field-magnet coils, a large resistance being inserted to prevent waste of current. A visible indicator can be used if the noise of the buzzer is objected to. An indicator should always be fitted to prevent accidents and waste of power.

Tests.—By the courtesy of the Otis Elevator Company the author has been able to carry out tests of an electric lift erected by them, the particulars of which are given in Appendix I. and in Fig. 4, which show the relation between the energy consumed and the cost of working with various loads. The height through which the lift travelled was 36½ft. The cost of working is lowest at about half-load, the cage and load being almost exactly balanced. This lift was new, and would perhaps give better results after working for some time; it may, however, be taken as a fairly representative example of its kind.

(To be continued.)

* Minutes of *Proceedings* Inst.C.E., Vol. CXXV., p. 515.

THE EDISON IRON ORE-MILLING WORKS.

In connection with our recent note on the Edison Iron-Ore Works, New Jersey, the following particulars, may be of interest. The works are situated near rich veins of iron-stone not far from Lake Hopatcong. These veins, it is stated, are known to contain over 200,000,000 tons of iron-stone suitable for crushing. Railways put the plant in direct communication with a good iron-making district 100 miles away. The stone is magnetite, in a feldspar gangue, containing about 25 per cent. of oxide of iron, and can be easily crushed. The enterprise has been rendered possible in consequence of its closer proximity to the market than other sources of Bessemer ore.

Two or three power excavators, each capable of excavating four or five tons per minute, are at work for winning the stone from the strata, which is previously loosened by dynamite. Thence the stone is conveyed to a series of rolls, which crush

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it gradually to particles of a maximum of half-an-inch diameter. Much ingenuity has been exercised in the design of these crushing rolls by Mr. Edison, who, taking the ordinary Cornish rolls, and finding that of the total power supplied something like 82 per cent. was wasted in friction, and this chiefly at the bearings of the rolls themselves, designed a form in which the separating thrust on the rolls while the stone passed between is met by passing an endless wire rope around grooved pulleys on the roll shafts, as in crossed rope gearing, thereby reducing the power loss to about 16 per cent. The ore, after being crushed, then passes through sieves and on to the separating plant proper, where it is subjected to a sort of magnetic winnowing, by being made to fall under the influence of the field of powerful magnets, which cause the iron or "concentrate," as it is termed, to be deflected out of the vertical path from the residue or "sand"—which latter, by the way, forms a valuable bye-product, as its particles are sharp, making it more suitable for use in cement or mortar than the ordinary variety. The "concentrate" is next dried and screened, the fine portion having to undergo another magnetic sorting, the coarse being returned to be recrushed. The final "concentrate" has a percentage of oxide of 91 to 93 per cent., every four tons of stone yielding one ton of "concentrate" and three tons of sand. To prepare it suitably for the blast furnace before it is railed, the "concentrate" is made into briquettes by the addition of a suitable binding agent and subjection to pressure and heat. By the use of these "concentrate" briquettes, it is stated that the output in pig-iron of a furnace per day may be increased from 35 to 50 per cent. over the ordinary mixtures of ores now being used, with a lesser consumption of limestone and fuel.

DIAGRAM ACCOUNTS FOR ENGINEERING WORK.*

BY JOHN JAMESON.

In engineering establishments few things are of more importance than a ready and accurate system of prime cost accounts. By promptness and accuracy in ascertaining cost, the net result on the completion of every contract or piece of work done is at once brought clearly before the management; and the profit or loss shown serves as a guide for the acceptance or rejection of other contracts or other work. Usually the elimination of unprofitable orders and the cultivation of profitable work, directed by actual knowledge of cost, are alone more than sufficient to justify the comparatively small expenditure involved. The requisites of a good cost system may be summarised as follows; and they form the foundation of such a plan of diagram accounts as it is the purpose of the present Paper to describe.

Firstly, costs should always be posted closely up to date. The requisite data are practically complete at the close of every day's work. They should therefore be posted under all their subdivided heads not later than the next day. The posting is more easily done the next day than at any subsequent time; and mistakes promptly discovered may be corrected with far less trouble and loss of time than if a week has elapsed since their occurrence. Secondly, the system should be one of balance. The total wages and total store issues and incidental expenses should balance the prime cost of all the work done for customers, for repair and maintenance, and for improvement or extension; and each of these items should be quite distinct by itself. Thirdly, it should indicate at a glance probability of error, if error exists; and much may be done in this way, in regard both to labour and to store issues. The ability to detect errors is of far more value than the mere correction of an individual error as it occurs. The occasional discovery of error by a process probably unknown except in the office, or even the occasional demand for an explanation of deviations from ordinary practice, produces a degree of care and a habit of accuracy in making the primary returns, which is a great benefit in itself, and which without such help it is difficult to secure. Fourthly, a charge should be included for the use of every machine employed. Work which involves the use of costly machinery should not be simply compared with other work involving perhaps equal labour but not requiring the same use of machinery. The capital value of the machine, its depreciation, the power required to drive it, and the space it occupies in the shop, are all elements of cost, which should be apportioned with careful consideration of their incidence. Moreover, machine time-boards present the further advantage of showing whether the machinery has been kept fairly employed while there was work suited for it to do. It can also be seen what class of machines may be deficient in number, as compared with other classes. The machinery employment diagram shows the percentage of the actual earnings of each class of machines, compared with their possible earnings. Fifthly, manufacturing and commercial trading should be kept distinct. If certain work is to get the benefit of good purchases in a rising market, and other work to be handicapped by bad purchases in a falling market, an element is introduced into the costs which should not exist therein; variation and confusion are produced in what ought to be uniform and simple. Trading profits or losses should be confined to the commercial books; manufacturing profits or losses alone should be entered into the cost books.

Since the introduction of the steam-engine indicator the performances of engines have been exhibited diagrammatically; and from the indicator diagram the horse-power is reckoned out in figures. But for enabling engineers to judge of their economy, the form of the drawn diagram is of greater importance than the arithmetical figures deduced therefrom. The diagram reveals at one view the whole performance; and upon it may be superposed a theoretically perfect diagram, bringing out every deviation and its effect. Precisely what an indicator diagram does in exhibiting the performance of a steam engine, a set of properly constructed account diagrams will do in disclosing the ecomomic working of a manufacturing concern, in all that pertains to the actual manufacturing costs. From the several lines of an account diagram adequately filled up may be deduced a closely approximate single line pointing directly to a graduated scale of greater or less profit or loss. Waiting till the close of the year for a balance sheet, produced too late for practical effect, is by no means a satisfactory course; the balance of profit or loss at the year's end is merely an aggregate of items arising day by day. If the exact tendency of this aggregation is displayed day by day or at short intervals, for the guidance of the management, a most important advance is realised. The varying results of five or ten years' work can be exhibited upon a single sheet in a few lines, the direction of which indicates their import. Not only does such a review furnish data of great value for comparison with present operations, but it fixes in the mind broad general principles of practical importance in regulating future work. In some exceptional cases these principles seem opposed to what appear to be the most obvious economic considerations. For instance, on a particular contract a heavy loss had been sustained in a bad year. Under such circumstances the first thought would naturally be that such a contract should be avoided in the future. When, however, the year's accounts were thrown into diagram form, and a comparison of results was instituted, it became at once apparent that without this losing contract the bad year's loss would actually have been increased.

If a case could exist in which the profits of manufacturing some special article were approximately uniform, manifestly the absolute amount of profit would depend on the output of work; but then, the sunk capital being a fixed quantity, the rate of profit would obviously not be uniform. Similarly, it might perhaps be imagined that, if half the normal quantity of work be done, an approximation to accuracy of estimate might be obtained by doubling the proportion of the fixed charges for rent, rates, insurance, depreciation, salaries, and other incidental expenses; but almost anyone who has not made a special study of the matter would be surprised to find how wide of the mark such an estimate would be. The following illustration is derived from facts of actual experience. In successive periods of abundance and slackness of work, where the work and management continued of the same character, less than £30 of wages usually completed £100 of finished work in the brisk times. In other words, in the same factory and under practically the same conditions a workman turned out five finished articles at higher prices when there was plenty of work, as against little more than half the quantity at lower prices when work was slack. In the latter case loss is almost inevitable. In this connection there is one consideration which must not be lost sight of, namely, that the percentage of labour cost to the total cost of finished work is dependent both on the wages paid and on the works charges and on the store issues; and that the percentage of the works charges is diminished in brisk times, while that of the store issues may be considerably increased. For instance, it is possible to buy forgings either finished or rough. With abundance of work in hand it may be expedient to buy in as finished a state as possible, and in slack times to do all possible work in one's own shop. The effect, however, is to pass through the store issues to finished work account a high-priced article when bought in the finished state, and the same article at a low price when bought in the rough, and thus to disturb the percentage of labour. Having examined individual cases, however, the author is satisfied that this consideration by no means accounts for the discrepancy pointed out. To what extent the latter may be explained by the supposition that workmen do not like to complete a job without prospect of more to follow—or how far it may arise from the necessity, when there is little work, for more change of job,

* Abstract of a Paper read before the Institution of Mechanical Engineers

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by employing a man upon a variety of work instead of continuously upon one kind; or how far the mere emptiness of the shop may give increased opportunity for skulking; or how far disheartening influences may unconsciously sap normal energy—it is perhaps both hopeless and useless to inquire. Under these circumstances it may probably be hopeless to ask for higher prices; but it is worse than hopeless, it is ruinous, to attempt to reduce loss by restriction of output. The remedy, whether practicable or not, would lie in the opposite direction. At all times therefore it is of the highest importance that the manager should have before him in the most simple and intelligible form the facts which day by day go to form an aggregate of prosperity or adversity. Before even the best management can have any chance of success, there must be provided an adequate supply of work to do reasonable justice towards the sunk capital and the staff. If the supply of work be inadequate, and therefore unfair in this respect, no management can prevent disaster. If the manager be an expert book-keeper and devote a good deal of time to the study of the books, he may acquire all the knowledge which can be embodied in a diagram. But a clerk once instructed in the method of procedure would probably in most cases produce more expeditiously, more correctly, and much more cheaply a diagram containing all the information in the best form. The author's idea is to present to the management, with the utmost clearness and the least possible trouble, an exact record of progress in any desired detail.

One other advantage in a good series of diagram accounts extending over a period of years lies in its showing that extreme overpressure of work is too costly; extreme deficiency of work is ruinous; between them somewhere lies a mean, at which the highest profit may be made. It is important, therefore, that this mean should be ascertained, and then that it should at all times be as nearly as possible maintained. Good management should be judged, not by the mere profit made, but by the profit viewed in the light of the favourable or adverse circumstances under which it has been made. Moreover, when the capacity of works for profit-making has been ascertained by the review of past operations, the practical result of each year should be gauged, not so much by the percentage gained on capital, which is the ordinary gauge, but by the result which past experience has proved the works are capable of producing. That is to say, if £30,000 can be gained in a typical year, and only £20,000 has been gained in a particular year, there has been in this year, whether brought out in figures or not, a loss of £10,000.

A NEW FORM OF ELECTRIC COAL-CUTTER.

The Jeffrey coal-cutting machine is already well known to colliery men, but the type hitherto used has been that of a rotary cutter bar worked parallel with the "face." While this machine is suitable for under-cutting in heading and pillar-and-stall work, it is not particularly so for long-wall work, and to meet economically the conditions obtaining in the latter system of coal mining, the Jeffrey Company are introducing a special long-wall type of electric coal-cutting machine. Instead of the bar cutter, a side wheel cutter, something like the Snell-Waterhouse cutter, is used. In width the machine measures 3ft. 8in. over all from the face of the coal when the cutter wheel is embedded; its total length is 7ft. 9in. and its total height a little less than 19in. The diameter of the cutter wheel varies from 36in. to 5ft., according to the thickness of the seam in which the machine has to operate. The feeding mechanism for regulating the speed of travel along the face of the coal is variable, allowing of three different speeds of travel, 8in., 16in. and 25in. per minute.

All the working parts are accessible, but protected from injury from falls. The gear is encased in steel, and runs in oil. The axis of the armature of the motor is parallel with the length of the machine or with the "face" when the machine is in use. The motor fields are multipolar, and wound for any pressure from 220 to 500 volts.

This machine is known as the single-track long-wall machine, as it operates on a single rail of simple and cheap construction, formed of two pieces of flat iron, one 4in. by ½in., upon which is rivetted a strip 2in. by ½in. This rail is held in place by suitably-arranged jacks which are braced to the roof. On account of the well-protected gearing and motor, it is possible to take up the track behind the machine as it advances, and simply slide the rails over the top of the machine to be laid constantly in advance. With this machine set for the highest speed it is possible to cut in coal or fireclay at the rate of 800 lineal ft. face in 10 hour shifts, the cut being the full depth of the cutter wheel. The operator remains at the front of the machine laying the track, handling the starting box and regulating the speed of the machine, and can also, by means of a hand wheel, so adjust the cutter wheel as to cause it to cut close to the bottom, or to cut over or under any impurities in the seam.

PHYSICAL SOCIETY.

At an ordinary meeting of the Physical Society, on Nov. 12th, Dr. G. JOHNSTONE STONEY, Vice President, in the chair, Mr. W. L. WATERS read a Paper on the

"Variations in the E.M.F. of the H-Form of Clark Cells with Temperature."

The authors, Messrs. F. S. Spiers, F. Twyman, and W. L. Waters, have investigated how nearly the true E.M.F. of Clark cells can be computed at different temperatures by applying the ordinary temperature-correction. As a standard, two cells of the Muirhead type are employed. The four cells under test could be put through cycles of temperature in a special heating bath, containing oil circulated by a centrifugal pumping vane. E.M.F.s were determined by a potentiometer method, and a careful study was made of the "lag" of E.M.F. behind temperature. The results are given in the form of curves. It is shown that "lag" in the H-form of cell is less than in the "Board of Trade" form. Under ordinary conditions, when the rate of variation of temperature is less than 2°C. per hour, by applying temperature-corrections the true E.M.F. of the H-form can be found to within a ten-thousandth of a volt. In this respect there is little to choose between the H-form and the "Muirhead" cell.

Mr. W. R. COOPER thought the authors did not express the case clearly. The E.M.F. of the "Board of Trade" cell could not, with reason, be itself stated within one per cent. But in some cases, when, for instance, cells were used differentially, greater accuracy might be required, as when a constant source of E.M.F. was being compared with the variations of another source. Here it might be necessary to know the "lag." He would like to know with what degree of accuracy the E.M.F. of the standard cell was determined by the authors. The "lag" that occurred in the "Board of Trade" cell was probably due to diffusion, crystallisation, and solution.

Mr. WATERS said the E.M.F. of the standard was measured by a Kelvin balance, to one in ten-thousand.

The VICE-PRESIDENT proposed votes of thanks to the authors, and the meeting adjourned until Nov. 26th.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, November 20th.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to the Islington Vestry Electricity Works, Eden Grove, Holloway, London, N.

MONDAY, November 22nd.

CAMERA CLUB.

8.15 p.m. A Paper on "Electric Waves," illustrated by telegraphy without wires, will be read by A. Campbell.

IMPERIAL INSTITUTE.

8.30 p.m. A Paper on "Electric Balloon Signalling Applied to Scientific Exploration in Arctic and Antarctic Expeditions," will be read by E. S. Bruce, illustrated by working models and experiments.

TUESDAY, November 23rd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "Central Station Electric Coal-Mining Plant in Pennsylvania," by W. S. Gresley.

WEDNESDAY, November 24th.

SOCIETY OF ARTS.

8 p.m. Second Ordinary Meeting. Paper to be read: "Progress of Metallurgy and Metal Mining in America During the Last Half-Century," by Prof. James Douglas.

THURSDAY, November 25th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Continuation of Discussion on L. Epstein's Paper "Accumulator Traction on Rails and Ordinary Roads."

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Wednesday noon.

Electric Tramway in Alexandria.—The electric tramway recently opened in Alexandria is of standard gauge, with Broca rails weighing 88½lb. per yard. The length of the line is 7½ miles. There are ten motor cars and no trailers, each car being equipped with two 25 H.P. motors. The cars are arranged so that they may be open for summer traffic, or closed in winter. There are three classes: 1st, 2nd, and ladies'.

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THE PROBLEM OF THE FLYWHEEL.

There is a popular scientific instrument by means of which attention may be directed upon the minutest detail of a small portion of an object, the whole of the remaining parts of the object being excluded from sight. It is called the microscope. As a means of studying the most refined detail, apart from the object as a whole, the instrument is without parallel; but when the exact proportions of a moderately large object are to be made manifest, the instrument is valueless and its use absurd.

At a recent discussion on a Paper on "Mechanical Features of Electric Traction," read by Mr. PHILIP DAWSON before the Institution of Mechanical Engineers, a well-known and experienced builder of steam engines, Mr. JOHN S. RAWORTH, brought under the microscope of his critical examination of the electric traction problem just one small, though undoubtedly vital, fragment of the subject, viz., the utility of the engine flywheel. He concentrated attention upon the action of that element of an engine upon the engine itself, to the exclusion of all thought of its action upon the traction system as a whole; which resulted in the enunciation of a doctrine so novel and so radically the opposite of what has been taught hitherto, that it can scarcely fail to startle the majority of electric traction engineers. Mr. RAWORTH'S new gospel is that for an electric traction steam engine the less flywheel there is the better; that to load the engine with a massive flywheel in order to meet the emergency of a sudden large increase in the demand for power is wasteful and ridiculous excess; and that were it not for the internal requirements of the engine itself no flywheel would be needed. This, read in

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the light of universal practice at home and abroad, as we have already said, is an astonishing doctrine. We have seen in our time many a promising engineering custom, like a sturdy oak, plucked up by its roots, a rival growth springing up in its place; we have seen the pendulum of engineering opinion, especially of electrical engineering opinion, swing to-and-fro from one extreme view to the opposite. In one session we saw almost everyone flock to the standard of the Lancashire boiler; in the next, to that of the water-tube boiler; later still, it was proclaimed that thermal storage is the one correct practice; shortly afterwards we heard that Lancashire boilers *are* thermal storage. And so the cycle of boiler practice, engine practice, dynamo practice, cable practice goes ceaselesaly round and round. We watch with curiosity to see to what extent flywheel practice in British electric traction stations will follow the lead of Mr. RAWORTH.

The new doctrine teaches that a heavy flywheel is a mistake, because it is the cause of all the sudden and severe shocks to which a traction power engine is subjected; that, inasmuch as the steam cannot develop more than the horse-power corresponding to the speed and cut-off at the moment, and all excess of horse-power must come from the flywheel, the remedy for the strains arising from sudden excess of horse-power is to cut down the weight of the flywheel. Undoubtedly this remedy will have the effect of preventing the possibility of any great sudden excess of power; but the question naturally presents itself, whether this is exactly what is required of a traction power engine? The practice may suit the engine well enough, especially if it be a frail one; but how about the tramcars? Will these cars, at a time when a sudden increase of power is required, run satisfactorily if they receive no additional power? In his anxiety to make things right for the steam engine Mr. RAWORTH appears to have forgotten that the public requires a smooth and regular service of cars. Let us examine what would happen if a lightly flywheeled engine were to drive a number of trolley cars: for convenience we may suppose there are three cars. When one car is running at normal speed and two are standing at rest the engine may be developing, say, 30 H.P. Now suppose the two resting cars simultaneously to start; each will require, say, 50 H.P., and there will be a call for 180 H.P. from the power station. Where is the extra power to come from? The governor cannot act with instantaneous promptness. For an appreciable time the requisite extra power will come from nowhere, and the voltage on the trolley line will fall a considerable amount. Consequent upon this lowering of the line pressure, not only will the two starting cars be unable to get away as fast as they should, but the voltage on the motors of the running car will fall and the speed of that car will be correspondingly reduced. Thus, whenever a heavy load is suddenly put on the line, the entire system of running and starting cars will be disorganised, and in place of smooth running there will be a sensitive jerkiness that will respond to every fluctuation of load on the line.

As a remedy for the lowering of line pressure, due to fall in speed, and to increase of current in the line, Mr. RAWORTH suggests that the field excitation should be increased so as to over-compound the dynamo a compensating amount. Present practice is to over-compound machines about 10 per cent., but apparently Mr. RAWORTH contemplates a much larger compensation than is represented by this figure. It is important to observe, however, that no change in the field excitation can increase the *horse-power* developed by the dynamo, unless a corresponding increase in horse-power is supplied from the engine or the flywheel. And it is extra horse-power that is required. Field regulation, therefore, can in no sense be regarded as a substitute for heavy flywheels, and the problem of supplying a sudden demand for extra power remains unaffected by the particular arrangements adopted for exciting the dynamos. In our opinion this problem calls for the employment of some system of energy storage—whether in the form of batteries or a heavy flywheel is a matter of detail.

REVIEWS.

Handbook to the Workmen's Compensation Act, 1897. By M ROBERTS-JONES. Third edition. (London and Cardiff: *Western Mail*, Limited. 1897.)

This is a handy summary of the law relating to employers' and workmen's liability, of the remarks by statesmen which may be interpretative of the statutes of the Act, and of decisions in cases in the past between masters and workmen. The author has included a useful section, in which schemes by mutual agreement between employers and employed are discussed, and he gives a specimen set of rules extracted from schemes which have already been accepted for regulating accident funds contributed to by both employers and employés. So convinced are we that only along these lines can be secured those smooth and amicable relations between the workman and his employer by which the former is sure of real compensation that we may specially recommend this ably-written section to the notice of both. The book concludes with an Appendix, wherein is a summary of the statutes referred to in the Compensation Act of 1897, besides various useful forms of claims, awards and notices for procedure under the Act. There is a good index.

Lectures on Physiology. First Series. "On Animal Electricity." By AUGUSTUS D. WALLER, M.D., F.R.S., Fullerian Professor of Physiology at the Royal Institution of Great Britain. (London: Longmans, Green and Co.)

In these lectures Prof. Waller sets forth the pith and essence of what is known of the electromotive forces of animal tissues. The subject is a difficult one; but the author has made it peculiarly his own, and has illustrated the points with tracings taken by very ingeniously-contrived recording apparatus.

Owing to its difficulties, the subject is one which only has an interest for a very limited circle, and the meaning of the phenomena which have been observed is not yet plain. It is probable that small electrical changes might be detected, with suitable apparatus, in all cases in which energy is set free, just as some heat may be found to be liberated under these conditions; and in this case both the heat and the electricity might be regarded merely as small amounts of inevitable waste in an imperfect mechanism; but, on the other hand, the small electromotive forces observed during voluntary muscular or nervous action may have their counterpart in the voluntary electrical discharges of the torpedo and other electrical fishes, in which case their importance is, perhaps, much greater. Some of the terminology which has grown up with the subject may seem strange to those whose knowledge of electricity lies chiefly in its commercial applications; but the author has defined his terms, and therefore they need not present any serious obstacle to the student.

The book is essentially a worker's book, with plans and full details of the apparatus used. The electromotive forces measured are of the magnitudes of thousandths or hundredths of a volt. Some of the figures are beautiful examples of automatic recording by photography.

Wechselstrommessungen und magnetische Messungen. Part 2 of Elektrotechnisches Praktikum. By Dr. C. Heinke. (Leipzig: S. Hirzel. 1897.)

The object of this work, as stated by the author in his preface, is to assist students to carry out investigations such as are ordinarily undertaken in electrotechnical laboratories, and within the compass of 300 pages he has certainly included nearly all the important methods of measuring alternate

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current and magnetic quantities. Educationally, however, it is difficult to understand for what class of students the work has been undertaken. The first part of the treatise, dealing with continuous current and photometric tests, has not yet appeared, and we are therefore unable to judge of the standard which the author expects.

A laboratory handbook should fulfil one of two conditions: either it should be carefully graduated to run concurrently with some theoretical course, or, if for advanced students, it should be a compilation of various experiments without lengthy theoretical explanations. From the former point of view the work utterly fails, as the author commences with a condensed account of Maxwell's mechanical ether analogies, and assuming the dynamical equation, which is certainly far from axiomatic, writes down its electrical equivalent, and integrates this equation by an unnecessarily cumbrous method. An intelligent student on reading this part might receive an impression that self-induction was analogous to the inertia of a flywheel, but would certainly never discover its connection with the magnetic field of the current.

Nor can the book escape criticism from the second point of view. For the advanced student the preliminary theoretical explanations given are in most cases unnecessary, and the attempted simplifications confusing. The whole of the theoretical explanations of the methods of measuring coefficients of induction and capacity by bridge methods are rendered ludicrous by the assumption of sine wave currents, although the author expressly describes the use of the secohmmeter which cannot by any possibility give such currents. As the bridge methods are perfectly independent of the wave form, and the results are more easily obtained from first principles, there is no excuse for this course.

The practical side of the work, however, may be recommended as of considerable value, and it certainly supplies a want often felt by those who, having sufficient theoretical knowledge, require a reference book to guide them to the most suitable methods of measurement to employ in various cases. The subjects taken up are: the measurement of current, potential-difference, and power, by direct and indirect methods; the determination of coefficients of self and mutual induction and of capacity, and the testing of characteristics, wave forms, and efficiencies of alternators and transformers. Special attention is given to the measurement of power for various synchronous and asynchronous motors, and for polyphase motors and transformers; and also to resonance phenomena in cables. The section devoted to magnetic measurements is also very complete and up to date, and includes the use of Ewing's curve-tracer and hysteresis meter, the bismuth spiral, Du Bois balance, &c.

Attention may also be drawn to the table of "form factors" for various shapes of waves, which Profs. Roessler and Wedding have shown to be of such importance to arc lamp and transformer efficiency. The descriptions and illustrations of the various instruments are uniformly clear, and one only regrets that more manipulative details are not given. It is to be hoped that the author may see his way, in a subsequent issue, to substitute such information for much of the theory now given.

STORAGE BATTERIES.*

BY E. J. WADE.

(*Continued from page 824, Vol. XXXIX.*)

A trouble to which electrodes of the grid type were even more liable some years ago than is the case at the present day was that of buckling and distortion of the support, or in extreme cases its fracture and tearing asunder. This action is mostly confined to the positive electrodes, and is due to the abnormal expansion of the active material contained in the holes in the support and consequent pressure put upon the surrounding walls.

In 1886 Farbarky and Schenek proposed to overcome this difficulty by constructing grid supports in which the cells containing the active material were surrounded by smaller apertures left empty, the idea being that as the active material expanded the enclosing walls would give and bulge into the unfilled spaces, and so relieve the strain that would otherwise be put upon the whole electrode. Fig. 12 is a cross-section and plan of the form of support illustrated in their patent, consisting of hexagonal holes for the active material divided from each other by oblong slots with curved sides.

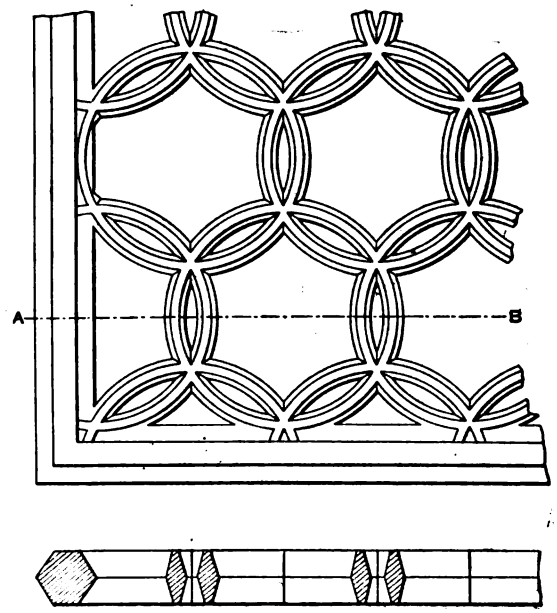

FIG. 12.

In 1889 Heyl proposed to construct electrodes on very similar lines, the grids shown in this instance containing rectangular cells surrounded by narrow grooves, either passing right through the support or divided into two by a thin wall in the middle. Fig. 13 shows a cross-section and plan of a portion of a grid constructed according to the latter method. Heyl also suggested turning in the walls of the cells after they were filled with active material, so as to hold it more firmly in position.

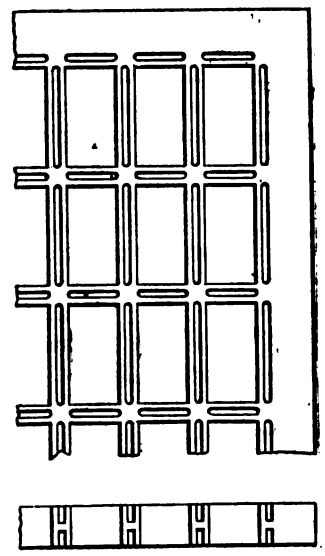

FIG. 13

In most forms of grid support, each pellet of active material is separated from the remainder by the cross-bars of the grid, but there are some in which the whole of the active material is in direct contact throughout the electrode. Sellon patented a grid of this kind in 1889, and it may be remarked, in passing, that, so far as the mechanical construction of pasted electrodes is concerned, there are not many possible directions for

* From a forthcoming book to be published by *The Electrician* Printing and Publishing Company (Limited). All rights reserved.

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improvement which Mr. J. S. Sellon does not appear to have investigated with more or less success. Fig. 14 shows a portion of this grid in plan and cross-section. The cells on either side do not coincide, but are so disposed that every cell opens into four others on the opposite side, and in this way continuity of the active material is maintained throughout. The result is just the same as if an ordinary grid with diamond section bars were split down the middle, and one half displaced diagonally over the other by half the width of one of the holes.

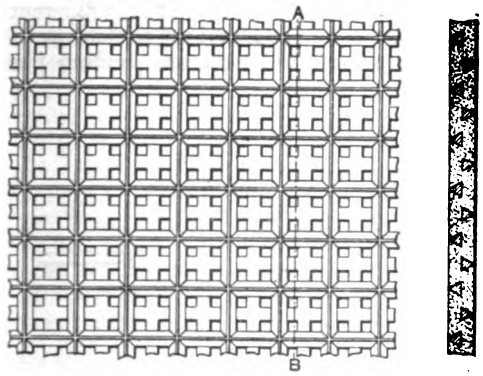

Fig. 14.

An ingeniously constructed grid of this kind is that patented by Correns later in the same year. His first plan was to superimpose two thin grids with square holes and parallel walls, placing them together so that the holes in each grid came centrally over the grid bars of the other. A stamp was next passed through the holes in one of the grids, and the bars of the grid underneath pressed into the shape of a triangle, with the apex inwards; then the grids were turned over, and the other bars stamped in the same fashion. By this method a good bearing surface was obtained at every point where the bars of the two grids intersect, which would not have been the case if two grids with triangular bars were merely placed back to back. Finally, the two grids were united by burning or other means.

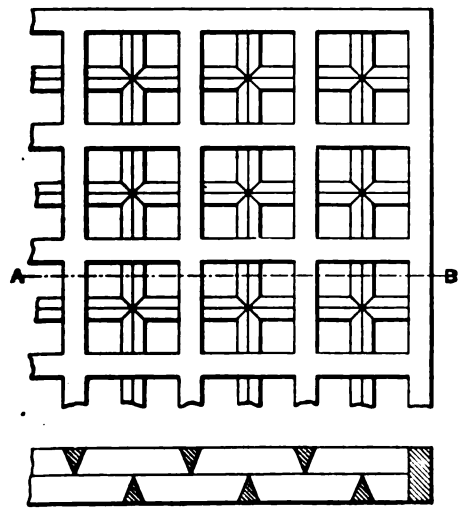

Fig. 15.

In a later patent this method was greatly improved upon and simplified by casting the complete grid at one operation in special interlocking moulds. Fig. 15 shows a plan and cross-section of a portion of such an electrode. It will be observed that in its general appearance it is very similar to Sellon's grid; but in the latter the bases of the triangular bars are inwards, giving inward tapering cells, while in Correns's grid the cells taper outwards. It is somewhat doubtful whether there is any real gain in having all the active material of an electrode in direct connection, but a more distinct advantage of these grids is that in proportion to their weight they offer a larger contact surface to the active material and divide it up more intimately without much diminution of their own strength. Also in 1889, Beyer and Hagen patented a form of grid support consisting of two half-grids held rigidly some distance apart by means of cross-connecting stays or studs and an outer frame, all cast in one piece with the grids. The holes in the two grids could either correspond or could overlap each other. Both methods are shown in Fig. 16. The casting of the complete support, *i.e.*, two grids and cross-connections all in one piece, appears at first not to have been a very practical affair, as it involved the use of cores of sand which would have to be re-made each time, but in 1894 the same patentees described and patented moulds which enabled them to cope with this difficulty, and to obtain cross-bars not only of a rectangular section as illustrated, but also of an undercut or triangular section. In 1892 Andreoli patented an electrode which, when completed, resembled the one just described, but was constructed in an entirely different manner. Two separate grids were held some small distance apart in a

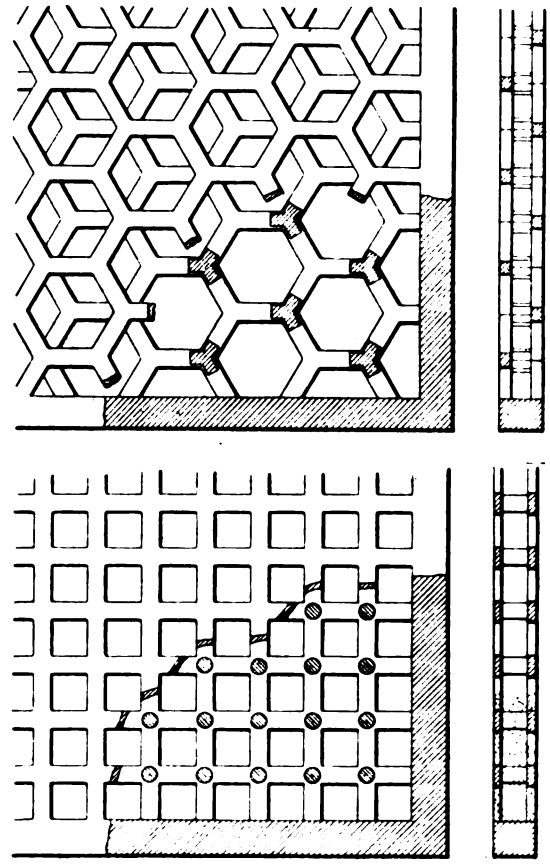

Fig. 16.

mould by means of brass pins passing through holes in both the grids. The space between them and the grids themselves was then filled in with molten lead chloride, and when this had solidified the pins were withdrawn and molten lead run into the holes left, thereby effecting a direct metallic connection between the two grids and binding them rigidly together.

In these two instances the supports have the same characteristics as other grids previously dealt with as regards direct connection between all the spaces left for active material and undercut cell walls, but the special object aimed at appears to be to reduce the weight of the support in proportion to that of the active material, for it will be perceived that, besides the active material held in the grids themselves, there is a complete layer of it between the two, except where the cross-connecting studs pass through.

Fig. 17 gives some cross-sections of a type of support patented by Clark and King in 1896. Here the two lattices are joined at intervals by crossbars or strips instead of by studs or pins. In addition, there is an intermediate partition

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which passes centrally between the lattices as in the first section shown, or runs obliquely from one to the other and from crossbar to cross bar as in the other two. There is also another modification in which the lattice on either side is not continuous, but only in alternate sections joined by crossbars, and there is no partition between them. The sections of the lattice are cast with curved faces (*see* Fig. 18) but are afterwards flattened out and the crossbars thereby set obliquely to them, so that the support finally appears as at Fig. 19.

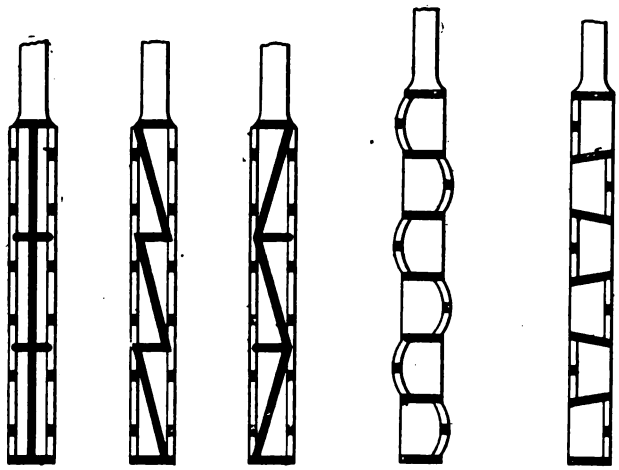

FIG. 17. FIG. 18. FIG. 19.

Schneider has also recently patented supports with various arrangements of partitions and crossbars between the two faces, and Lehmann constructs supports with grids in alternate sections but only connected by studs at intervals and not by continuous bars.

(*To be continued.*)

AN ELECTRIC CURVE TRACER.

BY PROF. EDWARD B. ROSA, PH.D.

Undoubtedly one of the most interesting and fruitful methods of study and investigation of alternating-current phenomena is the tracing of the forms and phases of alternating current waves. Without these curves one can gain only a very inadequate idea of the inner workings of a dynamo, motor or transformer. And considering the rapid multiplication of alternating-current apparatus, both of single-phase and multiphase varieties, it is evident that the field of usefulness of alternating-current diagrams, already very great, is constantly increasing.

The practicability of this method of investigation and testing has been seriously limited by the great labour of obtaining the curves, and the insufficient accuracy of the curves when obtained. To find and plot a dozen or two points and then draw a smooth curve through them and call it the curve of current or electromotive force will sometimes answer, for want of something better. But it is often unsafe to infer very much from such a curve. What is wanted is so large a number of points as to be practically equivalent to a continuous line, marking exactly the fluctuations of the current. And when several such related curves have been drawn to scale on a single sheet, showing the forms, phases and relative amplitudes of the currents and electromotive forces (and perhaps also the magnetisations and power waves) which are concerned in the operation of a given machine or system, we have a beautiful picture of what, in algebraic language merely, is not very attractive.

Various methods of obtaining these curves have been employed. An instantaneous contact-maker, connected with the armature of the dynamo, is generally used. The disc of the contact-maker revolves with the same angular speed as the dynamo, and a brush which rests upon its edge makes contact once in every revolution with a knife edge let into the disc. As the brush is advanced step by step, contact is made at later instants in the phase; but while the brush is at rest in any position the current and electromotive force return to the same values at each successive instant of contact. The value of current at the instant of contact (Fig. 1) is determined by measuring the difference of potential of the terminals AB of a known resistance through which the current flows. This potential difference is sometimes ascertained by joining a condenser, C (Fig. 1), to AB by a switch, N, through the contact maker CM, and then discharging the condenser through a ballistic galvanometer. Under these circumstances the charge of the condenser will be proportional to the difference of potential between A and B at the instants of contact in CM, and this in turn is proportional to the corresponding instantaneous

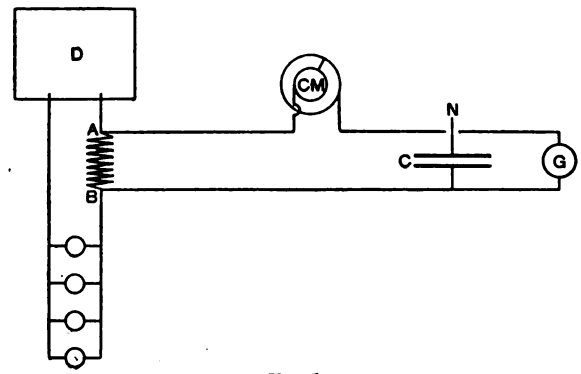

FIG. 1.

value of the current flowing from the dynamo. The position of the contact brush is then advanced, the condenser is again charged and discharged, and a second value of the current, corresponding to the new phase of contact, is obtained. Or, an electrometer may be substituted for the galvanometer, and its deflection read at each setting of the brush. In this way a number of points may be obtained and plotted out on cross-section paper and a curve drawn through them. But if the number of points is sufficient to give an accurate curve, the time and labour required are very great. Moreover, it may be impossible to keep the circumstances of the circuit constant for so long a time, and the later ones of a set of curves will not, therefore, correspond with the first.

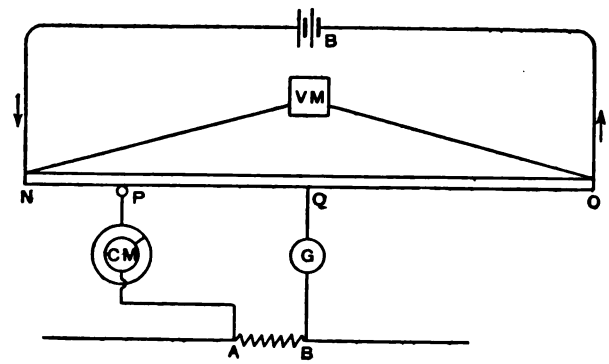

FIG. 2.

The Potentiometer Method.—In the following potentiometer method readings can be taken more rapidly, as well as more accurately, than by using a ballistic galvanometer or electrometer. A hard rubber rod, anywhere from 60cm. to 100cm. in length, is wound with one layer of copper or german-silver wire. If the wire is bare the rod may be threaded in a lathe, and this will secure insulation and uniformity of winding; if insulated, the insulation may be removed along the top side, so that a sliding contact piece passing over it will always make good contact (Fig. 2). A current from two or three storage cells flows through this potentiometer coil, and by means of a voltmeter and adjustable resistance the difference of potential of the ends of the coil is maintained constant. The instantaneous difference of potential at the terminals of AB

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is now measured by matching it against the known difference of potential of a part of the coil NO. The point Q, at the middle of NO, is joined through a galvanometer to B, while P, a sliding contact, is joined through the revolving contact-maker CM to the point A. When the difference of potential at AB and PQ are equal there is no deflection of the galvanometer. P is therefore moved in the direction indicated by the galvanometer deflection until the latter is reduced to zero. The distance PQ is then proportional to the current through AB; and knowing the difference of potential PQ, and the resistance AB, we determine at once the precise value of the current. The brush of the contact-maker may then be advanced, when the new setting of P will give the new instantaneous value of the current through AB. The galvanometer should be dead-beat, quick, and fairly sensitive. A D'Arsonval meets the conditions admirably, and indicating, as it does, the direction in which P must be moved to secure a balance, is superior to a telephone, which could be used. When the current is flowing from A to B, A will be at the higher potential, and P will fall somewhere on the left of Q. If, however, the current is from B to A, then P is on the right of Q. If the potentiometer coil is uniformly wound, and the settings of the sliding contact carefully made, this method gives very accurate results, and with less labour than most step-by-step methods. But at the best it is slow and laborious. If one undertakes to determine a large number of curves the successive settings of the brush are very tedious. The scale readings of the contact P must all be taken and recorded, and, finally, after these readings have been reduced, the curve is plotted out carefully by hand. One does this very willingly for a while, but if he attempts to determine accurately a considerable number of curves the work becomes a burden.

An Automatic Instrument.—It was while engaged in this kind of work nearly two years ago that I undertook to devise an apparatus that should reduce the labour and increase the speed of drawing electric curves. The apparatus, which is shown in Figs. 3 and 4, is the outcome of this endeavour. The most laborious parts of the operation, including setting the contact brush, are done automatically by the machine, and the work of several hours may be done in as many minutes. The measurements are made by the foregoing potentiometer method, the results are simultaneously plotted by the machine more accurately than they could be plotted by hand, and a curve being obtained in a few minutes the speed, voltage and other circumstances may be maintained more nearly constant than would be possible when the observations extend over several hours. For these reasons the curves obtained are of unprecedented accuracy.

To avoid the labour of reading, recording, reducing and plotting the various values of the current and electromotive force a pantograph is employed to print the curves automatically as the settings are made. The pantograph (Fig. 5) has one end fixed at P' and the other end fixed to the carriage, to which is attached the movable contact P. On an extra bar the printing electromagnet F is carried, and as the carriage and sliding contact P move to-and-fro along the spiral, F moves to-and-fro in a parallel line at a reduced speed. The distance of F from its zero position is therefore always proportional to PQ—that is, to the value of the current at the instant of contact. Hence, by printing a point directly under F upon a sheet of paper carried by a cylinder or plate, the instantaneous value of the current is permanently registered. This is done by closing a key, when an electric current passes through F and throws a steel point down upon a typewriter ribbon, printing a dot on the paper beneath it. This current also passes through an electromagnet on the contact-maker, and another on the record cylinder, attracting their armatures against the stop pins (*see* Figs. 3 and 4). When the key is released and the current broken these armatures are drawn back into their former positions by springs, and at the same time a pawl on each engages a ratchet wheel and advances it one or more teeth, according to the position of its stop pin.

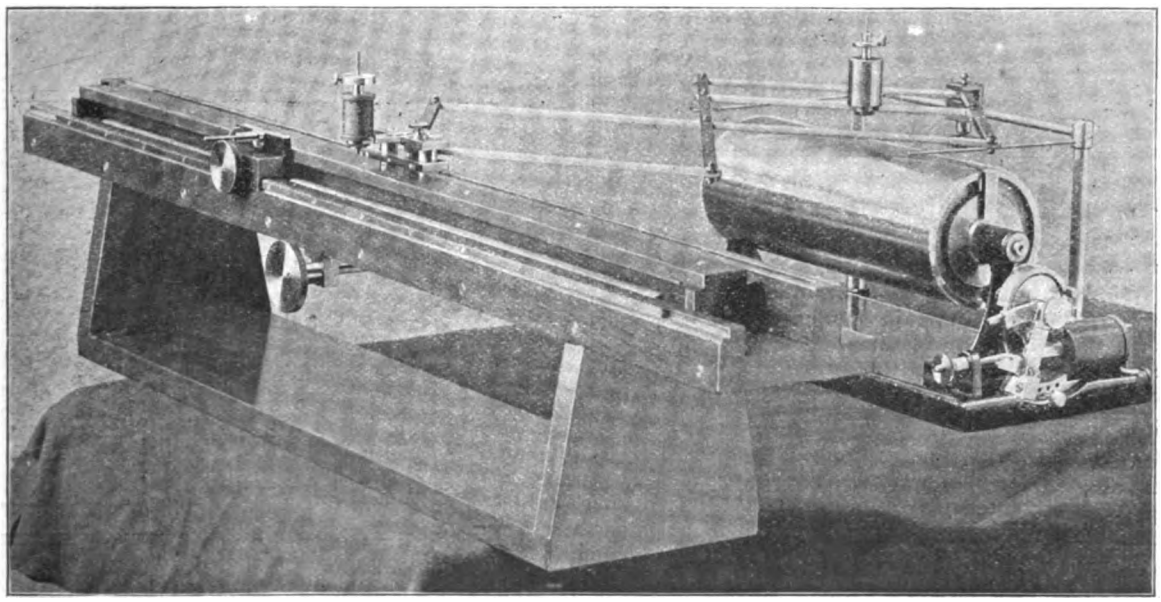

Fig. 3.—Prof. Rosa's Electric Curve Tracer.

Thus, closing the circuit prints a point upon a sheet of cross-section paper which permanently records the value of the current. Breaking the circuit an instant later causes the brush and cylinder to advance ready for a new setting of P and another point on the paper.

Drawing the Curves.—The galvanometer used is a quick, dead-beat D'Arsonval, and settings are made very rapidly. The carriage, to which the sliding contact and pantograph are attached, is moved to-and-fro by a cord which passes over pulleys at the ends, and is wound over a drum underneath the potentiometer coil. This drum is turned by a milled head shown in the photograph (Fig. 3.) The observer keeps his eye fixed upon the galvanometer scale. With his left hand he turns the milled head and so adjusts the sliding contact; with his right he works the contact key. As soon as the latter is opened the brush advances and the spot of light on the scale goes off the zero, to the right or left, according as the current has decreased or increased. The contact P is immediately moved in the same direction until the spot of light is brought back to zero, when the circuit is again closed, a point is printed, the brush advances, the spot of light again goes off the zero, &c. Twenty points a minute can be printed after some practice.

A second electromagnet mounted on the carriage prints a

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pencil point (if desired) on a strip of paper whenever the first one prints a point on the record sheet. Duplicate curves can then be printed by setting the pencil point over these dots, without running the dynamo, and curves originally printed on separate sheets can be combined on the same sheet. Typewriter ribbons of different colours are used for different curves, so that the curves are easily distinguished, even though they be considerably interlaced. The teeth of the two ratchet wheels are numbered, so that the contact brush and record

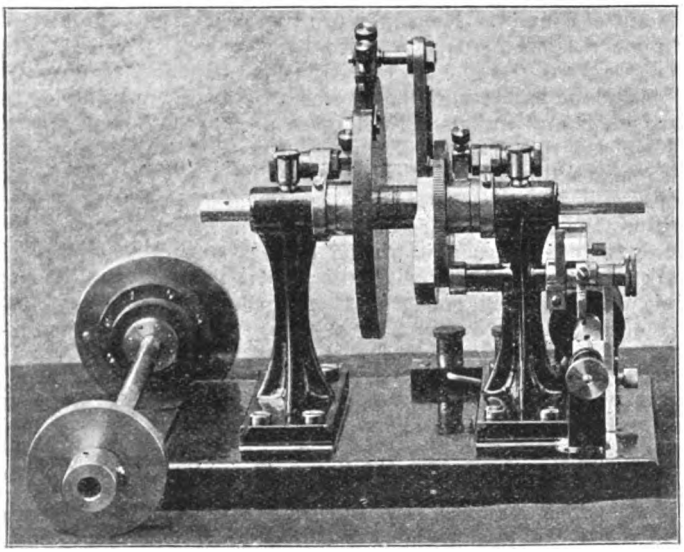

Fig. 4.—Contact-Maker for Prof. Rosa's Curve Tracer.

cylinder can be set at any particular position desired. In drawing a curve their initial positions are noted (Fig. 6), and when the curve is finished—suppose it represents the electromagnetic force of a dynamo—the brush and cylinder are turned back to the initial position, the switch S thrown so as to connect to the points AB of the primary circuit of the transformer, and the primary current is drawn. Turning

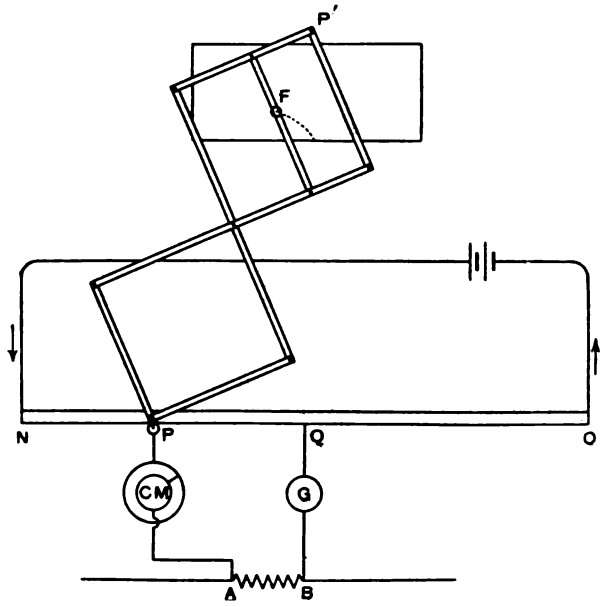

Fig 5.

back again to the initial position and joining to A'B' of the secondary circuit, the secondary current is drawn. The difference of phase of these waves will then be accurately represented by their distance apart on the record-sheet. The cylinder is 360 millimetres in circumference, and two complete wave lengths extend once around it. One wave is therefore 180mms. long on the record-sheet, and 1mm. is 2°. Hence, differences of phase are easily determined by counting the distance in millimetres on the record-sheet.

The Scale of the Curves.—The non-inductive resistances AB and A'B' are adjustable, so that any given current may be drawn to a suitable scale, which is chosen in advance. The potentiometer coil is 80mms. long, and the pantograph reduces the scale in the ratio of five to one. Hence, if the difference of potential of the ends of the coil is 4 volts, one volt corresponds to 20cms. on the coil or 4 cms. on the record sheet. If the resistance of AB is $\frac{1}{4}$ ohm, 4 amperes would give a potential difference of 1 volt, and this would be plotted on the paper as an ordinate 4 cms. high. Thus the scale of the curve would be 1 ampere per centimetre. If the resistance of AB is $\frac{1}{8}$ ohm, the scale would be 2 amperes per centimetre; if $\frac{1}{40}$ ohm, 10 amperes per centimetre, &c. If the cross-section paper is ruled in inches and tenths or twentieths, as is the case with what I have generally used, the scale works out similarly. 80cms. equal 31·5in.; one-fifth of this is 6·3in., the extreme range on the paper. Let the difference of potential of the ends of the potentiometer coil be maintained at 6·3 volts. Then one volt on the coil corresponds to 1in. on the

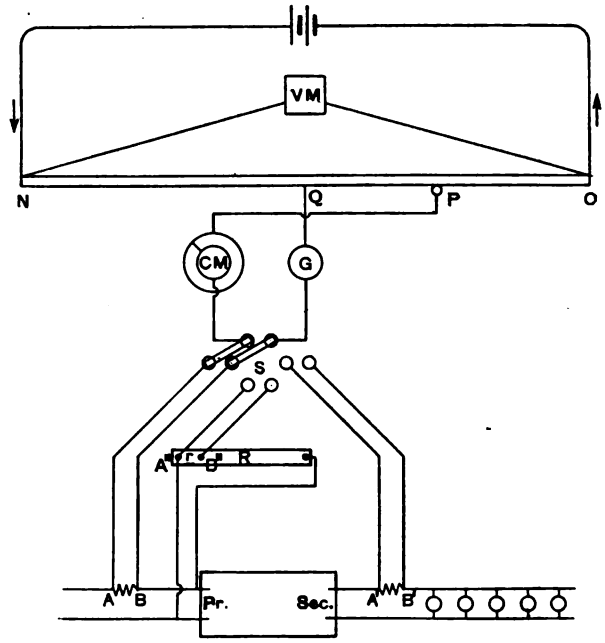

Fig. 6

paper. If AB has a resistance of $\frac{1}{4}$ ohm, the scale of the curve is 4 amperes per inch; if $\frac{1}{8}$th ohm, 8 amperes per inch; if $\frac{1}{40}$ ohm., 40 amperes per inch, &c.

(To be continued.)

THE BOSTON SUBWAY.

(BY OUR SPECIAL CORRESPONDENT.)

One of the most extensive systems of tramways in the world, as well as the earliest to be operated by the electric trolley, is that of Boston, Mass. It is indeed a matter of history and of common knowledge how the battle of the trolley for supremacy was fought on the Boston tramways in 1888, and how the victory it there and at that time won gave the requisite impetus for that great advance of the trolley which immediately ensued throughout America. The complex and far-reaching network of lines composing the Boston system comprises at the present time some 325 miles of track, the significance of which figure is best conveyed by a comparison with the mere 77 miles of track in the entire system of Glasgow tramways. These well-organised Boston lines are operated by the West End Street Railway Company, and, although an area including an immense population of over 700,000 people is served, the uniform fare for any distance on

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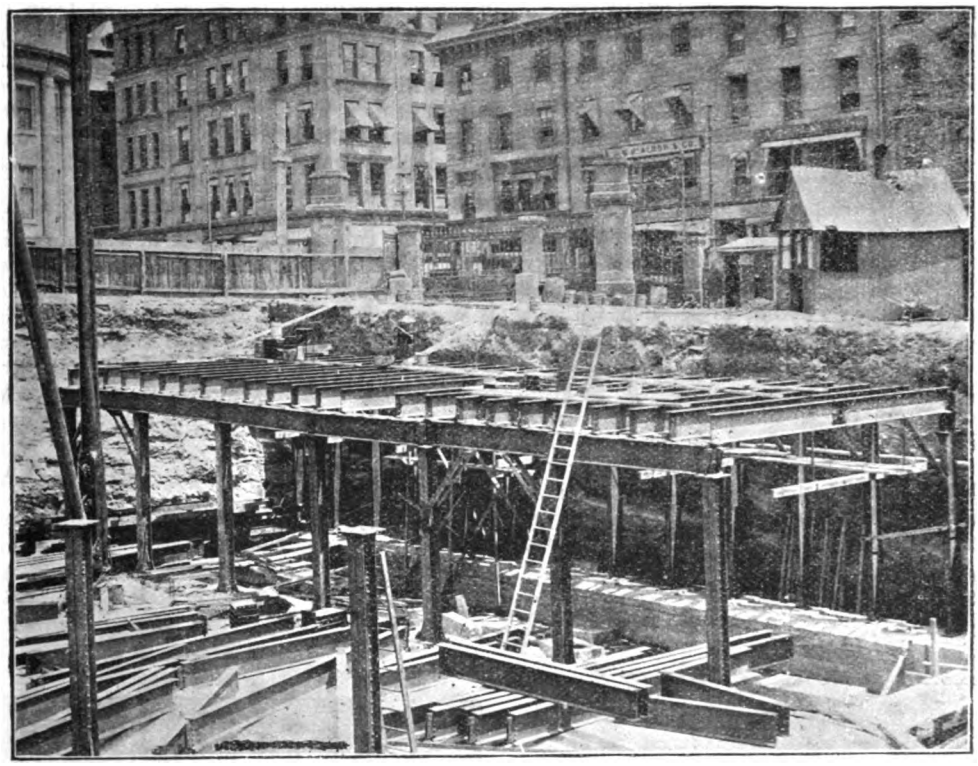

FIG. 1.—Boston Subway, showing Method of Construction.

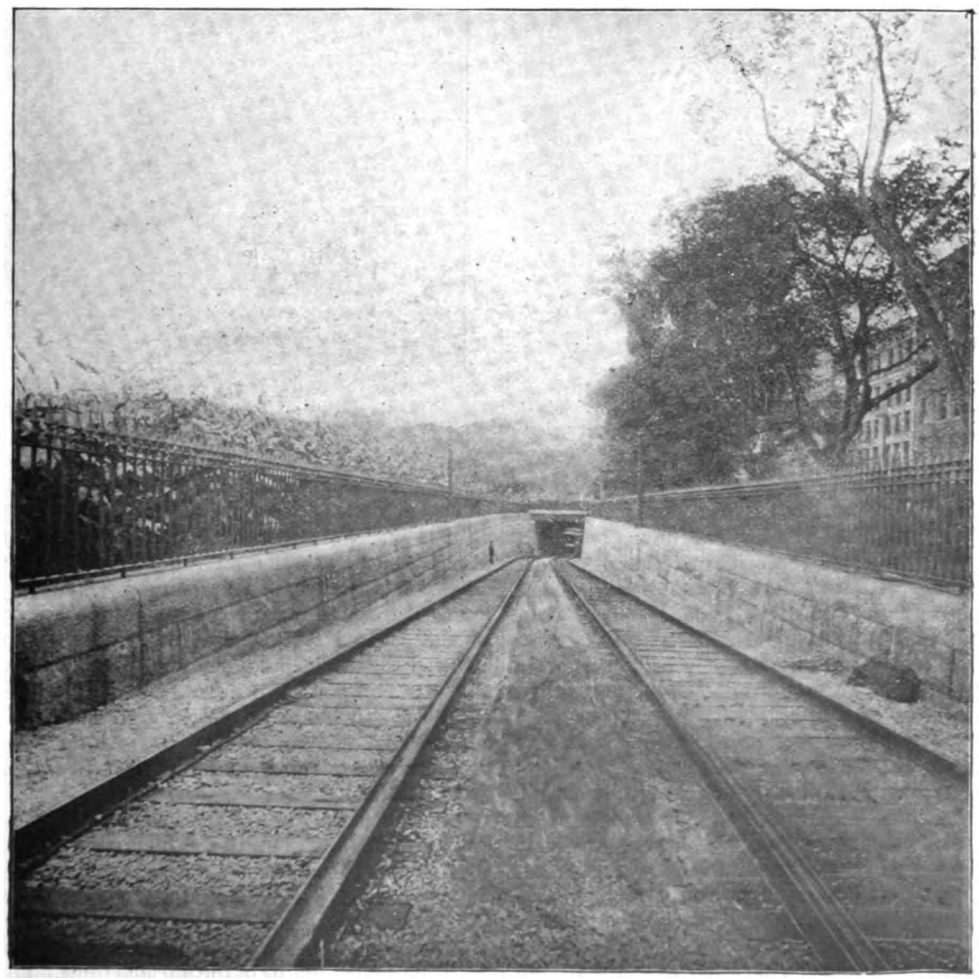

FIG. 2.—One of the Grade Entrances to Boston Subway.

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these lines, including transfer from car to car, is but five cents. A further comparison in this respect is of interest, viz., that whereas in Glasgow the capital expended in tramways is only 16s. per head of population, the outlay in the Boston system amounts to over £8 per head; while the sums expended by the public in travel on the tramcars are respectively 9s. 6d. and £2. 9s. per annum per individual. The Boston tramways, as we have already remarked, were one of the first of the American systems to be converted from horse lines to trolley lines, with the immediate consequence of an enormous accession of traffic. The effect of this, though satisfactory from a financial point of view to the company, and to the public in many ways, was not altogether without its drawbacks. The principal streets of Boston are narrower and less straight and systematically laid out than those of most American cities, and the enormous increase in vehicular traffic arising from the introduction of the trolley car threw these streets into a chronic state of congestion that finally became so bad that it pressed for a vigorous and decisive remedy. This remedy has been found in the new subway, by the construction of which the principal down-town streets, where the congestion was most acute, have been relieved of trolley cars, these now passing beneath the roadways. Another solution of the problem of providing rapid transit for Boston we may refer to in passing. This is the long-talked of system of electric elevated roads, similar to those of Chicago, some prospect of the actual building of which seems now to exist. These elevated lines, it would appear, are to form a loop around the principal business part of Boston, with branches radiating into the suburbs. As at Liverpool, a portion of these "elevated" roads will be constructed underground. We may also mention that the entire system of surface lines in Boston has recently been leased to the Boston Elevated Railroad Company, and will be worked in conjunction with the elevated lines.

The subway through which the cars now pass on their way through the busiest part of Boston is by no means a deep-level tunnel, being situated with but a few feet of concrete separating it from the surface roadway, as may be seen from Fig. 1. It is approached by short lengths of comparatively steep gradient, one of which is shown in Fig. 2. The object in view in placing the subway so near to the surface was to provide frequent and easy means of access between the underground cars and the sidewalks and shops on the surface. A deep-level tunnel might have saved the great expense arising from the necessity to divert sewers and conduits of all kinds, a fair specimen of which obstructions is shown in Fig. 3; but it would have entailed expensive elevators at frequent intervals, in order to convey passengers to and from the surface, or it would have deterred the public from travelling on the cars, by reason of their having to use long flights of steps.

As will be gathered from some of the illustrations accompanying this article, the form of the subway varies in different parts. Fig. 1 shows a method of construction largely adopted, and which we may remind our readers has also been adopted for the Budapest subway. The roof of the subway in this case consists of horizontal girders carried on principals supported on two or more lines of columns, the whole of this work being of steel and being covered in with brick arches overlaid with earthwork and concrete. Fig. 4 is a view of an alternative method of construction, in which the tracks are carried separately in elliptical tunnels. Cars enter the subway from the west and south, along a two-track way in each instance; and the two branch tunnels unite into a main four-track tunnel which extends northward to the present terminus at Park-street. At this terminus there is an underground loop, shown in Fig. 5, the purpose of which is to avoid shunting or the reversal of the trolleys and car driving. It is intended, however, to open up through communication with the surface lines at the northern part of Boston, so that this loop is but a temporary arrangement. Entrance to the subway is made by foot passengers through neat pavilions, built of granite and roofed with glass, three of which, situated on Tremont-street Mall, are shown in Fig. 6. Descending a short flight of stairs and passing through a registering turnstile (Fig. 7), the passenger reaches a granolithic platform, divided by iron trellis partitions to separate the up-town and down-town tracks. The subway tracks are more carefully guarded from trespass than are the majority of steam railroads in the United States, and instead of the passengers being allowed to wander at their own sweet will across the subway they are compelled to cross from the up to the down track, should they wish to do so, through such under-track passages as the one shown in Fig. 8. Along the subway a high-pressure water main is laid, with fire hose connections at every 125ft.

The track rails are of the usual girder type, weighing 85lb. per yard, in 30ft. lengths. They are spiked to timber cross-ties, and at the joints are bonded with two 0000 copper bonds at each joint. The rails and sleepers are carried on a foundation of rock ballast, varying from 12in. to 20in. in depth. Return conductors of heavy cable connect the subway tracks with the return mains of the surface lines. The trolley wire is of the peculiar 8-shaped section adopted in one or two other places in America. It has a cross-section of 360,000 circular mils, and weighs 3·192lb. per yard. The special shape of the

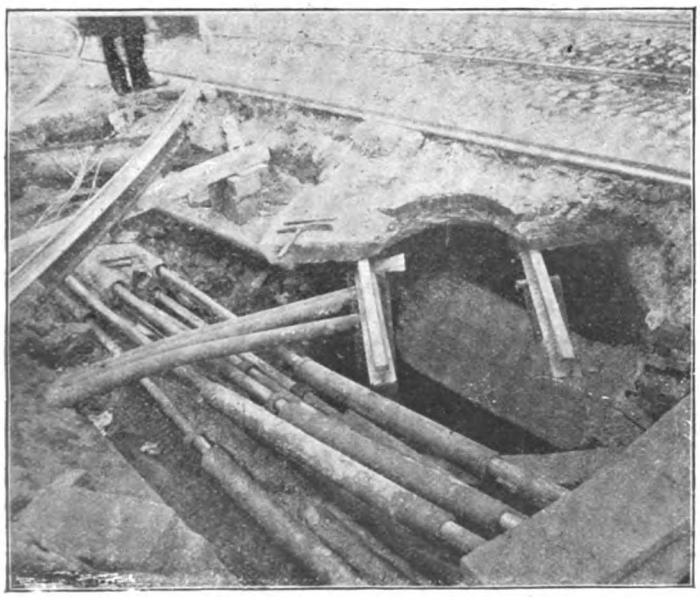

Fig. 3.—Broken Ground along the route of Boston Subway, showing some of the Underground Mains and Conduits which had to be Diverted.

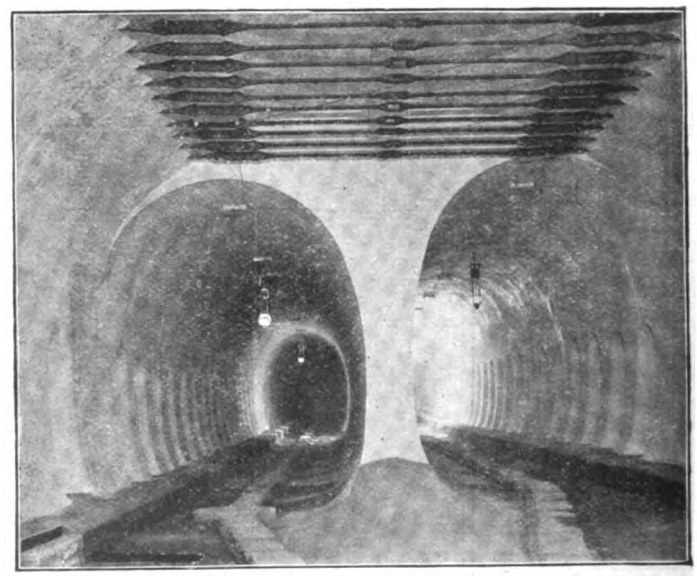

Fig. 4.—Elliptical Tunnel Construction in Boston Subway, showing Drain Culverts Exposed.

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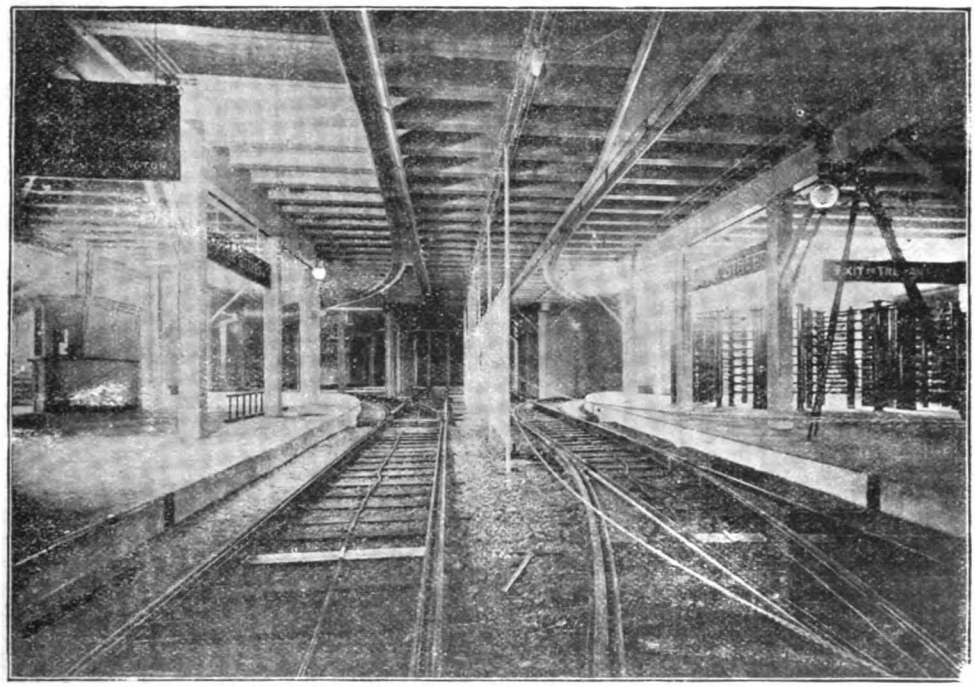

Fig. 5.—Poston Subway Terminus Station, showing the Loop Tracks.

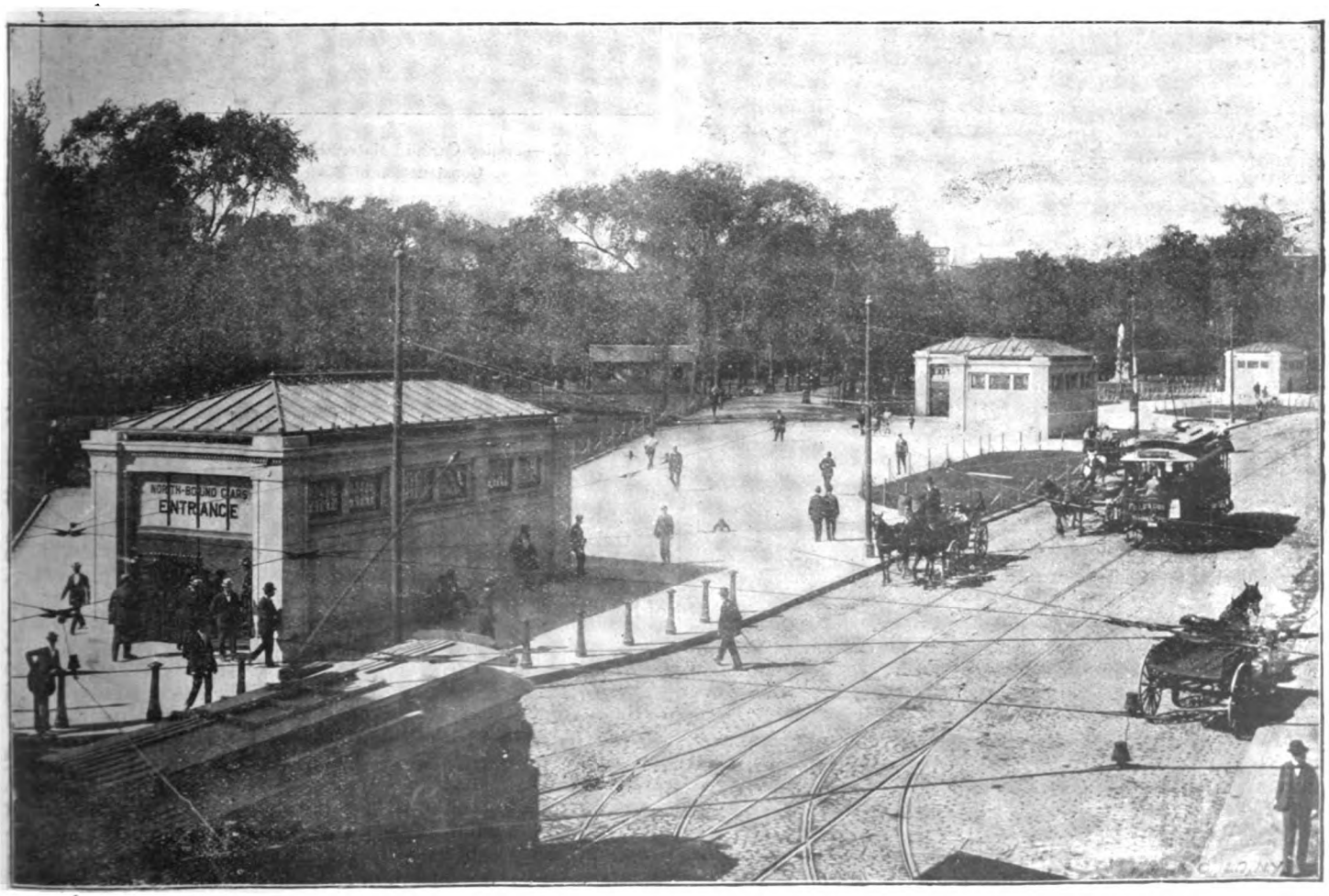

Fig. 6.—Surface Pavilions leading to Poston Subway.

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wire and the necessity to prevent it from twisting involve an unusually large number of hangers, these being spaced only about 12ft. apart on tangents and being as near together as

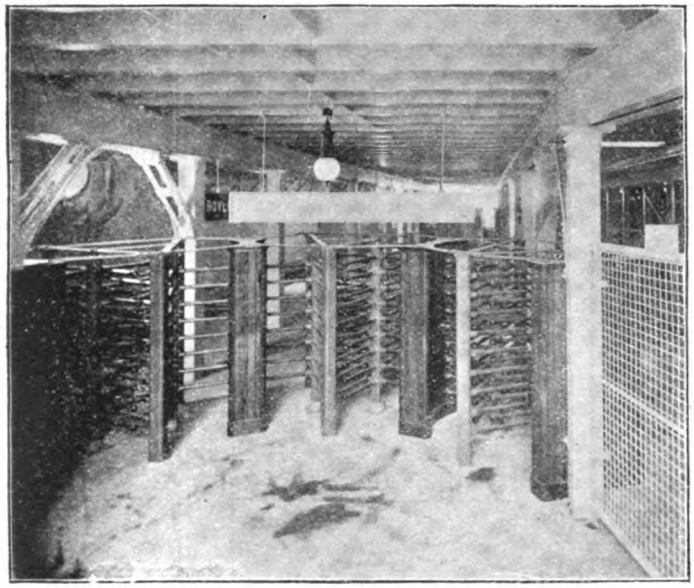

FIG. 7.—Passenger Entrance to an Underground Station.

6ft. on some of the curves. The hangers are supported from the roof by means of a running timber frame, shaped like an inverted trough (*see* Fig. 5).

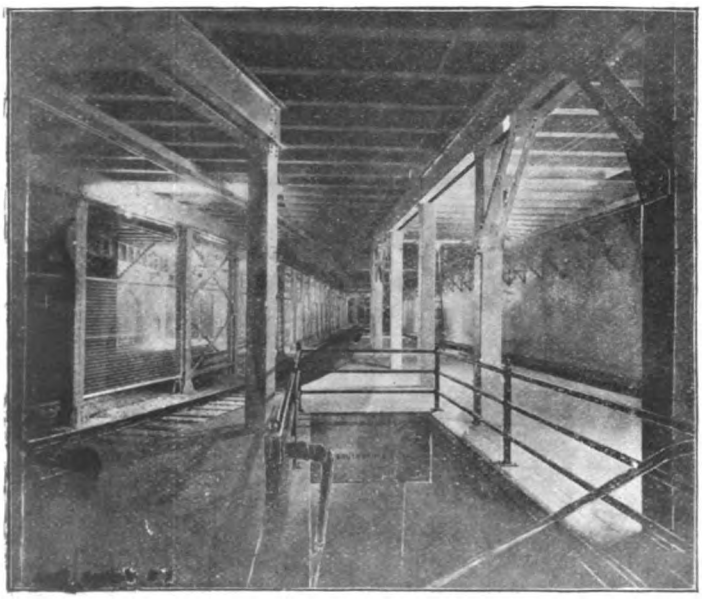

FIG. 8.—Under-track Crossing Tunnel for Passengers.

Admirable arrangements have been made for lighting and draining the subway, and the natural ventilation is perfect. The artificial lighting is effected partly by 600 glow lamps of

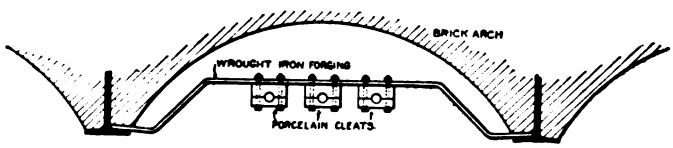

FIG. 9.—Insulating Supports for Suspending Cables to the roof of Boston Subway.

16 c.p. and some 55 enclosed arc lamps, the latter being capable of burning 100 hours without recarboning. The glow lamps are connected in series of five across the 500-volt trolley mains, while the "Manhattan" and "Helios" arc lamps are operated in a similar manner. There are also several ordinary arc lamps connected to the series mains of the Boston Electric Light Company. The cables for the lighting and trolley circuits are supported from the brick arches in the manner shown in Fig. 9.

In Fig. 4 may be seen the drainage conduits which are laid beneath the track ballast. These conduits convey the water to a system of electrically-propelled pumps, having a capacity of about 500 gallons per minute. The pumping plant is automatically operated by a float which is placed in a well, into which the conduits drain. On the water reaching a certain height the current is switched on to the motor, and a rotary pump is set in motion, the water being thereby discharged into the sewer. In regard to ventilation, a number of electrically-propelled fans have been provided for use at such times as when the natural ventilation proves insufficient.

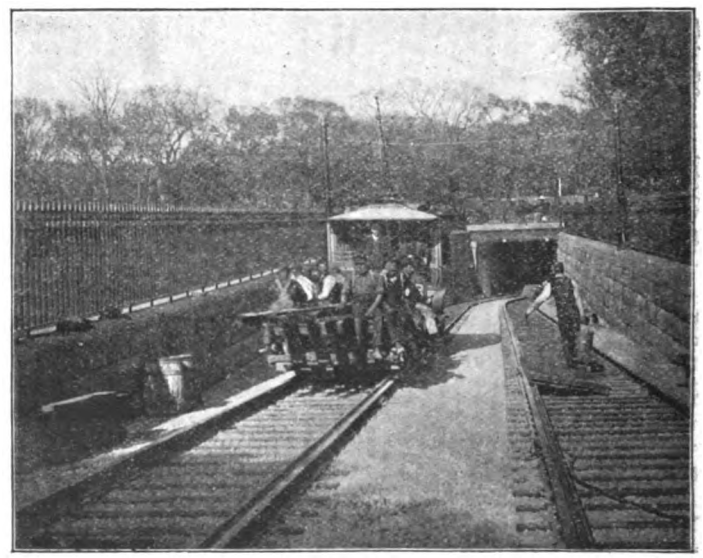

FIG. 10.—Trolley Car and Material Wagon Trailer as used during Construction of Boston Subway.

During the equipment of the track and overhead construction the material was carried forward on trucks hauled by the ordinary motor cars, as shown in Fig. 10.

CORRESPONDENCE.

A CORRECTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I see that you have altered a sentence in my article on page 91, and stated that Mr. Marconi was a student in Prof. Righi's class, whereas I only said "a student": a neutral and wide embracing term. I understood from Prof. Righi that Mr. Marconi had learnt about coherers and emitters from him; but that is not the same thing as being a member of his class.—Yours, &c., OLIVER J. LODGE.

THE PERMANENCE OF RESISTANCE COILS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There is an article on the above subject by Prof. Ayrton in your issue of Nov. 5th on which I should like to say a few words.

As my firm made the Lorenz apparatus for the McGill University, on which the tests of the ohm were made by Profs. Ayrton and Viriamu Jones, I may be considered to hold a brief on the same side, and certainly it would be most desirable that the standard of resistance should be able to be referred to simple measurements of length and velocity rather than to a coil of wire which cannot be reproduced if damaged.

But Prof. Ayrton, in his desire to show the evils of the "coil of wire" standard, very much overstates his case.

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Coils which are to be used as real master standards are most carefully treated. They are kept within reasonable limits of temperature, say, between 10° and 20°C. They are kept quietly in one room, and they are frequently compared with other coils. To begin with, they are never used at all till, from these checks against other coils, they are found, in the place they are to be used in, to have perfectly steady resistance. Now these four coils referred to by Prof. Ayrton have had a very different history. They have travelled about extensively between the tests, both by rail and carrier, and I have no ground for supposing that they have been kept from low temperatures, which often have very deleterious effects upon standards of the B A. pattern. They have, therefore, excuses for variation from which real master standards would be free.

But even allowing all this, I am by no means satisfied in my own mind that these coils have necessarily altered at all. The difference between the two platinum silver coils in 1894 (Test A) is 0·004 per cent. The difference in 1897 (Test C) is 0·0063 per cent. The difference between these differences is 0·0023 per cent. This amount of error would be caused by an error in temperature of 1/12 of a degree Centigrade, and he is a very bold man who will say that he is certain of the temperature of the wire in a B.A. coil to this accuracy, unless very exceptional care has been taken. In our own tests we do try for this accuracy, and I believe we obtain it even with the B.A. pattern, but only by keeping the coils in water in a room the temperature of which is kept steady to 0·5°C. for some 24 hours previous to taking the test. As far as the difference between the two coils goes, I think we may take it that the error shown is within the limits of error, that is, there is not sufficient proof that they have altered with respect to each other. With regard to absolute values they do appear to have altered, but I am by no means satisfied on this point either. The Cambridge value on the 10 ohm was in those days by no means so accurate as that of their 1 ohm, and the Board of Trade early values of the 10 ohm were, if I remember rightly, founded on the Cambridge 10; they now, of course, have worked up their 10 ohm from their 1 ohm.

The second pair of coils are $\frac{1}{10}$th of an ohm each only. Here again the difference between them remains exactly the same, namely, 0·008 per cent. between the two tests 1894 and 1897. There is a difference in the absolute value of 0·026 when taken by different observers against different standards at times 3½ years apart. This speaks well both for observers and standards, especially considering that errors of mercury cup contacts, etc., begin to have a very large influence when measuring these low coils.

By all means let us have the more scientific ultimate standard—one which depends simply on length and velocity. It is absolute and can always be reproduced, and we should all feel on a surer scientific bottom than now, depending as we now do on a coil of wire which is not reproducible, and which may at any time be burnt or otherwise destroyed. Such a standard, however, would be only of the same order as the standard yard, which is only looked at once a year, I believe. Wire sub-standards would be the only ones actually used for practical work.

The wish to have a better basis is, however, no reason for assuming against the old wire standards crimes which any jury of experts would bring in "not proven" on such doubtful evidence, and they would probably add as a rider that if guilty it was under great provocation.—Yours, &c.,

16, Red Lion-street, Clerkenwell. C. W. S. Crawley.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In *Le Mouvement Economique de Bruxelles*, of Feb. 27, 1892, under the head of "Telegraphie sans Fils," is a description of a patent granted to Thomas Alva Edison for a system of transmitting electric signals without the interposition of electric conductors.

An abridged translation of this article was embodied in a Paper on "Coast Telegraph Communication," read at the meeting of the Balloon Society of Great Britain on March 18, 1892. With your kind permission I will here repeat it in parts:—

He (Edison) says he has discovered that if one places oneself at a sufficient height not to be interfered with by the curvature of the earth . . . one can transmit from distant points telegraphic messages, or signals, by means of induction without being obliged to unite the two stations by means of wires. This discovery is especially applicable over a large expanse of water, or to make communication between two ships, or to establish communication between a ship and the shore. In the last case, to augment the height of the point of reception to the earth, he would employ balloons. At sea, at an elevation of 30 metres, communication can be transmitted to great distances, and the masts of ships, supplied with metallic plates, is all that is required.

Connection with the earth is established, and the secondary circuit of an induction coil of high resistance is placed between the surface of a condenser and the ground. The primary circuit is provided with a battery and some arrangement to produce signals. Closing the circuit produces inductive pulsations in the secondary circuit, which are transmitted to the condenser, whence they are transmitted by induction across the air, and are received by the electro-motograph connected with the distant condenser.

Now, although this system devised by Mr. Edison differs in the method employed of causing and transmitting the electric impulses, there are some points of similarity that are very striking; the employment of balloons, for example, to raise the metallic collecting plates sufficiently high to overcome terrestrial absorption, and the use of metallic plates at an elevation of 90ft. to 100ft. (about 30 metres) on land, and on the masts of ships, as intercepters or collectors of these impulses.

It is only just to Mr. Edison to call attention to these points.

In view, therefore, of Prof. Minchin's priority in the question of the collecting wire for Hertz waves, and Edison's practical adoption of elevated conductors to wireless telegraphy, some of the most important features in Signor Marconi's system appear to have been anticipated.—Yours, &c.,

Nov. 16, 1897. H. Benest.

THE COHERER AND HERTZ WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I should like to be allowed to confirm Prof. Jervis-Smith's remarks as to the sensitiveness of carbon powder or granules when used in place of the more usual metallic particles in a coherer. Some six months ago I conceived the idea that an experiment was worth trying to ascertain whether the conductivity of carbon powder was affected by the passage through the powder of Röntgen rays. On trying this, I found that the conductivity of the powder was enormously reduced at every discharge through the X-ray tube if duly shaken up during the intervals. It was not long, however, before I discovered that the effect was produced whether the X-rays were allowed to fall on the tube containing the powder or were prevented from so doing, and that the effect was, in fact, not due to the Röntgen rays at all, but to the electromagnetic Hertzian oscillations set up by the exciting induction coil.

A tube filled with granulated carbon, of the kind used in modern telephone transmitters, was found, in fact, to act as a coherer of considerable sensitiveness.

With regard to what Prof. Lodge says as to the advantage, for the long-distance transmission of Hertzian waves, of arranging the apparatus so that the electrical oscillations are normal to neighbouring conducting planes such as the earth, I may say that I have found that conducting planes, and even single copper wires, placed quite out of the direct path between transmitter and receiver, and even behind the latter, have a powerful effect in arresting the response to signals.

It occurs to me to suggest that the somewhat indifferent results usually obtained with parabolic or other metallic reflectors used for receiving and concentrating the waves may be due to this effect, the conducting and consequent damping action of such reflectors being in most cases more injurious than their reflecting power is beneficial.—Yours, &c.,

66, Victoria-street, Nov. 15, 1897. A. A. C. Swinton.

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TUNNEL ARMATURES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Several letters have been published in your columns concerning my article in your issue of Oct. 15, and I beg to offer the following explanations:—

First, with regard to the letter from Prof. du Bois: I owe him an apology, since at the time of writing my article I had overlooked his own article of Aug. 27, and only saw it for the first time a few days after mine was published. Had I seen it before I do not think I should have written anything, since I have added but little to what was given by him. Our phraseology differs in places. He prefers the expression "tubes of induction" to "lines of force." In that I am quite at one with him, but in writing an article intended to be as simple as possible one must employ terms in common use, even though from an academic point of view they are not above criticism.

His experiment on the mechanical force exerted on circularly-magnetised rings in a magnetic field pleased me very much, for this result had occurred to me as a necessary consequence of the explanation given in my Paper, and I was in fact meditating much the same sort of experiment on the matter when I read his own work and found myself anticipated.

The letters of Mr. Menges and Mr. Wilson attach the diagram of the lines of force round a buried conductor (Fig. 1 of my article), and in this I must join issue with them. The method of transmitting the mechanical force to the upper polar face I did not enter upon, but of course it is obvious that the forces on the two masses of iron must be equal and opposite. I do not find in my Paper any statement that can be interpreted as an assertion that the strain in the iron of the armature acts at a distance on the opposite pole piece. If I were to state that the force in a system of cable trams entered the system at the engine house, I should not thereby be taken to imply an action at a distance, merely because the statement did not, and was not intended to, carry information about the wire rope.

I had, as a matter of fact, drawn the lines of force in the upper pole in the conventional way without thinking. Taking it in detail, the direction of the lines of force between two pole faces, in the lower of which there is a buried conductor carrying a current, is shown in the figure, where ABCD is the path near the surfaces and in the air space. Let the angle made at the pole-face in the iron with the normal = δ, the angle in air = ϕ, and δ' ϕ', the respective angles at the surface of the armature. The component along the surface of the magnetic force must be equal on the two sides of the polar face in iron and in air, while the induction through the face remains constant. Hence, if μ = permeability of iron, or in the more general case the ratio of the permeabilities of the two media,

$$\frac{\tan\delta}{\tan\phi} = \mu,$$

and at the armature face, $\frac{\tan\delta'}{\tan\phi'} = \mu'$.

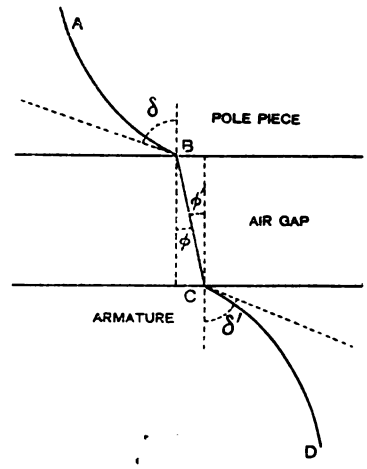
Unless near a polar horn, ϕ and ϕ' will be equal. In actual practice ϕ is very small, for $\tan\phi$ is the ratio of the tangential pull on the armature to the direct magnetic pull between pole-piece and armature, and this, I find, comes out about 1:30, or ϕ = 1deg. or 2deg.

This diagram will, I think, show the manner in which the mechanical drag is transmitted by magnetic strains from the iron round the conductor to the iron in the pole piece across the air-gap. In a real dynamo BC is practically perpendicular, and tan ϕ is small, but since μ may be 1,000 or more, δ and δ' will be large angles, and the lines will abruptly change their direction as they pass across from one medium to the other. Indeed, my diagram (Fig. 1), which Mr. Menges stigmatises as theoretically impossible, is much more nearly accurate than his own, which is wrong at both surfaces, and is refuted by his own statement that the magnetic force due to the exciting coils is very "stiff" and little altered by the armature current. This is quite true in the air-gap, where the magnetic force may be 5,000 to 8,000, but quite untrue in the iron, when the force will be about one-thousandth of this value.

Mr. Wilson is correct in one point. The little bend of the lines just at the lower face in my former diagram is incorrect, and I do not remember if my drawing gave this as it stands or not. It is quite possible I was wrong, for the law of refraction, mentioned above, is almost universally ignored in drawing diagrams. I have had the curiosity to look through half-a-dozen well-known text-books, and in all, except that of Prof. du Bois, the same mistake is made, a free-hand flowing curve being shown for the transition from iron to air, or *vice versâ*.

Mr. Wilson also correctly says that there will be a backward force in the iron below the armature bar, but I would point out that as the curvature is much more gradual the force will be much smaller. In fact, if the other side of the armature be drawn with its corresponding bar, this double curvature becomes the cause of the pull on the iron near to it, and properly acts in the opposite direction.

Mr. Menges' contention that the iron transmits the whole of the force, including that part exerted by the bar itself, is, I think, quite justified, though I fail to find any denial of this in Prof. du Bois' Paper. I understand that he only maintained that there was *some* mechanical force on the conductor, but the two statements are quite in harmony, since they deal with different parts of the path of transmission of the force.



Lastly, I distinctly object to the suggestion that I have implied that the lines of force "are like strings, passing within the iron and held there by friction along their surfaces." Mr. Menges may adopt this simile or not, as he likes, but I disclaim all responsibility.—Yours, &c.,

Heriot Watt College, Edinburgh. FRANCIS G. BAILY.

THE NEW MAXIM LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The letter of Mr. H. S. Maxim in your issue of the 12th inst. is interesting to me. This gentleman is apparently working upon lines I have endeavoured to advocate for some years past, and at one time tried to put into practice. I reasoned the matter as follows:—A short, thick filament will stand the molecular action better than a long thin filament, and, other things being the same, the efficiency will be greater. This view appeared to be common sense, but then came the question of how to increase the specific resistance of the material to be subsequently carbonised. After making various experiments the addition of a small percentage of alumina was discovered to have the desired effect. The filaments were carbonised at the highest temperature I could obtain, and fixed in the lamp bulbs, without being subjected to the process known to lamp manufacturers as "flashing" or "treating," in order to maintain the homogeneity of the filament.

The lamps were then run on the vacuum pumps at a gradually-increasing temperature until a peculiar kind of blue dazzle appeared, when they were sealed off. Lamps so prepared were found to run some hundreds of hours at a mean efficiency of well under two watts per candle without any indication of blackening on the globes.

I was, unfortunately, not able to carry out my views as I desired, but the results obtained convinced me that the efficiency of the electric lamp can be raised to a degree that is not yet obtained in practice.—Yours, &c., R. C. JACKSON.

Pandon Dene, Newcastle-upon-Tyne, Nov. 13, 1897.

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LEGAL INTELLIGENCE.

Taylor v. Sax.

We last week gave particulars of an action brought by a Mr. Taylor against Mr. Chas. William Sax, electrical engineer, for £500 allowed to have been promised by the defendant to the plaintiff in connection with the transfer of the Provisional Electric Lighting Order of the Lambeth (London) Vestry in certain contingencies. In the absence of the defendant Mr. Justice Mathew gave judgment for the plaintiff for the amount claimed.

On Friday last the case again came up for hearing before Mr. Justice Channell on an order to have the case reconsidered. Evidence for the plaintiff, in agreement with the account given in our last issue, was again adduced, and in the course of the remarks by Mr. C. A. Russell (who appeared for the plaintiff), Mr. Justice CHANNELL said it was for the defendant to show that the agreement was not carried out.

Mr. TINDAL ATKINSON, Q.C., for the defendant, said his client's application for the transfer of the Lighting Order to him was refused by the Board of Trade. His letter to the plaintiff was written on the supposition that he would obtain the Order, and if he had got it a company would have been promoted, under which he would have got £80,000, of which £55,000 would have been in cash. Instead of that, not one single share or penny of the consideration referred to in the agreement ever came to his client, and he had no interest whatever in the Company which was ultimately formed.

His LORDSHIP, after hearing evidence, said that there was no evidence of a transfer of interest to defendant, and he gave judgment for him, with costs.

New and Mayne (Limited).

Mr. Justice Wright on Wednesday granted (on the petition of J. K. and R. Lord) a supervision order in the matter of the winding-up of the above Company. There was no opposition.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

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"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced, and all the usual important articles, &c., which have made the book indispensable to the industry, will be brought up-to-date and amplified where necessary.

Tenders Invited.—Tenders are invited for plant and works in connection with the scheme for the conversion of the Blackpool Corporation electric tramways to the overhead trolley system. Tenders by 10 a.m. of Monday, 22nd inst.

——— The Londonderry Corporation invite tenders for the supply of electric-light carbons for one year from Jan. 1, 1898. Some additional information is given in an advertisement elsewhere, and schedules of quantities and further particulars may be obtained from the city electrical engineer (Mr. John Christie), Guildhall, Londonderry, with whom tenders must be lodged by Thursday, Dec. 9. Sir R. Newman Chambers is town clerk.

——— The Electric Lighting Committee of the Canterbury (Kent) Corporation invite tenders for the supply of: (*a*) boiler-house plant, (*b*) engine house plant, (*c*) overhead travelling crane, (*d*) switchboard and instruments, (*e*) accumulators, (*f*) mains, (*g*) public lamps, and (*h*) meters; of which further particulars will be found in an advertisement elsewhere. The specifications, &c., can be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., after Wednesday, the 24th inst., and tenders must be sent in to Mr. Henry Fielding, Town Clerk's office, Canterbury, on or before Monday, Dec. 20.

——— From our advertisement columns it will be seen that the Dundee Gas Commissioners invite tenders for an economiser for their electricity supply works, Dudhope-crescent-road. Specifications may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), and tenders must be sent in to the clerk to the commissioners (Sir Thomas Thornton), City-chambers, Dundee, by Friday, Dec. 3.

——— The Blackburn Corporation Tramways Company invite tenders for eight tramcar bodies, with trucks, motors, controllers, trolley poles, &c. Further particulars appear in our advertisement columns, and drawings, plans of route, &c., may be inspected at the office of the engineer (Mr. E. M. Lacey), 10, Delahay-street,

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Westminster, London, S.W. Tenders must be sent to the secretary of the Company (Mr. J. W. Baker), Railway-road, Blackburn, by noon of Saturday, the 27th inst.

Tenders Invited.—The Sanitary Committee of the Leicester Corporation invite designs and tenders for motor vehicles for house refuse collection. Further particulars appear in an advertisement elsewhere. Proposals, addressed to the Chairman of the Sanitary Committee, must be delivered at the office of the borough engineer and surveyor (Mr. E. George Mawbey, C.E.), Town Hall, Leicester, by Monday, Jan. 31 next.

——— The Directors of the Great Northern Railway Company require tenders for the supply of new, and the purchase of old, stores for twelve months from Jan. 1 next. A list of the contracts and other information can be obtained on application to Mr. Martin, Stores Superintendent, Doncaster. Some information is given in our advertisement columns, and particular attention is directed to, and the places at which, the sealed samples and patterns will be exhibited from the 22nd inst. to Dec. 3. Tenders have to be sent in not later than 10 a.m. of Saturday, Dec. 4, to the Company's Offices at King's Cross, London, N. Mr. William Latta is secretary.

——— The Metropolitan Asylums Board invite tenders for the execution of certain additions and alterations to the electric fire alarm system at the South-Eastern Fever Hospital, Hatfield-street, S.E. Copies of the specifications, &c., which have been prepared by Messrs. Burstall and Monkhouse, electrical engineers, 14, Old Queen-street, London, S.W., can be obtained at the offices of the Board, Norfolk House, Norfolk-street, London, W.C., and tenders must be sent in to the offices not later than 10 a.m. of Thursday, Dec. 2. Mr. T. Duncombe Mann is secretary to the Board.

——— The Postmaster-General invites tenders for the purchase of old telegraph stores, including about 26 tons of gutta-percha, 40 tons copper (wire, plates, &c.), and a quantity of other metals, india-rubber-covered wire, &c. Tenders by 10 a.m. on Tuesday, the 23rd inst.

——— Tenders are invited for providing telephonic communication at the workhouse and offices at Bishop Auckland. Particulars from the Master, and tenders to the Clerk, by 24th inst.

——— The Municipal Authorities of Catanzaro, Italy, invite tenders until Dec. 30 for the construction of a tramway, to be operated by electricity or cable.

Tender Accepted.—The Eccles Town Council have accepted the tender of Mr. George Macfarlane for the erection of electricity supply station buildings at £1,990.

Sales by Auction.—Messrs. Fuller, Horsey, Sons and Cassell notify in our advertisement columns that, by order of Mr. Justice Vaughan Williams, they will offer for sale at the Waverley Typewriter Works, Handforth-road, Clapham, London, S.W., on Thursday and Friday, Dec. 2 and 3, at 11 o'clock each day, a costly collection of modern machine tools, including screw-cutting and other lathes, milling machines, a 6 H.P. Otto gas engine, a complete electro-plating plant (including two dynamos, two plating backs, tanks, polishing lathes, &c.), as well as the office furniture, stock and stores, consisting of about 250 Waverley typewriters, &c. Catalogues, when ready, may be had of the Receiver, Mr. James Harris, F.C.A., 8, Old Jewry, E.C.; Messrs. John H. Mote and Son, solicitors, 11, Gray's Inn-square, W.C.; and of the auctioneers, 11, Billiter-square, E.C.

——— Messrs. Percy Huddleston and Co., of 72, Finsbury-pavement, London, E.C., have received instructions to sell by auction, in one lot, at the Mart, Tokenhouse-yard, E.C., on Wednesday, Dec. 1, at one o'clock, the leasehold premises known as the Copper Depositing Works, West Ferry-road, Millwall, E. Some particulars will be found in an advertisement elsewhere, and all other information can be had from Mr. E. Wilding, 2, Clement's Inn, W.C.; Messrs. Ward, Perks and McKay, 85, Gracechurch-street, E.C.; Mr. William Bullock, Bushbury, Wolverhampton; Messrs. Morley and Shirreff, Gresham House, London, E.C.; and of Messrs. Percy Huddleston and Co.

Appointment Vacant.—The Urban District Council of Llandudno require a clerk of works to supervise, under the consulting engineer, the erection of the electric lighting plant and other works in connection therewith. Salary £3. 10s. per week. Further particulars are given in an advertisement elsewhere.

Dissolutions of Partnership.—The partnership business contemplated and announced between Messrs. Alfred John Harrison and Eliot C. Pringle (trading as Harrison, Coles and Co.), electricians, Hermitage Electrical Works, Richmond, Surrey, Market-place, Kingston, and Kensington-court-place, London, and W. C. Middleton (trading as the Thames Cycle Company), cycle manufacturers, Kew Gardens, has been abandoned and dissolved. The businesses will be carried on separately as before.

——— Messrs. William Henry Johnstone, Wesley Sutton, and Samuel Lord, electricians and electrical and general engineers, 16, Redcross-street, Liverpool (trading as the Howe Electrical Engineering Company), have dissolved partnership. Debts by Messrs. Sutton and Lord, who continue under the old title.

Business Notice.—The Fowler-Waring Cables Company (Limited) have appointed Mr. H. F. Harris, 40, Merrion-avenue, Blackrock, Dublin, as their agent in Ireland for the supply of all types of both lead-covered and rubber-covered electric light and tramway cables.

Personal.—Mr. J. Cecil Bull, secretary and general manager of the City of London Electric Lighting Company (Limited), has been elected as a member of the Council of the Institute of Secretaries.

——— Mr. Reginald Arthur Egerton has been appointed to the position of secretary to the Post Office, in Ireland, *vice* Mr. Cresswell.

Liquidation.—At a meeting of the I.E.S. Accumulator Company (Limited), on Oct. 26, it was resolved to wind up the Company voluntarily, and to appoint Mr. D. F. Basden, 33, St. Swithin's-lane, London, E.C., liquidator.

Bankruptcies.—In the failure of S. Bousfield Tatham, electrical engineer, 26, Thurloe-place, South Kensington, the first meeting of creditors will take place on 22nd inst., at Bankruptcy Buildings, Carey-street, London, W.C., and the public examination at the same place on Dec. 14.

——— Claims against Edgar Haworth Berry, electrical engineer and contractor (trading as E. H. Berry and Pope), 22, St. Matthew's-street, Burnley, must be in by 30th inst. Mr. H. L. Price, 79, Mosley-street, Manchester, is trustee.

——— Frederick Griffin, late of 26, Clarges-street, London, W., whose bankruptcy was recently announced in these columns, attended at the Bankruptcy Court, London, last week for public examination. Liabilities £1,850, assets £154. Debtor entered into a partnership with another person early in 1895, with a view to exploiting a patent electrical battery. A syndicate had financed the project to the extent of £300: but negotiations for the formation of a limited liability company to take over the business proved unsuccessful, and the partnership was dissolved on condition that the partner, in the event of success being attained later, would take over the patent and recoup the syndicate. Examination closed.

Changes in American Patent Law.—Mr. J. C. Chapman, Chartered Patent Agent, 70, Chancery-lane, London, W.C., writes:—

It will interest your readers to know that on 1st January next certain changes of great importance in the U.S. Patent Law will come into force. Hitherto an inventor could always obtain an American patent if he applied at any time during the life of his English or foreign patent for the same invention, provided such invention had not been in public use in America for more than two years before his application for patent. This was a most generous law. Under the new Act, however, an inventor will not be able to obtain a United States patent for an invention unless he applies within seven months from the date of application of his English or other first foreign patent for the same invention. Therefore, those who now have English or foreign patents granted for an invention have still time to obtain, if they so desire, a United States patent for the same invention, but they must apply before January 1, 1898, in order to protect such invention under the provisions of the present law; they will lose the right when the new law comes into operation. If, therefore, inventors here have not already applied and desired protection in America they must act at once.

New Lamp.—We are informed that the Edison and Swan Company are about to place upon the market a new lamp, the chief feature of which is that "it is capable of being run at a very high efficiency." It is claimed that "when the pressure is steady an ecomony of at least 25 per cent. is effected."

The Jervis-Smith Chronograph.—The recent developments in fire arms of all kinds, and the very high velocities now dealt with, require the use of chronograph apparatus of much greater precision than has been formerly used. The well-known tramway form of chronograph, patented by the Rev. F. J. Jervis-Smith, F.R.S., Millard Lecturer in Mechanics, Oxford, is being largely used in connection with this work. Messrs. Elliott Brothers, of St. Martin's-lane, London, are the sole makers of this apparatus, under Mr. Smith's patents.

Lamina Accumulators, &c.—A catalogue is just issued by the Elieson Lamina Accumulator Company (Limited), 4, Greenland-place, London, N.W., giving particulars and prices of the several types of cells manufactured by the Company. The illustrations include the motor car type cell C7, and the particulars refer to the "Monarch" cell, which is especially designed for use with tricycles. The "Phona" type of cell is made specially for phonograph driving.

Electrical Supplies.—An excellent catalogue is to hand from Messrs. O. Berend and Co., of Basinghall-avenue, London, E.C., in which a large number of switches, resistances, cut-outs, instruments, tools, &c., are described and illustrated, and trade prices given. Ninety large quarto pages are filled with neatly-drawn figures of electric light and power apparatus and supplies of great variety, and bold-type textual particulars relating thereto.

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Telephone Plant and Apparatus, &c.—We have received from Messrs. L. M. Ericsson and Co., of Stockholm, the fourth edition of their catalogue of telephone plant, instruments and apparatus. It is five years since the third edition of this book was published, and note is made of the rapid development which has taken place in matters telephonic since that time. The demand for Messrs. Ericsson's plant has necessitated an enlargement of the works, which enables the Company to deal with all classes of plant required for public and private telephone installations. The catalogue is prepared in a manner which might with advantage be more generally adopted for this class of publication, the text being in English, German, and French in parallel columns. The illustrations are very effective, and the general get up of the catalogue is all that could be desired.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 10 to Nov. 16, with the ports of destination :—

Argentina—Buenos Ayres, £181 (telegraph material). *Australasia*—Albany, £185; Adelaide, £21; Fremantle, £188; Melbourne, £158; Sydney, £1,059 (including £23 telegraph material). *Belgium*—Antwerp, £88. *Brazil*—Rio Janeiro, £850. *Ceylon*—Colombo, £44. *Colombia*—Santos, £48 (including £22 telegraph material). *Egypt*—Alexandria, £220. *Gibraltar*, £151. *Holland*—Amsterdam, £45; Flushing, £98. *India*—Bombay, £46; Calcutta, £213; Madras, £443. *Italy*—Genoa, £767. *Japan*—Yokohama, £420. *Malta*, £73. *Mauritius*, £100. *Mexico*—Santa Cruz, £50 (telephones). *Portugal*—Lisbon, £67. *Russia*—Novorossisk, £8; St. Petersburg, £15. *South Africa*—Cape Town, £584; Durban, £391 (including £359 telegraph material); East London, £157; Port Elizabeth, £433 (including £130 telegraph material). *Spain*—Barcelona, £10; Malaga, £215; Pasages, £188. *Sweden*—Gothenburg, £197; Stockholm, £1,209 (including £249 telegraph wire). Total, £8,922, against £8,222 in the corresponding week last year (Nov. 11 to Nov. 17).

The "Engineering Magazine."—The contents of the November issue of this Magazine include articles on "The Effect of Trade Unionism upon Skilled Mechanics," by Hiram S. Maxim; "The Enormous Possibilities of Rapid Electric Travel," by C. H. Davis and F. S. Williamson; "The Economical Governing of Steam Engines," by John S. Raworth; "Future Supremacy in the Iron Markets of the World," "Modern Wharf Improvements and Harbour Facilities," "Cost-keeping Methods in Machine Shop and Foundry," "The Modern Tall Building from a European Point of View," "The Growing Importance of Cement in Constructive Work," "Iron Ore Loading on the American Great Lakes," and "English Goods Station and Railway Yards." The usual review of the World's Technical Press is also given. Copies may be had at *The Electrician* Office, Salisbury-court, Fleet-street, London.

Electro-Harmonic Society.—A "Ladies' Night" entertainment of this Society will be given in the St. James's Hall Restaurant, Regent-street, London, on Friday evening next, at eight o'clock.

Asylum Lighting.—At the fortnightly meeting of the Governors of the Richmond (Dublin) District Lunatic Asylum a discussion arose as to the lighting of one of the blocks at Portrave Asylum. The architect had recommended the use of acetylene gas, but as the medical superintendent (Dr. M'Weeny) expressed himself in favour of the electric light, this course was decided upon.

Bangor.—The Town Council have purchased the land for the site for their electricity generating station.

Barrow.—The Town Council are to apply to the Local Government Board for sanction to a loan of £30,000 for the purpose of establishing electricity supply works.

Bedford.—The Town Council have obtained the sanction of the Local Government Board to borrow a further sum of £19,650 for electric light extension purposes. The loan is to be placed at 2¾ per cent., the lowest rate of interest ever paid by tne authority.

Bermondsey (London).—The electric lighting project was again discussed at the last meeting of the Vestry, and it was decided to limit the initial expenditure to £16,000. The Vestry will apply for a Provisional Order next session.

Blairgowrie.—An improvements committee has been formed, at the instance of Mr. J. L. Ford, for the purpose of erecting electricity supply works and establishing a telephone exchange in the district. Mr. Ford is collecting information as to the lighting of other towns in Scotland similar to that of Blairgowrie, and will probably submit full details at the next meeting of the Police Commission.

Bray.—In order to further increase the demand for electric current the Township Commissioners have decided to reduce the price from 8d. to 6d. per unit, the reduction to take place on Jan. 1 next, when the Commissioners propose to give a continuous supply.

Cardiff.—The Chairman of the Electric Lighting Committee (Alderman Carey) announced at the last meeting of the Town Council that it was proposed to lay electric light mains in several additional streets, and the by-streets within 100 yards of the mains will shortly be lighted electrically.

Cheltenham.—Lieut.-Col. A. C. Smith held a Local Government Board inquiry here on Thursday last into the application of the Town Council to borrow £18,385 for electric light extension purposes. The town clerk (Mr. E. T. Brydges) said that sanction had already been received to borrow £47,405, of which £41,137 had been expended. The chairman of the Lighting Committee (Mr. Ald. Norman) submitted particulars as to the financial position of the undertaking. He said that at the end of the year they expected to have a balance of £1,700, or, after paying interest, allowing for depreciation and sinking fund, and meeting all capital charges, a surplus of £300 to £600. On the first ten months' working a deficit of £1,800 was incurred, but at the end of the first complete year this sum was reduced to £1,150. The equivalent of 12,002 8-c.p. lamps was now connected (representing 195 customers), and there were 22 more customers awaiting supply, representing 1,368 8-c.p. lamps. Current was being supplied to 63 public lamps at 1½d. per unit. He then handed in a detailed statement of the new machinery and building extension works proposed to be carried out. Mr. H. Kilgour, borough electrical engineer, also gave evidence in support of the application, and said the Council had been obliged, in order to meet the demand for the winter, to incur beforehand liability for practically the whole amount now under request by ordering the requisite additional machinery, &c.

Commission of Sewers (London).—In respect to the dispute between the City of London Electric Lighting Company and the Commission of Sewers as to the expenses of the City electric-light inspector, the Streets Committee reported at the last meeting that when the action came before Master Pollock in chambers an order was made for payment to the Company of £5,252. 5s. 7d., the amount originally offered, with liberty for the Commission to defend the action as to the residue of the claim. The Company, however, gave notice of their intention to appeal against the decision, and the solicitors to the Commission announced that the appeal had been dealt with by Mr. Justice Day, who had reversed Master Pollock's decision, and made an order for the payment of the additional amount claimed by the Company. The Commission have arranged for an appeal to the Divisional Court.

At the same meeting the solicitor announced that a summons had been issued by the Postmaster-General under the Telegraph Acts of 1863 and 1878, in respect to the dispute with the Commission as to the laying of telegraph pipes under the streets, and that the summons would be heard at the City of London Court on Dec. 1.

Crieff.—Mr. W. Arnot has submitted his report on the proposal to utilise the water power of the Barvick and Turret Falls in the generation of electric current for the lighting of the town. The falls are about three miles to the north-west of Crieff, and Mr. Arnot states that it would be necessary to form a large reservoir near the Barvick fall. The current would be conveyed from the generating station by means of overhead cables placed on poles 60 yards apart, to a sub-station at Crieff, where motor generators would be erected, and the current would be distributed on the low-tension continuous-current system. The cost of the necessary works at Barvick alone would not be less than £4,000, and that depended upon the nature of the ground forming the bottom of the reservoir. The electrica equipment could not be done under £4,000. Assuming that they would be able to sell 66,576 units of electric current per annum, working expenses would amount to £1,418, and if the District Council charged 6d. per unit, the income would be £1,664. Mr. Arnot thinks the cheapest way of lighting the town by electricity would be by steam-power. They could erect in Crieff a steam-driven station for £6,000. The working expenses would, in this case, only amount to £1,276, and by charging 5d. per unit for current there would, he estimated, be a net profit of £111.

Dudley and Stourbridge Light Railway Scheme.—The Light Railway Commissioners held an inquiry at Dudley on Saturday into the application of the British Electric Traction Company for powers to construct additional light railways and tramways in the Dudley and Stourbridge district. Mr. Sydney Morse, Mr. E. Garcke (Managing Director of the promoting Company), and Mr. S. Sellon appeared in support of the application. Mr. Morse explained that in connection with the existing Dudley and Stourbridge tramway, which was the basis of the scheme for which an Order was required, it was proposed to make extensions from Dudley to Kingswinford, through Pensnett, from Kingswinford to Stourbridge; from Stourbridge to Kinver, and from Dudley to Cradley, through Netherton, Old Hill, and Cradley Heath. The promoting Company had a share capital of £600,000, of which £300,000 had been paid up, and they had also power to borrow a further £300,000, making a gross capital of £900,000. The Company were in no way contractors, but investors, who had faith in the future of such undertakings. The total length of the lines would be 8 miles 5 furlongs 4·60 chains, and the population of the towns which would be affected by these tramways was,

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according to the 1891 census, between 110,000 and 120,000, and there had since been a considerable increase in the population. They proposed to work the line by electricity on the overhead system. His clients were, at the present time, negotiating for the purchase of the South Staffordshire Tramways, and so far as those tramways were electrical his clients were working them under arrangements. They wanted to purchase the South Staffordshire lines before Dec. 31 next. With regard to the Dudley and Stourbridge lines the terms of purchase had been practically concluded and agreed upon. The South Staffordshire Company had running powers into a portion of Dudley. So far as he was aware, no local authority except Dudley appeared to offer opposition to the preamble of the Bill, and he believed these objections were formulated to a large extent to allow of a discussion of terms. At this stage Mr. Warmington, for the Dudley Corporation, stated that they objected to the scheme being carried out under the Light Railways Act. The Earl of Jersey said that objection was not stated in the letter to the Commissioners, and he pointed out that the assent of the Corporation was not essential under the Light Railways Act. Other objections having been made or withdrawn, Mr. Emile Garcke stated that in the event of his Company carrying out the present scheme it would be possible to ride in a tramcar from Stourbridge through Dudley to Walsall. The principal point of disagreement between the promoters and the Dudley Corporation was that of the supply of electric current. The price asked for by the Corporation for current was excessive, and would prevent them making the line remunerative. The Company had made arrangements with several corporations for the supply of current at much lower prices, and one company, who proposed to obtain powers for generating electricity in the immediate district, were prepared to give them a supply at 1½d. per unit, against 2½d. and 2d. by the Dudley authorities. If the Dudley Corporation exercised their powers of purchase under the Tramways Act, the Company would still carry out the remainder of the scheme. The Company's lines would then only come up to the boundary of Dudley. Speaking generally, if they could get electricity at a fair market price, tramways could be worked more economically than by steam. The Company's engineer (Mr. S. Sellon) said the cost of the 8½ miles of lines in the scheme would be £51,682. If he could not get further than the boundary of Dudley he should drop the Netherton portion of the scheme. The Company desired to work the whole of the line from one central generating station. The Earl of Jersey announced that with regard to sections 1, 2, 3 and 4 of the scheme (those tramways affecting the districts of Pensnett, Kingswinford and Stourbridge), it seemed perfectly clear that they would be of great advantage to the district, and the Commissioners would have no difficulty in recommending an order for them. With respect to 5 and 6 (from Dudley to Old Hill and Old Hill to Cradley) they would reserve their decision, in the hope that more opportunity would be given for the purpose of considering whether one whole scheme would not be better for the district generally. There was no doubt whatever that the people of Cradley Heath would be much benefited by the line, and he could not help expressing their opinion that it would be a good thing if the Dudley Corporation and the promoters were to reconsider their position with the view of seeing what would be of real advantage to the whole of the district. Mr. Morse intimated that his company would be willing to open fresh negotiations with the Dudley Town Council, and the inquiry then terminated.

Dublin.—Prof. Kennedy has now reported against the scheme to erect new electricity supply works at Pigeon House Fort. He will, however, present a supplemental report as to the most suitable site for a new station.

Owing to the Corporation's inability to supply current, the Postal authorities have decided to put down an independent generating plant for the lighting of the General Post Office.

The proprietors of the Empire Palace theatre have also put down an independent gas engine plant. The installation has been carried out by Messrs. Handley and Shanks. Crossley gas-engines are used.

Electricity on the Metropolitan Railway.—Col. Mellor, M.P., Deputy Chairman of the Metropolitan Railway Company, at a meeting at Radcliffe, on Wednesday, announced that the Company hoped shortly to run their trains by electricity. He believed they were now within measureable distance of accomplishing the object which had long been looked forward to by the management of the railway—the substitution of electric for steam locomotives.

Electric Light Notices.— The following official notices of intention to apply for Provisional Electric Lighting Orders in the ensuing Session have appeared during the week :—The Vestry of *St. Marylebone* (*London*), the *Chorley*, *Colne*, *Doncaster*, *Ossett*, *Rotherham*, *St. Albans*, *Weymouth Melcombe Regis* and *Crewe* Corporations, and the *Aldershot*, *East Ham*, *East Stonehouse*, *Rawmarsh*, *Stourbridge*, *Westgate-on-Sea*, and *Willesden* District Councils, and the *Michelstown* (*Ireland*) Board of Guardians. The *Norwich* Electricity Company are seeking powers to extend their area of supply, and the General Power Distribution Company are promoting a Bill to supply electric current in the districts of *Sheffield*, *Nottingham*, *Lincoln*, *Derby*, *Gainsboro'*, *Retford*, *Worksop*, *Mansfield*, *Ilkeston*, *Newark*, *Rotherham*, *Chesterfield* and other districts. The radius of the proposed area of supply is about 25 miles.

Extension of Telegraphic Communication in the Philippines. Attention is called in a report from H.M. Consul at Manila to a concession recently granted by the Spanish Government to the Eastern Extension Telegraph Company to extend their cable from Manila to the islands of Penay and Cebu. The report states that the "Sherard Osborn" had arrived at Manila with the new cable on board, and with the staff to take charge of the cable stations on the islands. It is stated that the cable will be laid from Lucena, in the province of Tayabas, island of Luzon, to Capiz in the island of Penay; from Iloilo to Bacalod, in the island of Negros; from Escalante, in the island of Negros, to Tuburan, in the island of Cebu. This extension, the report proceeds, will probably be a great benefit for British commercial interests in these islands, as the only connection with the adjacent islands was carried on by means of British steamers of the Spanish line La Compania Maritima, which during stormy weather had to suspend their trips.

Gibraltar.—It is stated that the Government have arranged to take over the lighting of the streets as well as Government quarters from the gas company, and to substitute the electric light early in the year.

Glasgow.—A meeting of the Electricity Committee was held on Tuesday for the purpose of considering the applications sent in for the position of chief electrical engineer. Altogether, 33 applications were received, and a sub-committee was appointed to draw up a short leet.

The Governors of the Glasgow and West of Scotland Technical College have accepted Mr. Andrew Stewart's offer of two gold medals for annual competition in the College ; one to be called the Kelvin medal, to be given in the day classes, and the other, to be called the Macquorn-Rankine medal, for the evening classes. The medals are to be open to the students in the mechanical engineering laboratory, who have been at least two years in the classes of the College. Special weight will be given to any original experimental work done. Regarding the intimation made to the Bursaries Committee that the Pender memorial scholarship was intended for the University, and not for the Technical College, the secretary intimated that Lord Kelvin had agreed to recommend, as a modified arrangement, the condition that the scholarship be awarded each year to the best student who had gained the diploma of the Technical College in the department of electrical engineering, and who, further, agreed to attend for one year the Natural Philosophy and Engineering Classes of the University.

Gravesend.—A proposal to shelve any discussion on the electric lighting question until Dec. 8th was discussed at the last meeting of the Town Council and defeated. The report of the Finance Committee submitted to the meeting was to the effect that negotiations and correspondence had been continued with Messrs. Crompton and Co., and that a report had been received from the Council's electrical engineer, Mr. W. G. A. Bond, with regard to electric lighting matters generally. Dealing with the proposals of Messrs. Crompton and Co. and the Electric Supply Corporation as to the transfer of the Council's order, Mr. Bond reports that these proposals appear satisfactory, and that the system of distribution recommended by Messrs. Crompton and Co. was one most suited to the peculiarities of the district. He also approved Messrs. Crompton's proposal to charge for electric current on the "demand indicator" system at 7d. and 4d. per unit. The terms of purchase offered were, he considered, just and generous, and it was doubtful if the Council could secure substantially better terms from any other electrical engineering firm of equal status. Mr. Bond recommends the Council, in completing the transfer arrangements, to provide for all street lighting being effected by electricity, current being supplied for this purpose at 3d. per unit, "in which case it will be cheaper than gas, and much better." Finally, it is recommended that the supply and distribution should be on the three-wire continuous-current system, with pressure at consumers' terminals of not less than 150 nor more than 250 volts. The Finance Committee recommended the adoption of the report, and this was agreed to.

Great Yarmouth.—The accounts of the electricity department for the past month show an excess of income over expenditure of £203. 11s. 2d., and after allowing for sinking fund and interest there was a net profit of £13. 11s. 2d. Messrs. W. J. Crampton and Co. have submitted particulars of a "free wiring" scheme for the district, and a special meeting of the Committee is to be held for the purpose of considering this. The Committee have decided not to provide electric motors, &c., for letting on hire, on the ground that the time allowed for repayment of loans was too short to permit of a sufficient return on the outlay.

Hammersmith (London).—The Vestry at its last sitting authorised certain extensions of the electric light mains, estimated to cost

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£820. Mr. A. H. Preece has been requested to prepare specifications and estimates of the cost of completing the electric lighting of the three main thoroughfares in the district.

Hornsey (London, N.).—The Hornsey District Council on Monday considered a report of the Electric Lighting Committee, which suggested a scheme of lighting the district by electricity, and this was agreed to. Reports had been received from Mr. E. J. Lovegrove and Mr. R. Hammond. In the former the writer recommended that a small area only should be included in the application for a Provisional Order, and that the best system to adopt was the high-pressure alternating-current, and the most suitable place for the central station would be the sanitary depôt at Hornsey, and that it might be possible to use the spare heat from the dust-destructor at this depôt. Provision should be made for 6,000 8 c.p. lamps for private and public buildings, and 45 2,000 c.p. arcs for public lighting. The plant should have a capacity of 10,000 8 c.p. lights, which would be equal to 15,000 8 c.p. lights on consumers' premises. The cost of the scheme is estimated at about £30,000. To meet contingencies, the Committee made this figure £35,000. Mr. R. Hammond, to whom the scheme was submitted, after referring to the difficulties in the district for electric light purposes, and with reference to the dust-destructor says, "My experience leads me to believe that too much reliance cannot be placed upon the source of power derived from a dust-destructor." He recommends the Council to lay down a reasonably large plant in duplicate. He suggests that the £30,000 should be increased to £35,000, for which sum an installation could be obtained with sufficient generating plant and mains to deal with the number of lights which would yield revenue, at 6d. per unit, sufficient to cover the cost of working, and the interest and sinking fund.

Hove.—The project of the British Electric Traction Company to construct a network of electric tramways in the Brighton and Hove districts came up for discussion at the meeting of the Hove District Council on Tuesday. It was decided to oppose the scheme, the principal objection being, apparently, to the method of procedure.

Kidderminster-Stourport Electric Tramway.—The contractor (Mr. G. Low) for the permanent way of this line has now started work on the Shortheath section of the line. This portion will be pushed on, so as to be ready for working in conjunction with the line to Stourport. The work at the generating station is well advanced, and it is anticipated that the line will be ready for traffic early in 1898.

Kingston-on-Thames.—The Local Government Board has sanctioned the borrowing of an additional £1,600 for electric lighting purposes. Some time ago the Council applied for authority to borrow £20,000, but of this only about £18,000 was sanctioned.

Leeds.—The question of the purchase of the undertaking of the Yorkshire House-to-House Electricity Company's undertaking was under the consideration of the Parliamentary Committee on Tuesday, but after some discussion it was decided to convene a special meeting to discuss the matter.

Lewes.—The Corporation have instructed Mr. F. J. Warden-Stevens to submit plans of an alternative area of supply in connection with the proposed electric lighting scheme for the borough.

Liverpool.—The Corporation propose to include in their forthcoming Bill provision for borrowing a sum not exceeding £200,000 for the extension of the electric lighting undertaking.

Sir A. B. Forwood, M.P., has been elected Chairman of the Tramways Committee, and Mr. Petrie Chairman of the Lighting Committee.

In connection with the scheme for the equipment of the tramway from St. George's Church to the Dingle, it has been decided to lay down for experimental purposes three different kinds of rails. Tenders have been accepted for supplies of English and American types, which will be put down for some distance side by side while the remainder of the road will be laid with rails on Mr. Deacon's plan—placing the rails upon creosoted sleepers.

Llandudno-Colwyn Bay Light Railway.—The Light Railway Commissioners held an inquiry on Saturday at Colwyn Bay into the application for powers to construct this line. Mr. L. Coward, for the promoters, gave a *résumé* of the movement in favour of the project since the application last year. The Llandudno District Council had decided to apply for power to carry out an electric tramway scheme, which it was proposed should be a self-contained scheme for Llandudno only, and the route proposed by the Council was the same as that proposed by the promoters so far as Llandudno was concerned. Mr. Conway, a member of the Llandudno Council and chairman of the Penrhynside Parish Council, said he was strongly opposed to a line being constructed at Llandudno at the expense of the ratepayers, and considered that the proposals made by the promoters to the Council were fair and reasonable. Other evidence in support of the scheme having been given, Lord Jersey intimated that, having in view the decided opposition of Llandudno, and their intended application for tramway powers, the Commissioners could not recommend the Board of Trade to grant an Order in this case, but they would like to hear the evidence of the engineer. Mr. Alfred Dickinson therefore submitted technical details, and after further argument his Lordship agreed not to quash the application but to adjourn the inquiry until the result of the application by the Llandudno Council was known.

Llandudno.—The District Council has decided to light the promenade by means of arc lamps suspended from pillars in the centre of the thoroughfare.

London County Council.—At Tuesday's meeting Mr. Cornwall raised the question of the desirability of the Council obtaining an extension of its powers in regard to approving electric lighting works when carried out by a private company under an Order transferred to them from a Vestry. Earl Russell said the Highways Committee had communicated with the Board of Trade on the subject, and the latter had gone so far as to say that in granting any further Provisional Order to a Local Authority in the Council's jurisdiction they would see that notice of transfer was given to the Council, and that they would have the opportunity of suggesting the insertion of clauses giving them the same control over the works as they now possessed in the case of private companies.

Lynn.—A Special Committee has been formed for the purpose of considering and reporting upon the advisability of complying with the terms of their Provisional Order.

Middleton.—Mr. S. V. Clirehugh has been requested to prepare a report for the Town Council as to the advisability of establishing electricity supply in the borough.

Municipal Honours.—In the list of Mayors connected with electrical and engineering enterprises given in out last issue we omitted the name of Ald. F. T. Garrett, who has been elected Mayor of Dunstable for the coming year. Ald. Garrett has been engaged in electric lighting work for some years, and is at present installing a plant in his own premises. He is a partner in the firm of F. T. and A. Garrett and Co., of Dunstable, Northampton and Luton.

Norden (Lancs.).—The District Council have decided to make some experiments in electric lighting by illuminating one of the thoroughfares electrically at an estimated cost of £100.

Oldbury.—The Council have appointed Mr. F. J. Warden-Stevens to prepare a report on the question of erecting electricity supply works.

Smethwick.—Mr. F. J. Warden-Stevens has been retained by the Council as consulting electrical engineer.

St. Anne's-on-Sea.—The District Council have decided to erect electricity works here, and Mr. S. V. Clirehugh has been instructed to prepare and submit a report.

St. Just (Cornwall).—Mr. V. Corin has presented a report on the proposal to utilise the water power of a neighbouring stream in connection with the electric lighting of the district. For effective lighting, 25 H.P. would be required, but only 5¾ H.P. is available, and consequently Mr. Corin favours the use of a gas engine.

St. Pancras (London).—At the last meeting of the Vestry the Electricity Committee submitted a report recommending the extension of the electric light mains in Malden and Prince of Wales-roads and Queen's-crescent, at an estimated expenditure of £5,400. The consideration of the matter has been deferred to the next meeting. The extension of the mains to the Somer's Town district is also to be considered.

The Strike.—Contrary to expectations the preliminary meeting of the representatives of the employers and the strikers in the engineering trades did not take place until Wednesday, when Col. Dyer and Mr. A. P. Henderson (of Messrs. D. and W. Henderson and Co., Glasgow), together with Mr. Thomas Biggart, one of the joint secretaries, represented the Employers' Federation, and Mr. A. Sellicks, Chairman of the Executive Committee, and Mr. G. N. Barnes, Ssecretary, represented the Amalgamated Society of Engineers. The meeting was at the Westminster Palace Hotel, London, where the ensuing conference itself will be held. The meeting was private and lasted for nearly two hours. The following arrangements were ultimately agreed upon:—

"A conference shall be held at the Westminster Palace Hotel, at 11 a.m., on Wednesday next (24th inst.). Each side shall have 14 representatives. Each party shall appoint its own chairman. The following truce is to be observed: It is agreed that from this date until the termination of the conference (*a*) The employers will suspend any notices not already carried into effect, and will not post further notices; (*b*) The societies will not interfere in any way with men who may be in employment at any time during the conference."

The question of the appointment of chairmen is thus definitely settled, and it is anticipated that Col. Dyer will represent the masters and Mr. Sellicks the men. It is probable that the discussion will be strictly confined to the proposals embodied in the "amended draft" of the Board of Trade given in our last issue. Mr. G. N. Barnes has expressed an opinion that the struggle should be over in a fortnight. The London boilermakers, whose strike was calculated to greatly complicate matters, have, on the advice of the officials of their union, returned to work.

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The Telephone in West Australia.—Telephonic communication has been established between Coolgardie and Kalgoorlie. The subscription is £6.

Tramway Bills.—Notice is given by the *East Ham* District Council that they propose to introduce a Bill in the next Session to authorise the purchase of the tramways within their district, and to work the same by electricity or other motive power. The *Halifax* Corporation are also promoting a Bill for the construction of additional tramways, and the adoption of electric traction thereon. In the Omnibus Bill to be promoted by the Corporation next Session powers are sought to permit the manufacture, hire, sale, or letting on hire or otherwise, dynamos, electric motors, accumulators, meters, and all electrical apparatus for the production, supply, distribution, or utilisation of electricity.

Tramway Provisional Orders.—Official notice is given that the *Cardiff* Corporation and *East Ham* District Council propose to apply for power to construct tramways and to employ electrical or other form of mechanical traction. The *Huddersfield* Corporation also intend to apply for powers to construct additional tramways (over two miles in length), and to adopt electricity as the motive power. The General Electric Tramways Company are applying for similar powers at Hartlepool.

West Bromwich.—A special meeting of the Town Council was held on Monday for the purpose of settling the area of supply to be inserted in the Council's Provisional Electric Lighting Order. The initial expenditure is to be limited to £20,000.

Western Australia.—Reports from Perth (W.A.) mention a number of cases where electric lighting plant has been put down for the purpose of enabling mining operations to be carried on at night under more favourable and economical conditions. In every case the expectations of the mine managers have been realised, and a considerable saving effected by the introduction of the electric light. At the Lake View Consols, the Great Boulder, and other mining properties electric lighting has been introduced, both arcs and incandescents being installed.

Withington (Lancs.)—The Parliamentary Committee have been instructed to submit a report on the electric lighting of Withington, Chorlton, Didsbury and Whalley Range.

DIRECT SPANISH TELEGRAPH COMPANY.

At the Trocadero Restaurant, London, on Saturday last, the Head Office Staff of the Direct Spanish Telegraph Company entertained at dinner the manager of the Company and a number of guests (including the general manager, Mr. Charles Gerhardi), under the presidency of Mr. F. T. Preddle. After the usual loyal toasts had been well received, the Chairman, in proposing "Success and Continued Prosperity to the Direct Spanish Telegraph Company," referred to the cordiality which existed between the members of the staff generally with their genial manager, and that they were met to commemorate not only the twenty-fifth anniversary of the establishment of the Company, but of the connection of Mr. Gerhardi with the Company and its fortunes for that long period. His association with the Company would, the staff trusted, continue for many years to come. Any representation made by them was always received by their manager with the greatest kindness and consideration, and he was there to say that no more loyal staff was possessed by any Company in the kingdom. Mr. Gerhardi thanked those present for the kindly feelings expressed by the Chairman, and so cordially acquiesced in by the staff, and said that the many flattering remarks which had been made on this and other occasions connected with the twenty-fifth anniversary of the Direct Spanish Company's existence was evidence that a man in a position of authority was respected and appreciated when he received and dealt with his staff in a frank and cordial manner. He would say for himself that the welfare and comfort of his staff had always been to him a matter of consideration, and never more so than when the Company was in a prosperous condition, as he was pleased to say was now the case. Other toasts included "Spain and her Representatives in this country," which was responded to by Senor Don N. E. Jauralde; "The Staff," responded to by Mr. C. E. Morgan; "The Officials of the Eastern Telegraph Company," responded to by Mr. W. Hibberdine; and "The Chairman." During the evening a message was despatched to Madrid, conveying the good wishes of the assembled guests to the authorities of that city.

Utilisation of Niagara Rapids.—The latest power project at Niagara is one that advocates the construction of a tunnel on the New York State side, from a point at the head of the rapids to the Devil's Hole, or thereabouts. This tunnel would be sunk at a depth of about 200ft. across the neck of land formed by the river turning at a right angle at the whirlpool. The distance is about 10,000ft., it is estimated, and about 83ft. head would be available. The tunnel would start and end on the property of the Niagara Falls and Lewiston railway, better known as the Gorge-road. The Devil's Hole, the point referred to, is midway between the Falls and Lewiston; it takes its name from an excavation in the cliff.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

October 19, 1897.

24,098. W. G. POTTER. London. Improvements in oval incandescent filament lamps.

24,051. R. FABIAN. Manchester. Improvements in electrodes for primary and secondary batteries in chemical cells.

24,073. F. W. HEATON and H. SMITH. Manchester. Improvements in switches for electric light or power.*

24,111. J. SHULTES. London. Improvement in electric conductor-wire connections.*

24,112. C. EDWARDS and E. W. BROWN. London. Improvements in machinery for the production of motive power and the generation of electricity.

24,123. A. DIX. Liverpool. A new or improved device for use in writing down telephone messages and the like.

24,129. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London Improvements in electrical transformers. (W. S. Moody, United States.)*

24,130. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London Improvements in mountings for the contact shoes of surface contact railways. (W. B. Potter, United States.)*

24,131. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in and relating to electric controllers. (H. G. Reist, United States.)*

24,132. O. IMRAY. London. Improvements in telantographs. (L. O. McPherson, United States.)

24,150. H. S. LLOYD. London. Improvements in electrodes for storage batteries.*

24,155. R. J. HATTON and W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED). London. Improved joint box for electric cables.

24,156. R. J. HATTON and W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED). London. Improved joint-box for coupling underground and aerial electrical cables.

24,157. W. H. NICHOLS and W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED). London. Improved clamp connection for electrical conductors.

October 20, 1897.

24,196. W. FEATHERSTONE. Manchester. Improvements in and connected with the overhead system of electric traction.

24,257. F. O. PRINCE. London. Improvements in and connected with electric primary batteries.

October 21, 1897.

24,368. G. F. W. SHORT and C. A. UNDERWOOD. London. A new or improved method of code telegraphy.

24,382. F. TISCHENDÖRFER. London. Improvements relating to the generation of multiphase currents and multiphase electromotive forces from single-phase currents and single-phase electromotive forces, and to the utilisation of the same.*

24,405. W. H. NICHOLS and W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED). London. An improvement in field telephone and other cables.

24,417. J. H. BARKER. London. Improvements in electrical and other recording instruments.

24,419. G. DRAPER and W. GAYE. London. Improvements in telegraphic transmitting instruments.

24,421. H. H. LAKE. London. Improvements in systems for the transmission of electrical energy and apparatus for use therein. (U. Tesla, United States.)*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

19,558. ANDRÉ. Printing telegraph instruments.

19,593. CEREBOTANI AND BERNSTEIN. Writing telegraphs.

22,360. BERDITSCHEWKSKY-APOSTOLOFF. Automatic telephonic exchange systems.

22,783. HOLLINS. Electric locking and block apparatus on railways.

23,399. KLEINSCHMIDT. Electric switches.

25,896. SAX. Electric insulators.

1897.

5,131. BOWLES. Electrical resistances.

5,136. STANGER. Electric tan bark bath and apparatus therefor.

9,945. BROMILOW. Apparatus for magnetically separating iron and steel from brass or the like cuttings.

15,491. FRALEY. Electric heating apparatus.

17,470. SCLATER. Automatic transformer switch apparatus.

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20,496. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) (Potter). Surface-contact electric railway systems and apparatus for use therewith.

20,502. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) (Potter). Surface-contact railway systems and apparatus for use therewith.

COMPANIES' MEETINGS AND REPORTS.

Western and Brazilian Telegraph Company (Limited).

The thirty-fourth ordinary general meeting was held at Winchester House, Old Broad-street, on the 12th inst., under the presidency of Mr. W. S. Andrews.

The SECRETARY (Mr. R. M. Cunningham) read the notice calling the meeting and the minutes of the last ordinary general meeting; and the report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, it is my painful duty to make a reference to the loss we have sustained in the death of one of our colleagues and one of your faithful representatives at the Board—Mr. Earle, who was killed suddenly by an accident. We all of us feel his loss very much, and I am sure that you are deprived of a man who was always desirous of doing the best he possibly could for all your interests. We have elected in his place Mr. T. W. Andrews, who is a young man rather, but who has exceptional experience in cables and administrative telegraphic work. Unfortunately I cannot stop there, because most of you must have heard that our old Managing Director, who has been with us 24 years, Major Wood, is dangerously ill. He has been away now for some little time, but we all of us hope that he will recover and be restored to us within a limited period. But altogether these things are a little disappointing; they do not give men the courage they would like to feel. To turn to business, of course the statement of accounts which I shall have to explain to you to-day is not satisfactory by any means to any of us, but at the same time I am pleased to say that I think it is about the very worst you are likely to see, as you will gather pretty plainly when we come to analyse the figures of the present current period, and what they promise to be in the not remote future. The revenue from messages for the six months ended June, 1897, amounts to £59,349, and with interest and transfer fees to £59,754. These figures compare with £71,082 for the half-year to June, 1896, and consequently they exhibit a falling-off of £11,327. Well, of course, those figures are not what we should like them to be, but unfortunately they are figures which we have been able in no way to control. The expenses were £44,575, and they compare with £37,428, or an increase of £7,147. Well, decreases of traffic you do not like, but when decreases of traffic and increases of expenses come together, you like them still less. At the same time you will find that the main part of this is something that will not recur. If, for instance, we take the expenses first, the reasons for their being larger are not far to seek. The main increase is occasioned by the hire of the "Buccaneer" and the "Viking" during necessary repairs which had to be made to the Company's steamer "Norseman." This was explained at the last meeting, I think, by the acting Chairman, Lord Richard Browne. These items are composed thus—ships, £5,830 (so you see that out of the £7,000, nearly £6,000 was for ships alone), and maintenance of cables and other things £1,130, making together roundly £6,960. Then in the staff account and expenses in Brazil there is an increase on balance of £1,129. These figures altogether exceed £8,000, but economies in other directions reduce our increased expenses to £7,147. The main item, £5,830—the bulk of the whole thing—will now disappear from our accounts. The item of maintenance, which is small, depends of course on the accidents of the particular year; they may be a little more or a little less. The expenses in London under Abstract C are just the same. I do not propose to take up your time with any further analysis of these matters, because in substance I have told you all that I think you will find it to be useful for you to know. Of course, on one side and the other the figures are very numerous. As a result of the half-year's working we bring down profits, adding £6,405, the balance brought over from last half-year of £21,584. From this we have to deduct debenture interest £8,983, and the income tax was £1,625, leaving £10,975 available. We propose to supplement this amount by withdrawing £7,500 from the reserve fund, and this enables us to recommend a dividend of 3s. per share, or at the rate of 2 per cent. per annum, the same as for the corresponding period of last year. In the period under review up to June last, we have still had to contend against the unfavourable exchange. During this half-year that has pressed upon us with greater severity than ever; it has been going lower and lower, and has only averaged $8\frac{1}{16}$d. against $9\frac{5}{8}$d. in the corresponding period of the previous year. This, together with the closing by the Argentine Government of the line which connects our route with their territory, accounts for our much smaller receipts. This line, however, is now opened again, and is recovering trade in a satisfactory manner. We understand that legal matters are pending with reference to this question, and therefore, perhaps, it is not well that I should go into it any further. Of course, the one salient feature of our meeting is that we recommend supplementing the dividend from the reserve fund, which I may say is, among other objects, intended for the equalisation of dividend. Therefore, it is a thing which has been thought quite reasonable and a thing which has been contemplated. True, the Directors might have recommended the shareholders to minimise the dividend, but we thought that the shareholders had done quite enough for some years past, and it must be remembered in this connection that the shareholders, out of the revenues of the Company, have reduced the Debentures to an amount, as reorganised, of £389,521, with some £9,000 to come in, for which the money is already provided and set aside. That makes £399,521, and this is at 4 per cent., and it takes the place of £450,000 at 6 per cent. There is a good difference there. In fact, the courage with which the shareholders have acted and the determination with which they have pursued the reduction of the Debenture debt, have, I think, entitled them to some claim upon the reserve fund, into which a lot of the money has gone, for I may tell you that after providing for everything, and the small balance of debentures still to come in, we have been able to place £47,414 to the credit of the reserve fund. The total of the reserve fund, after deducting the £7,500, remains at £56,181, as against £17,932, which was the figure of the corresponding period last year. I do not think that that looks very bad; it is rather encouraging. But there are other reasons which I am pleased to be able to give that have actuated us in this matter. I may tell you that the receipts of the Platino Company—which are practically ours, because they come to us in the shape of dividends—together with our own, combined with lesser expenses, show an improvement in the current half-year of about £21,500, although the connection that I spoke of with the Argentine territory was not re-established until the 9th August, and further, although the modified collection introduced by the Brazilian Government under the International Telegraph Convention on the 1st of July was considerably under the amount calculated to produce the par of exchange. It is true that was increased on the 1st of October, but even with that increase the amount still falls short of the sum which would be required to give us the par of exchange as demanded by the Telegraph Convention. There is another little crumb of comfort. These improvements, as far as they have been applied—and, of course, they are improvements, or we should not be getting this increase—have only been applied to the international traffic. We are informed that measures are to be laid before the Chambers of Brazil for the application from January 1st next to the internal traffic, which is a very large proportion of our business, of somewhat similar measures to those that are being applied to the international traffic—in other words, to level up all round. The tariffs hitherto have been so low that the lines have been crowded, and the expense of working has been considerable, but the revenue has been excessively small and disappointing. We believe that when we are enabled to follow the measures that are adopted in Brazil by raising our rates correspondingly and in somewhat similar proportion to those that the Government may introduce, our revenue from the traffic will decidedly increase. I cannot estimate it, but it will be very good. Under these circumstances, we think that you will approve of our action in supplementing the amount available for dividend by taking this sum from the reserve fund. You will admit, I think, that we have not done it imprudently, and that we have not been running any risks of any sort in doing it. There is a gentleman opposite who has sometimes accused me of being a little pessimistic. Perhaps he may not have been altogether wrong in that, although I think that the figures have borne me out in my gloomy opinions. I am glad, however, to say that I can now take a more optimistic view. I think we have turned the corner, and I think this meeting, as regards the figures and conclusions of the working we have had to show to you, will represent about the worst you are likely to see; and when we meet again we shall have a more satisfactory story. There is no change in the Government purchase question. I think I have now perhaps detained you quite long enough, and I will, therefore, propose:—

"That the report and accounts to June 30, 1897, now submitted, be, and the same are hereby approved and adopted, and that a dividend for the half-year, free of income tax, at the rate of 2 per cent. be, and is hereby declared payable on the 12th inst."

Mr. JOHN COPPEN seconded the motion.

Mr. TILLEARD remarked that the Company had had a heavy loss by the death of Mr. Earle, and he could not help feeling that they were handicapped through the illness of Major Wood. He hoped that the Chairman's expectations as to Major Wood's recovery might be completely realised. He desired to express the shareholders' sympathy with their Managing Director. They had, on the other hand, to congratulate the chairman on his return among them, and that his enforced absence was now at an end. He thought that the work that had fallen on the other members of the Board, and particularly on the staff, must have been very severe in connection with the re-organisation of the debenture debt and other matters. There was one gentleman to whom he would like to offer their thanks for the way in which he had stuck to the ship—he referred to Mr. Cunningham.

The CHAIRMAN: Will you pardon me for one moment? There is one point which I omitted which you have been so good as to supply. I should have said that during my absence, and during the absence of Major Wood Mr. Cunningham has very efficiently represented both of us. He has worked hard, and I do not think that your interests have in any way suffered from being very much consigned to him under Lord Richard Browne and the other members of the Board in the direct conduct of the business of the Company. I am very glad you mentioned this.

Mr. DRYSDALE desired to ask whether the increase in the receipts mentioned by the Chairman of £21,000 would come into their next half-year. Could the Chairman also explain why the arrangement for the increased collection as regarded the European traffic had fallen short of their expectations—he meant with respect to the gold collection?

The CHAIRMAN: With respect to the increased amount which is coming to us, I have every reason to believe that it will be more than the sum I mentioned, because the increase is going on week by week, and therefore it promises to be greater. It will all come into this half-year. With reference to the gold standard, that does not rest with us. It is an obligation to collect a something which represents the par of exchange We have often explained this to you before. Under the Telegraph Convention every Government having a depreciated currency is bound to collect so many parts of that currency as are required to produce the amount in gold or in effective francs of the tariffs fixed by the Convention or the Companies, as the case may be. The Brazilian Government, I

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suppose, did not like to put it on all at once. They thought it would cause dissatisfaction with the Brazilians who sent messages, and consequently they have had it applied in instalments, neither of which, perhaps, taken singly, will be very severe. We hope that the next amount will establish the actual par of exchange as regards the international messages.

Mr. WEBB asked whether he was right in assuming that negotiations had been going on with the Brazilian Submarine Company for a closer working arrangement between the two Companies. It was an open secret in the City that such negotiations had been going on.

The CHAIRMAN: There have been negotiations going on—I suppose it is an open secret—and we have not been very far apart, but still we have not come together.

Mr. WEBB inquired whether there was any chance of their doing so.

The CHAIRMAN: I do not know. We are like Oliver Twist, and we should like a little more. They have been disposed to give us a little less. We think that in the face of a rising revenue, and of a great probable improvement, as far as we can see, upon all scores, we are entitled to somewhat better terms. We are not greedy, I assure you; we are very moderate, but at the same time we think that you gentlemen have been patient and have borne a good deal for a long time, and we do feel that if it is in our power, either in the direction of working our own lines with these large improvements coming on, or by an arrangement with our friends on the other side, we ought to do our best for you. He then put the resolution, which was carried unanimously.

Mr. CUNNINGHAM briefly expressed his thanks to the Chairman for his kind remarks and to Mr. Tilleard. In doing so he desired to acknowledge the excellent assistance which he had received from all the members of the London staff.

Mr. ENNIS remarked that they were all very glad to see the Chairman back again among them, and in a better frame of mind as to the Company's prospects. He sincerely hoped that the Chairman's views in this matter, as foreshadowed in his speech, might be realised. He thought the directors, even in these hard times, deserved the hearty thanks of the shareholders. He also desired to recognise the services in particular of Major Wood and Mr. Cunningham. They were all exceedingly pleased to see the Chairman back again, but he must say that no one could have filled the chair with greater dignity and force than was done on the last occasion when Lord Richard Browne presided. He moved a hearty vote of thanks to the Chairman and Directors, and to Major Wood and Mr. Cunningham for their services.

Mr. TILLEARD seconded the motion, which was carried unanimously.

The CHAIRMAN: We beg to thank you for your kind vote, and you may depend upon it that we shall do our best to deserve it.

Wireless Telegraph and Signal Company (Limited).

The statutory general meeting of this Company was held yesterday, Mr. Edgar Appleby presiding.

The SECRETARY having read the notice calling the meeting,

The CHAIRMAN said: As you will see by the notice calling this meeting, the whole of the share capital has been applied for and allotted. The meeting we are now holding is a formal one, called simply to comply with the section of the Act of Parliament. There is little information that we have to give you to-day. The Company is proceeding with the development of a useful and valuable patent. The progress made so far has been satisfactory, although in a matter of this description it was bound to be a little involved and intricate. Mr. Marconi has been making experiments on Salisbury Plain which have added greatly to the usefulness of the experiment he made across the Bristol Channel, and have also led to the development of certain points. These have been submitted to Messrs Carpmael, who have taken steps to cover them, thus adding to the value of the property the Company possesses. We are assured by Messrs. Carpmael that, in all respects, our patent is valid and fully covered. The cash department has been fully attended to. Nothing has been done extravagantly, and we hope that when the scheme comes to be fully developed, and a financial statement put before the shareholders, they will acknowledge that the Company has been managed fairly and honestly. I have nothing more to say now, but I shall be pleased to answer any questions.

Mr. GOODBODY asked if the board were satisfied with the experiments which had been made.

The CHAIRMAN, in reply, said: If I did not convey that feeling it was only owing to my usual caution. I did not like to exhibit any bounce, but the experiments which have been conducted by Mr. Marconi, and in the presence of other experts, have, so far, been all perfectly satisfactory. The uses of our patent are very great for such purposes as communication with lighthouses, not only from the land, but from lighthouses to passing ships, and ships in distress. Mr. Marconi has been successful in sending messages 12 miles, and he is sanguine that in the course of a few weeks he will be able to transmit a message 20 miles.

A SHAREHOLDER inquired if any message had been sent across the English Channel from Dover.

Mr. MARCONI said he had not attempted to send messages across the English Channel. In Italy, where the invention was in use, he had sent messages 12 miles, and he had also sent a message across the Bristol Channel from Weston-super-Mare to Penarth.

Mr. W. SMITH said it was important to remember that everything attempted had been successfully carried out. Greater things might have been done, but they had paid more attention to perfecting their instruments than to obtaining sensational results. He believed there was no limit to the usefulness of the invention, not only at sea but on land, and the Directors were very sanguine as to the ultimate value of their patent.

The proceedings then terminated.

Venezuela Telephone and Electrical Appliances Company (Limited).

The ordinary general meeting of this Company was held yesterday (Thursday), under the presidency of Sir Douglas Fox.

The SECRETARY (Mr. J. Simpson) having read the notice calling the meeting,

The CHAIRMAN said: You will be glad to see that there has been a very fair amount of progress in the affairs of the Company during this year. We not only show an improvement on our general business, but we also show—which is very satisfactory—that the result of the extensions which have been acquired by the Company between Caracas and Valencia, and also into the Cua and Sucre districts, has been attended by a very fair profit. The property has been thoroughly well maintained. We have an excellent manager in Venezuela, in whom we have complete confidence, and who keeps us thoroughly acquainted regularly with what is going on there. The number of subscribers has increased from 2,524 on June 30, 1896 to 2,737 to the same date of the present year. We have had to provide additional capital for the purpose of extending. There is a constant growth in the number of telephones required, and we have also had to purchase these additional lines. In order to do that, we have issued 550 of the Preference shares of £10 each authorised by the resolution passed at the extraordinary general meeting held on November 24 last. I do not think there is anything more for me to say on this occasion, and I will therefore conclude by formally moving the adoption of the report and accounts.

Mr. J. W. PHILIPPS seconded the resolution, which was carried unanimously.

On the motion of Mr. PHILIPPS, seconded by Mr. J. S. AUSTEN, the retiring Director, Sir Douglas Fox, was re-elected; as were also the auditors, Messrs. Price, Waterhouse and Co.

The proceedings then terminated.

The seventh annual report of the Directors of this Company for the twelvemonth ended June 30, presented at the meeting held yesterday, states that there is a profit of £10,241. 13s. 6d. (added to £545. 7s. 11d. brought forward from 1896), after payment of dividends amounting to £5,600. After providing interest, amounting to £4,513. 19s. 8d., on the First and Second Debentures, &c., the Directors have written off £2,525. 17s. 6d. from discount and expenses on Debenture issues, and transferred £2,500 from reserve to write off balance of discount and expenses on Second Debenture issue account which is now closed. This leaves a balance of £3,177. 4s. 10d., out of which a dividend on the Preference shares up to June 30 has been paid, and the Directors now recommend the payment of a dividend on the Ordinary shares for 1897 at the rate of 4 per cent per annum, absorbing £2,800, leaving £198. 15s. 5d. to be carried forward. The capital outlay for the year was £8,423. 8s. 7d., against £4,108. 15s. 3d. in 1896. This outlay includes the purchase from the "Central Bell Telephone" Company of the line between Caracas and Valencia, a distance of 105 miles. The switchboard capacity in Caracas has been further increased by 200 numbers, and the Company's system extended in the Cua and Sucre districts with satisfactory results. The number of subscribers has increased from 2,524 to 2,737. In order to provide additional capital, the Directors have issued 550 of the Preference shares of £10 each duly authorised.

NEW COMPANIES, STATUTORY RETURNS, &c.

CHRONOSIGN ADVERTISING (PARENT) COMPANY (LIMITED).—This Company was registered on Nov. 12, with a capital of £100,000, in £1 shares, to carry on the business of clock makers, electrical and mechanical engineers, advertising sign manufacturers, &c.

RAILWAY LIGHTING (LIMITED).—This Company was registered on Nov. 9, with a capital of £75,000, in £1 shares, to enter into an agreement with Mr. W. P. James Fawcus, and to acquire all the interest in and carry out the contract entered into by the said W. P. James Fawcus with the Great Central Railway for the erection of electricity generating stations, and to supply electric current to the said railway company. The first subscribers, with one share each, are: G. W. Lowcock, electrical engineer; John S. Raworth, civil engineer; F. A. Cortez-Leigh, electrical engineer; S. V. Clirehugh, engineer; A. E. Tanner, engineer; W. P. James Fawcus, engineer; and E. E. Johnson. The first Directors are: W. P. James Fawcus, J. C. Waterhouse, John S. Raworth, and G. W. Lowcock (Managing).

SPIRAL GLOBE (LIMITED).—This Company was registered on Nov. 9, with a capital of £150,000, in £1 shares, to enter into an agreement with Mr. Serge B. Apostoloff, electrical engineer, to acquire, develop and exploit any patents and inventions, and to manufacture, sell and deal in globes, lamps and other lighting appliances.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26⅞d. per oz. (Nov. 18). Consols (2¾ per cent.) 113¼—113⅝ for money, 113⅜—113½ for account; 2½ per cent. 105⅝—106 (Nov. 18). Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Days, Nov. 24 and Dec. 13; Ticket Days, Nov. 25 and Dec. 14; Pay Days, Nov. 26 and Dec. 15; Mining Share Carry-over Days, Nov. 23 and Dec. 11.

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ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.—The directors' report for the year ended June 30, 1897, has been issued. After writing off a considerable sum for depreciation, &c., and paying one million marks to the reserve fund, 15 per cent. dividend is declared on the 25 million of marks capital which is entitled to dividend. The capital was increased by another 10 million marks in March last. The dynamo and motor department has been unusually busy during the past year, over 5,000 machines having been turned out, representing 76,300 kilowatts, an increase of 52 per cent. over the previous year's production. The building of the new cable works is completed, and the machinery is being installed. It is stated that the number of the Company's employés at work in their various shops and offices is nearly 10,000. The incandescent lamp factory has adopted a number of new types, including high-voltage lamps. There are 49 electric railways running, or in process of completion, worked on the Company's system, representing 766 kilometres of track and 1,275 motor cars, and several extensions to existing lines are in process of construction. Considerable activity is also reported in the central-station and electro-chemical departments.

BRITISH MOTOR SYNDICATE (LIMITED).—A report has just been issued by the Directors of this Syndicate for the period from the date of the incorporation to Sept. 30 last, the profits being put at £446,285. It appears that dividends and bonuses have been paid, absorbing £217,172. The cost of the patents has amounted to £413,681, against capital issued £250,000, so that nearly half the cost of the patents has been paid out of profits and not out of capital. The Directors state that whereas last November no British-made motor car was in existence, at the present moment 200 motors and motor cars have been turned out under the Syndicate's licences at Coventry, and motor cars are being delivered weekly. With regard to the electrical patents owned by the Syndicate no better evidence could be given of their value than the electrical cabs now running in the streets of London, and in the matter of speed their oil motors had secured a long list of records. In certain Government departments these motors are being submitted to severe tests. More progress is shown in this particular direction in this country than even in America or Germany, and only by France has this progress been exceeded. In that country the railway companies, the post office, the army, and other departments were adopting the Syndicate's motors. In litigation, competitive trials, and in everything destined to secure the permanent interest of the Syndicate, their claims had proved victorious.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—A list of 420 Five per Cent. Mortgage Debentures of £100 each of this Company will be found set out on another page. These debentures have been drawn for payment at par on Jan. 1 next by Messrs. Barclay and Co., 54, Lombard-street, London, E C.

ELECTRICAL FINANCE.—In an article dealing with the comparative capitalisation of London electric supply companies, the *Financial Times* of the 12th inst. refers to electrical undertakings as having "now taken a high position in the ranks of home industries; and, being practically free from political disturbances or the influence of trade fluctuations, they form one of the very few industries in which a good return on the capital invested and a progressive increase in the business are assured."

IMPERIAL TRAMWAYS COMPANY (LIMITED).—An extraordinary general meeting of this Company was recently held at Bristol for the purpose of authorising certain alterations in the articles of association and the issuing of fresh capital. The Chairman (Mr. Geo. White) said that the cost of constructing and equipping the Middlesbrough, Stockton and Thornaby electric tramways would be about £200,000. They were pushing on rapidly with the works, with the intention of opening in good time for next summer's traffic, and, from progress already made, he had no doubt they would succeed. They had made satisfactory purchases of all material, and had also concluded a very satisfactory cash contract with the British Thomson-Houston Company for the electrical plant and equipment of the line, including the supply of 50 double-bogie cars, each capable of carrying 60 passengers. Their new lines would cost approximately £73,000, and the electrical plant, machinery and cars about £70,000, whilst the purchase of land, building of power station and car sheds, interest, &c., would be approximately £25,000, making a total outlay of about £200,000. They had over £20,000 in hand at the end of the last half-year, and it was intended to raise the balance in the following manner: Debenture stock (4½ per cent.), £70,000; 6,500 preference shares (6 per cent.), at £12 each, £78,000; 2,230 ordinary £6 shares, £13,380; total £161,380. In consideration of capital responsibilities assumed by his firm for the Company it had been agreed that they should take up at par this debenture stock and the small issue of ordinary shares. The preference shares would be issued to the ordinary shareholders in the proportion of one new preference for every three ordinary shares. Their capital would then stand as follows: 4½ per cent. debentures, £100,000; 6 per cent. preference, £100,000; ordinary, £120,000; total, £320,000. The resolutions approving the alterations and the increase of capital were carried unanimously.

MIDDLESBOROUGH (U.S.A.) TOWN AND LANDS COMPANY (LIMITED).—At the annual general meeting of this Company, the chairman (Mr. G. B. Mee) announced that the Middlesborough Electric Light Company, in which they were interested to a large extent, was continuing to do well. The monthly returns for some time past had shown an approximate profit of about $150 per month.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to, £100,000 Five per Cent. First Debenture Stock of the Sulphide Corporation (Ashcroft's Process) (Limited), and also to appoint a special settling day in the scrip of £120,000 Four and a-Half per Cent. Debentures of the Direct West India Cable Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Nov. 12 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,127.

WESTERN UNION TELEGRAPH COMPANY.—The annual report of the President of this Company for the year ended June 30th last states that the capital stock outstanding is $97,370,000, of which $28,850 35 belongs to and is in the treasury of the Company. During the year the capital stock outstanding was increased $2,000,000 by the issue and sale of 20,000 shares of the unissued balance of 46,300 shares of the increase in the capital stock authorised by the stockholders in Oct., 1892. The bonded debt at the close of the year was as follows:—

Bonds due March 1, 1900, 6 per cent.	$781,002 00
„ May 1, 1900, 7 per cent.	4,920,000 00
„ May 1, 1902, 7 per cent.	1,163,000 00
„ Jan. 1, 1938, 5 per cent.	8,488,000 00
	$15,352,002 00
Less balance of sinking funds appropriations	494,269 24
	$14,857,732 76

During the year £2,100 sterling bonds (due March 1, 1900) were redeemed, and $87,000 of 5 per cent. collateral trust bonds (due Jan. 1, 1938) were issued in exchange for capital stock of the New York Mutual, International Ocean and Gold and Stock Telegraph Companies, upon which interest was being paid at the rate of 6 per cent. per annum. The surplus July 1, 1896, was $7,643,693·73; the net revenues, expenses and profits, $5,732,203·13, a total of $13,375,896·86, from which there was applied—for dividends $4,792,855, interest on bonds $895,509·80, sinking funds appropriations $39,991 (equals $5,728,355·80), deducting which leaves a surplus on June 30, 1897, of $7,647,541·05. The total mileage of poles and cables for 1897 was 190,614, against 189,918 in 1896; total miles of wire for 1897 was 841,002, against 826,929 in 1896; total offices for 1897 was 21,769, against 21,725 in 1896. This decrease in the number of messages transmitted was in great measure due to the continued depression of general business throughout the country during the fiscal year. The total revenues show an increase of $26,122·88 over the previous year. The expenses show an increase of $191,899·93; this increase was due to the settlement of long-standing disputed tax accounts with several States. The cost of construction of new property for the year was $449,747·07. The Company has shared in the revival of business since the close of the fiscal year, the test office weekly statements continuing to show substantial increase. If this percentage of increase is kept up throughout the current year, the next annual statement will show a larger balance.

WILLANS AND ROBINSON (LIMITED).—The registers of debenture stockholders and of transfers of this Company will be closed, prior to the payment of interest, from Nov. 16 to 29, inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Aggregate—to date. Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Nov. 13	3,603	+365	...	...	...
Bristol Trams & Carriage	„ 12	2,498	+623	19	51,072	+7,286
City & South London Ry.	„ 14	1,081	+ 3	20	18,661	− 164
Dover Tramways	„ 13	98	...	10	1,238	...
Dublin United (Southern)	„ 12	413	+ 5	19	13,169	− 555
Liverpool Overhead Rly.	„ 14	1,283	+140	20	28,713	+3,903
Sheffield Tramways	„ 14	976	+137	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Nov. 10.	Price Wednesday, Nov. 17.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending Nov. 13. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,125	£10	8/0	Central London Ordinary	9¾ 10¼	9¾ 10¼	2 17 2	June and December	10	9¾
145,106	10	1/3	Do. (6s paid)	5½ 6	5½ 3	3 0 0	„ „	5¼	—
£600,000	Stock	2	City and South London Railway Con. Ordy.	69 71	69 71	2 12 10	January and July	70½	71
2,419	£10	5%	Do. 5% Perpetual Preference	15½ 15¾	15½ 15¾	3 4 6	„ „	..	..
£125,761	Stock	4%	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	..	..
54,000	10	1/??	Waterloo and City Ordinary	12½ 13	12½ 13	2 6 1	June and December	13	12¾
27,500	10	8	Liverpool Overhead Railway Ordinary	11¾ 11¾	11⅞ 11¼	3 11 4	February & August	—	—
10,000	10	5%	Do. 5% Preference	16 16½	16 16½	3 0 7	„ „	—	—
125,000	Stock	4%	Do. 4% Debenture	110 112	110 112	3 11 5	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 10.	Price Wednesday, Nov. 17.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 13. Highest	Lowest
			TELEGRAPHS			£ s. d.			
£923,980	Stock	14/0	Anglo-American	57 59	58 60	4 12 6	Feb., May, Aug., Nov.	58	..
£3,038,020	Stock	28/0	Do. Preferred	104 105	104 105	5 6 6	" "	105	104½
£3,038,020	Stock	5/0	Do. Deferred	12¼ 12¾	12¼ 12¾	..	" "	1⅛	12⅜
£ 37,400	£100	4%	*African Direct Telegraph (Red)	101 105	101 105	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	5½ 6½	5½ 6½	..	" "	—	—
130,000	10	5/0	Brazilian Submarine	16 16½	16 16½	4 4 10	Mar., June, Oct., Dec.	16⅛	16½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	114 118	114 118	4 5 10	June and December	..	—
10,000,000	$100	7%	Commercial Cable Capital Stock	185 190	182 187	4 6 2	Jan., Apr., July, Oct.	183	..
£853,586	Stock	4%	Do. 4 per Cent. Debenture Stock	106 107	105 107	3 14 9	" "	106½	106
16,000	10	8/0	Cuba Submarine	8½ 9½	8½ 9½	8 8 5	February and August	9⅜	..
6,000	10	10%	Do. Preference 10 per Cent.	18½ 19½	18½ 19½	5 2 7	" "	..	—
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October	..	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	..	—
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞ 106⅞	103⅞ 106⅞	4 4 11	January and July	..	—
60,710	£20	3/0	Direct United States Cable, 1877	10¼ 10¾	10 10½	5 14 3	Jan., Apr., July, Oct.	10⅜	10½
400,000	£10	2/6	Eastern	17 17½	17 17½	3 14 4	" "	17½	17
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18 19	18 19	3 3 8	" "	18 1/16	18½
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131 134	131 134	2 19 9	May and November	132½	132
£89,900	£100	6%	* Do. 5 per Cent. Debentures, 1899	101 104	101 104	4 14 9	February & August	..	..
250,000	10	2/6	Eastern Extension	18 18½	18 18½	3 17 9	Jan., Apr., July, Oct.	18⅜	18½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	131 134	131 134	3 0 0	February & August	134	131⅜
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	100 104	100 104	4 17 4	January and July	..	—
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	100 104	100 104	4 17 4	" "	—	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103 106	103 106	3 15 8	February & August	—	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞ 111⅞	108⅞ 111⅞	3 12 1	May and November	—	..
180,227	10	1/9	Globe Telegraph and Trust	11⅛ 12	11⅛ 12	3 15 0	Jan., Apr., July, Oct.	11⅜	11⅝
180,042	10	6%	Do. 6 per Cent. Preference	17 17½	17 17½	3 8 7	" "	17 1/16	17½
150,000	10	5/0	Great Northern of Copenhagen	26 27	26 27	3 14 1	January, April, July	26⅛	22½
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	102 105	102 105	4 15 3	March & September	102	..
17,000	25	12/3	Indo-European	53 56	52 55	4 10 11	May and November	53½	53
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	107 110	107 110	5 9 7	March & September	109	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	107 110	107 110	3 13 5	June and December	..	—
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	136 141	136 141	4 5 1	" "	..	..
15,609	10	6/0	West African Telegraph	4½ 5½	4½ 5½	5 0 0	.. ..	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103 106	103 106	4 14 4	March & September	—	—
30,000	10	2/0	West Coast of America	¾ 1½	¾ 1½	..	..	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	106 108	103 103	3 14 10	June and December	..	..
88,321	10	1/0	West India and Panama xd	⅝ ¾	⅝ ¾	..	May and November	11/16	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference xd	9½ 9¾	8½ 8¾	6 17 2	" "	9⅝	8¾
4,669	10	6/0	Do. 6 per Cent. 2nd Preference xd	7 8	5 7	8 11 5	" "	—	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107 110	107 110	4 12 2	January and July	109½	..
64,256	15	3/0	Western and Brazilian	9 9½	9¼ 9¾	3 1 6	May and November	9½	9¼
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½ 7¾	7½ 8	3 15 0	" "	7½	7⅛
33,129	7½	1/6	Do. Deferred Ordinary	2 2½	2¼ 2⅜	..	" "	2½	2⅜
£382,230	—	4%	Do. 4 per Cent. Debenture Stock	105 109	106 109	3 14 1	June and December	106	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	103 107	103 107	6 10 10	Feb., May, Aug., Nov.	..	..
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	102¼	102⅛
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	3⅛ 3⅜	3⅛ 3⅜	5 6 8	August	..	—
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16 1/16	1/16 3/16	..	July	9⅜	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2 2½	2 2½	8 0 0	October	..	—
484,597	5	3/0	National	6½ 6⅝	6½ 6½	4 12 4	February & August	6⅝	6 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15 17	15 17	3 10 7	" "	16 1/16	15⅝
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14 16	14 16	3 15 0	" "	15½	15 1/16
20,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6 6½	6 6½	3 16 11	" "	..	—
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104 109	104 109	3 5 0	June and December	105½	..
171,504	1	0/4	Oriental	1/16 1/8	1/16 1/8	4 2 4	April and October	—	—
58,000	5	5/0	United River Plate	3½ 4½	3½ 4½	5 17 8	July	—	—
£146,738	Stock	0%	* Do. 5 per Cent. Debenture Stock (red.)	102 107	102 107	4 14 4	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.						
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	12 ..	12 ..	..	March	..	..
£50,000	5	..	Do. (New Issue) £3. 10s. paid	.. ..	.. ..	..	..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	25 26	27½ 28½	2 9 1	February	27½	25 7/16
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17 18	17 18	3 6 8	January and July	17⅜	17⅜
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131 136	131 136	3 14 3	June and December	132½	..
30,000	5	3/3	Charing Cross & Strand Electricity Supply Corp.	12 13	12 13	2 0 0	February & August	12⅝	12 7/16
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6 6½	3 6 8	" "	6 1/16	6½
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	— —	— —	—	January and July	..	..
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	10 10½	10¼ 10¾	3 9 9	March	10½	10½
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	110 113	111 114	4 0 0	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	12⅜ 13½	13½ 13⅝	..	..	13½	13⅜
20,000	£10	6/0	Do. 6% Cumulative Preference	15½ 15⅝	15½ 15⅝	3 16 2	March & September	15⅝	15 7/16
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9 9½	9½ 9¾	..	..	9⅝	..
10,000	£5	7%	Do. 7 per Cent. Preference	10⅜ 11½	11 11½	3 0 11	March & September	11¼	10 15/16
111,000	£5	..	London Electric Supply Ordinary	2 2⅛	2⅜ 2⅝	..	..	..	—
48,050	£5	..	Do. Preference	4⅞ 5⅛	5⅜ 5⅝	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	17½ 18½	17½ 18½	2 19 6	April and October	18 7/16	17 13/16
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	17 18	17½ 18½	..	" "	..	—
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119 123	119 123	3 13 6	June and December	..	..
6,452	10	8/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	2 8 2	March	16½	15 11/16
275,000	1	—	Rand Electric	1 1/16 1 1/8	1⅛ 1⅛	..	—	8⅜	—
£125,000	Stock	..	River Plate Elec. Lt. Tr. c'n, Ltd., 5% 1st Mor. Deb.	93 98	93 98	..	..	..	..
150,000	$100	..	Royal Electric Company of Montreal Shares	148 150	148 150	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	103 105	104 106	4 5 4	April and October	105	104⅜
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	16 17	16½ 17½	3 5 9	February & August	17	16⅜
20,000	5	3/6	Do. 7 per Cent. Preference	9½ 10½	9¾ 10½	3 6 8	" "	10½	10 1/16
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	103 106	103 106	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	14½ 15½	14½ 15½	3 4 0	March & September	15⅜	14½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	£3	1/6	Brush Electrical Engineering	1½ 1⅝	1½ 1⅝	—	—	1 7/16	..
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	1⅝ 2⅛	1¾ 2⅛	..	—	2	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	107 111	107 111	4 1 8	February & August	110½	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	98 102	98 102	4 9 7	June and December	—	—
10,000	£10	..	British Aluminium Ordinary	.. ..	— —	—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference	.. ..	— —	—	—	—	—
£100,000	£5	int. 4/0	Callender's Cable Construction, Limited, Shares	7 8	7 8	3 15 8	June and December	..	..
£90,000	Stock	4½	Do. 4½% Mort. Deb. Stock	103 113	108 113	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½ 1⅝	1½ 1⅝	—	—	1½	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1½ 2	1½ 2	—	—	—	—
£32,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	89 94	89 94	5 6 5	January and July	—	—
93,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 2⅝	2½ 2⅝	6 0 0	February & August	..	..
17,139	5	2/9½	Do. (£5 paid)	4 5	4 5	5 10 0	" "	..	..
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101 103	101 103	3 17 8	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	1⅞ 2⅛	2 2½	4 13 4	February & August	2 7/16	2
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½ 3⅝	3½ 3⅝	4 3 4	August	3⅜	—
91,156	1	10/0	Elmore's Patent Copper Depositing	⅛ ¼	⅛ ¼	..	..	..	—
10,000	10	6/0	Henley's Telegraph Works Ordinary	19½ 20½	20 21	4 15 3	February & August	20½	19½
3,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 12 0	" "	..	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 10	" "	..	—
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21½ 22½	4 8 11	" "	21⅜	21⅛
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103 107	103 107	3 14 9	March & September	—	—
37,350	12	12/0	Telegraph Construction and Maintenance	36 39	36 39	4 12 4	March and July	38	37½
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102 105	102 105	4 15 3	January and July	—	—
£22,500	£5	3/6	Willans and Robinson Ordinary	8½ 8¾	8½ 8¾	4 0 0	April and October	..	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	7 7½	7½ 7¾	3 17 5	" "	7¾	7½
£100,000	Stock	26/7	Do. 4½% First Mort. Debs.	105 108	105 108	4 3 4	" "	108	107

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NOTES.

ELECTRICITY is playing a part gradually increasing in importance in our British navy. Rightly enough, the authorities were cautious in adopting it until its powers had been well tried, and even now it would seem that there is some hesitation about using it as extensively as might be. When it is a question that may affect the efficiency of our first line of defence, caution and, it may be, conservatism are commendable up to a certain point; but if these otherwise excellent qualities are unduly exhibited, nations which are less cautious and more ready to adopt new ideas for their naval equipment are likely to gain a corresponding advantage. Electric motors and lighting have already been extensively adopted for the navies of many foreign countries, and so superior has this form of power proved that we sincerely hope the Admiralty is making every reasonable use of it. Among its many services on board a man-of-war we may mention motors for handling ammunition, for working the heavier armament, and for ventilation, besides which electricity plays an important part in search-light equipment and in signalling. With such varied applications it is essential that great care be exercised in the simplification of the system, as, for example, in making all similar parts interchangeable, and in providing means for ready and quick renewal and repairs.

BY the proposed extensions of the Metropolitan Electric Supply Company's system, if they are carried out, the character of the system as a whole will be brought more into accord with its electrical details. For a high-pressure alternate-current system supplying an extensive area of valuable property, it would seem to be more in harmony with the engineering fitness of things that the principal power station or stations should be situated at such a distance from the centre of supply as would enable the advantages to be realised of cheap land, inexpensive labour and the greatest facilities for obtaining fuel and water. Powers are about to be sought to enable the Company to erect a new generating station on a site bounded on one side by the Grand Junction Canal, on another by the London and North Western Railway, on a third by two other important railways, and on the fourth by Acton-lane, the land lying in Acton and Willesden. The site selected is one that must undoubtedly prove advantageous to the business of the Company. Cables are to be laid connecting the new station with existing stations of the Metropolitan system, and it will be a matter for no great surprise if the bulk of the energy supplied should ultimately be passed through these cables.

COLONIAL engineering, it would appear, is simply British engineering multiplied by a coefficient. In a Report on the electric lighting of Brisbane, by Mr. JOHN HESKETH, this principle has been carried into practice, evidently with satisfactory results. Firstly, as to competition:—

> Broadly, we may assume that if electric lighting will pay when competing with gas in England, it will pay when competing with gas in Queensland, if the relative charges are the same. For instance, if, with gas at 2s. 6d. per 1,000 cubic ft. electricity finds a ready sale and is a profitable investment when sold at 6d. per unit in England, we may safely assume that, with gas at 5s. or 6s. per 1,000 cubic ft., electricity would be an equally successful competitor if sold at 1s. per unit in Queensland.

This consideration, however, requires to be modified by such matters as climatic conditions; for, as Mr. HESKETH rightly observes, the argument that it gives warmth as well as light tells against gas in Brisbane, while it may conceivably favour it in London. Next, as to items of cost. Thanks to such periodical publications as *The Electrician* supplements, these are well determined for the electric supply business of the United Kingdom. The trouble begins when the data are to be interpreted abroad; but the useful coefficient—useful if it be not indeterminate—comes to aid the perplexed engineer. From Mr. HESKETH'S report we learn the values of the constants—are they constant, however?—for Queensland:—

> *Coal and Fuel.*—Steam coal in Brisbane is not much dearer than in the majority of English midland towns, but I have allowed an increase of 20 per cent.

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Oil, Waste, Water, and Stores.—I think it will be ample if you allow 25 per cent. advance.

Wages of Workmen.—Skilled labour is more expensive in the colonies than at home, and although to train men for general central station work is not difficult, it is not advisable to underpay them. I would allow an increase of 50 per cent. on this item.

Repairs and Maintenance.—An allowance of 25 per cent. increase is, in my opinion, sufficient. No increase need be allowed for on the item of *rent, rates, and taxes*, but on *management*, &c., I think 50 per cent. advance is just.

The estimated cost of production will therefore be :—

Fuel	0·94	plus 20%	or	1·13
Oil	0·25	„ 25%	„	0·31
Wages	1·21	„ 50%	„	1·82
Repairs	0·28	„ 25%	„	0·35
Rents	0·25	„ —	„	0·25
Management	0·92	„ 50%	„	1·38
Total costs				5·24d.

THE London County Council intends to apply to Parliament to enable it to extend the Westminster tramway from its present terminus on the south side of Westminster bridge, across the bridge, and along the Embankment, but such is the fatuity with which an antiquated and unhealthy mode of traction is still clung to in this metropolis, "it is intended to employ animal power." Nevertheless, we welcome the prospect of this new tramway, for it cannot be long before horse traction on London lines will have become obsolete. The thousands of unhappy mortals living in the southern suburbs, who now spend from two to two and a-half hours a day in going to business and back in slow and dimly-lighted horse cars, would not tolerate for a single day the present depressing state of affairs if they could once realise what trolley traction would mean for them.

SOME of our southern watering places are exhibiting the same egregrious folly as London in their antipathy to tramways and the trolley car. Both Folkestone and Brighton appear to be desirous of acquiring a reputation for being the only seaside resort possessing no tramway, though obviously they cannot both attain that unenviable notoriety. The attitude of the authorities in the latter place is: We will not let a company build electric tramways here because we believe all such things ought to be done by the Municipality for the good of the community; and we will not build them ourselves because we want to be the only place without them. Truly an enlightened policy!

THERE is a curious law in the United States which permits of the construction of a railway unhampered by risk of an injunction, provided only that the work be done, and a car or train be run over the finished line, between midnight of Saturday and the same hour on Sunday. Twenty-four hours is no long time in which to transform a few miles of ordinary road into a completely-equipped tramway, but the thing has been done more than once. The custom probably leads to a deal of "jerry work," and, from an engineering point of view, is more honoured in the breach than the observance. Recently, about 2½ miles of single track was completed, including grading and overhead construction, in about 22 consecutive Sabbath hours, on a line now being laid down by the New York and Philadelphia Traction Company. In work of this sort great foresight and immense preparation are essential, as it is risky to let the matter leak out before the midnight hour has struck. The men, to the number of several hundreds, together with all material and stores, are usually kept under cover, the men being ignorant of the job in hand. At the psychological moment they are hurried out, each man and each item of material, to places pre-arranged by the officials; and it is rarely that any hitch occurs at the time—the hitch comes later on, when they try to make a jerry-built line pay.

THE "Prism" globe for arc and glow lamps and other artificial lights is a clear glass envelope, the outer surface of which is perfectly smooth, the inner surface being covered with a large number of small prismatic ridges arranged regularly in longitudinal or "meridianal" circles. Recently we saw an exhibition of the capabilities of the "Prism" globe as a light diffuser. By the simple method of comparing the general effect when a room was lighted by bare glow lamps with that produced by covering each lamp with a globe, we were able to ascertain approximately that there was practically no loss of light when the globes were used, while the improvement in the distribution of light and the complete elimination of the dazzling effect of a bare filament were unmistakable. We shall have occasion to refer more particularly to this form of lamp globe in a future issue.

Correspondence.—Pressure on our space compels us to hold over some of our correspondence, including a letter from Mr. J. S. Raworth on our leading article last week.

Electric Light in the Roman Catacombs.—From the *Pall Mall Gazette* we learn that on Tuesday, being the date of the feast of St. Cecilia, the catacombs of St. Calixtus, in Rome, were lit by electricity for the first time.

The Lachmann Conduit System.—The Viennese Tramway Company has resolved to try the Lachmann underground conduit system on 600 metres of a new line it is constructing. A description of this system will be found in *The Electrician*, Vol. XXXIX., pp. 299 and 310.

Royal Society.—At a meeting of the Royal Society held last Thursday, the following Papers were down for reading :—"On the Determination of the Indices of Refraction of Various Substances for the Electric Ray," on the "Index of Refraction of Glass," and "On the Influence of the Thickness of Air-Space on Total Reflection of Electric Radiation," by Prof. J. C. Bose; and "On the Geometrical Treatment of the 'Normal Curve' of Statistics, with Especial Reference to Correlation, and to the Theory of Error," by W. F. Sheppard.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Obidos—Parintins	Dec. 7, 1896	—
Otranto—Vallona	Oct. 11, 1897	—
Santarem—Alemquer	Oct. 21, 1897	—
Paramaribo—Cayenne	Oct. 25, 1897	—
Cadiz—Teneriffe	Oct. 26, 1897	Nov. 20, 1897
San Thomé—Loanda	Nov. 8, 1897	—
Pernambuco—Ceara	Nov. 22, 1897	—

Communication with Manaos by the Amazon Company's lines has been restored.

The New Brest–St. Pierre Cable.—We called attention last week to the failure to complete the laying of this cable by the c.s. "Silvertown," owing to stress of weather. We learn that very heavy seas were experienced in the Atlantic, and that after two attempts to splice on to the section of cable laid by the previous expedition further effort had to be given up. The French engineers, under whose charge this second expedition was conducted, considered that no further chance of success at this time of year was possible. The French engineers, we think, (or at least many of them) had their first taste of what heavy weather means in submarine cable work.

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The Great Fire in the City.—Considerable damage was done to the telephone lines by the fire of Friday last. Although there were only nine telephone instruments belonging to the National Telephone Company in the buildings that were burnt down, nearly 250 lines were interrupted. One H pole and two single poles were burnt, and three spans of 120 wires each came down, besides another span of 70 wires, two smaller spans, and from 20 to 30 branch wires. The wires included a number of trunk lines to Birmingham and Liverpool, which, though now the property of the Post Office, are still being maintained in repair by the National Telephone Company. Thirty-five men, under the superintendence of three or four engineers, were employed in carrying out the repairs, and every circuit was made good again (with the exception of those of the nine subscribers whose houses had been burnt down) by three o'clock on Tuesday afternoon.

Magnetic Observatories and Electric Traction Disturbances.—There are two magnetic observatories in North America, one at Toronto, Ont., and the other at Washington, D.C., the latter being a branch of the Naval Observatory. Both of these stations are now rendered useless, owing to the disturbing effects of trolley return currents in the vicinities of each. Unless some means are perfected to neutralise the pernicious effects of these currents which escape from the rail return sections of railway circuits, magnetic observations at both places will have to be either discontinued or the stations themselves removed to some point sufficiently remote to get beyond their influence. The loss to science by the disablement of these institutions is, of course, great, and it is the hope of the observatory authorities in Washington that some means can be adopted to neutralise the effects of these disturbing currents so that the work of taking magnetic observations may be resumed.

Electric Balloon Signalling.—In a lecture at the Imperial Institute last Monday Mr. E. S. Bruce gave an illustrated and experimental description of his system of electric balloon signalling as applied to Arctic exploration. We have already referred to Mr. Bruce's system as applied to war, and need therefore now only state that it consists in flashing Morse signals from a captive balloon, inside which is placed a group of incandescent lamps controlled from the ground by a tapping switch. The lines along which Mr. Bruce has endeavoured to render the system applicable to Arctic exploration have been towards reducing the weight and dimensions of the balloon, chiefly by attention to the material of its structure, and in this respect he confirms what long has been generally believed, that gold-beaters' skin makes the lightest envelope. The lecturer made a good case for the use of his signal balloon as a landmark, enabling an exploring party to locate its base and to communicate therewith.

Train Lighting in America.—A complete new car equipment has been built by the Wagner Palace Car Company for what is known as the "Lake Shore Limited" running between New York and Chicago. The trains consist of seven cars each, all solid vestibuled, and fitted out in the modern hotel style with private compartments, barber shops, bath rooms, etc., complete. They are equipped with the standard Pintsch gas-lighting system, to which has been added a complete electric-lighting plant. This latter consists of a Westinghouse enclosed crank two-cylinder trunk piston vertical engine of about 80 H.P., direct-connected to a six-pole Westinghouse compound-wound generator, the whole running at 400 revolutions per minute. The plant is very compact, the outside dimensions of the generating unit in plan being 64 by 86 inches. Steam is supplied from the locomotive at 80 pounds pressure through a 1½-inch steam coupling. The train distribution is made on the three-wire equi-potential system. The plant is peculiar in that while the Pintsch gas system is ordinarily considered satisfactory for train lighting, the electric light has evidently been sufficiently desirable to warrant the expense of its installation and maintenance in addition.

Use of the Trolley for Fire Engines.—An electric car for fire engines has, says the *Engineering News*, been introduced by the Watson Manufacturing Company, which bids fair to meet with considerable success. The car consists of two motor trucks supporting between them a platform large enough to hold a regulation fire engine. The extreme length is 30ft. 10½in., greatest width 8ft. 6½in., and height of car floor above the track 9½in. The total weight, including trucks and suspended floor is 14,000lb. The car can be propelled by motors mounted upon the axles as is customary at present, or it may be drawn by an electric locomotive, or an electric car can be pressed into service in an emergency. To load on a fire engine the side channel beams are released from the front truck and lowered until the front end of the floor rests upon the ground. The forward truck is then run ahead out of the way, the engine backed into place and drawn on the platform by a winch on the rear truck. The front truck is then run back to its former position and the channels raised to place by a windlass. In the course of a recent test it was demonstrated that the car could be run into position, uncoupled, the engine loaded on, and all made ready for a trip in 2¼min. Better time was made in unloading, only 1¼min. being required to detach the forward truck and hitch the horses ready for a run.

Annual Dinner of the Institution of Electrical Engineers.—The ninth annual dinner of the Institution of Electrical Engineers took place on Wednesday evening, at the Hotel Cecil, under the presidency of Sir Henry Mance. The chief guest was the Right Hon. the Marquis of Tweeddale, and among other distinguished persons present were Lord Kelvin, Sir Courtenay Boyle, Sir J. Crichton Browne, Dr. W. J. Collins (Chairman of the London County Council), Sir J. Wolfe Barry, Gen. Sir. E. Markham, Sir A. K. Rollit and Mr. J. Denison Pender. About 230 persons took part in the celebration of the annual banquet, and, after an excellent repast, listened to speeches that had the merit of being neither dull nor too numerous. In proposing the loyal toasts Sir Henry Mance reminded his hearers that the year of Her Majesty's accession witnessed the first practical success in telegraphy. Proposing the toast of "The Scientific Societies," Prof. Ayrton made a witty speech on these institutions and their names, and then went on to give an interesting sketch of the early days of physical laboratory work at Glasgow University. In those days the luxury of text-books was scarcely known, most of the books now regarded as standards in theory had not been written, and work was carried on with simple apparatus "literally in the coal-cellar." Lord Kelvin replied on behalf of the Royal Society. He reminded Prof. Ayrton that it was the "wine cellar" in which the first laboratory at Glasgow had existed. Scientific societies he considered one of the most powerful aids to the progress of science. Sir J. Wolfe Barry replied for the Institution of Civil Engineers, and Sir J. Crichton Browne made an eloquent response on behalf of the Royal Institution. In the course of his remarks he observed that if "Speech is silvern and Silence is golden" electricians had taught the world the precise value of Language in copper—"one halfpenny per word"! To the toast of "Our Guests," proposed by Prof. S. P. Thompson, the Marquis of Tweeddale replied on behalf of submarine telegraphy and the cable companies. Electrical engineers, he said, had tamed electricity, and turned a powerful agency for harm into one that bestowed innumerable comforts upon mankind. The Chairman of the London County Council, in replying to the same toast, stated that the County Council would soon have to look to electrical engineers for a solution of the rapid tramway transit problem for London. Sir Courtenay Boyle proposed the toast of "The Institution of Electrical Engineers," taking occasion to state that over 256 Provisional Orders for electric lighting had already been issued by the Board of Trade. A notable decrease in the price of electric energy had taken place recently; and he looked for immediate extension of electric traction in this country. He believed that "electricity was in its infancy." In replying to the toast, Sir Henry Mance observed that the "question of mains was going to be the main question of the future," and hoped engineers would pay increasing attention to this matter. He also expressed a hope that electric traction would be adopted for the Underground Railway. In conclusion, he proposed the health of Mr. F. H. Webb, the Secretary of the Institution, which was received with an outburst of hearty applause that testified to the high esteem in which Mr. Webb is held by every member of the Institution.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

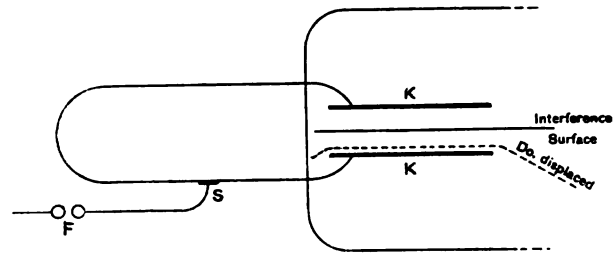
Discharge by X-Rays.—C. D. Child's Paper on "The Discharge of Electrified Bodies by X-Rays" contains a valuable summary of the state of this question, including references to the work of Thomson, Perrin, Minchin, Benoist and Hurmuzescu, Lenard, Villari, and a host of others. This summary brings out in a striking manner the diversity of the results obtained, a diversity which speaks volumes for the difficulty of these experiments, and also for the great theoretical interest attaching to them. Child himself limits his researches to a narrow field, and investigates in detail the rate of discharge of an electrified zinc plate contained in a metal box kept at a constant potential, in its relation to the pressure of the surrounding air. The box was closed at one end by a slab of paraffined wood, which was freely traversed by the Röntgen rays; better, in fact, than an aluminium window, and was sufficiently air-tight to permit exhaustion down to 6mm. It was found that at high differences of potential the law given by Benoist and Hurmuzescu, that the rate of discharge is proportional to the square root of the density of the gas, is very closely verified. At lower potentials, however, a maximum rate of discharge occurs at a certain pressure, which is 350mm. at 11 volts, and is approximately proportional to the voltage, just as it is in the discharge by ultra-violet rays, except that the absolute values differ. Child also found that discharge takes place through a layer of paraffin, and that Perrin's surface effect (*effet métal*) is very small.

[Child, *Physical Review*, October, 1897.]

Electric Interferometer.—Michelson's interferometer may be used for determining the wave-length of an electric vibration, and G. F. Hull has made some experiments with that object, hoping to gain the same advantages in electric work as have been conferred upon optical research by the superior sensitiveness and accuracy of this instrument as compared with the spectrometer. But here the want of an "electric eye" has made itself keenly felt. The eye is sensitive to all wave-lengths comprised in a certain narrow range, and it does not perceptibly alter their character, whereas all electrical receivers devised up to the present do. Hull found this to be the case even with the coherer. His coherers were made of short bits of wire contained in a tube filled with vaseline oil. With one of these he obtained very decided maxima and minima, while with another these were nearly obliterated by damping within the receiver itself. Unlike the Hertzian receiver, the coherer does not appear to exercise any influence upon the wave-length of the incident train. It only affects the amplitude, sometimes fatally. The author suggests taking a number of different receivers, which will give a fair estimate of the nature of the waves to be analysed. Further progress must be sought by obtaining a more constant source than metallic spheres immersed in oil, and a more constant, dead-beat, yet sensitive receiver. It is a noteworthy fact that the error in determining the index of refraction need not exceed 1 per cent.

[Hull, *Physical Review*, October, 1897.]

Longitudinal Light.—G. Jaumann defends his theories and conclusions against the doubts expressed by Wiedemann, Schmidt, and Tollenaer, on the genuine character of his alleged interference surfaces produced in cathode rays. He repeated the experiments and obtained the interference surfaces in a more pronounced form. The apparatus used is shown in the diagram. The two aluminium plates *k k* which formed the cathodes were placed in a large exhausted vessel. They were 10cm. long and 4cm. broad, and were mounted 2cm. apart. Outside the vessel they were joined by a loop of brass wire 250cm. long and 0·8mm. thick. The anode was a wire placed at a considerable distance away from the cathodes. A sliding contact, S, travelled along the wire and connected it at any point with the negative pole of an influence machine without condensers, through a spark gap, F. Under these circumstances the interference surface developed between the cathodes is a light blue flat surface about 0·5mm. thick, flanked by a somewhat thicker and darker layer on both sides. The rest of the space between the cathodes is dark. It is only when this surface is perfectly formed that it is sensitive to displacements of the sliding contact S, and it only succeeds when the joints between the wire and the cathodes are perfect, and when the spark gap is so adjusted that the interference surface is not reddish, nor traversed by a bright line of discharge perpendicular to it. If all these conditions are fulfilled any displacement of the contact produces a displacement of the surface in the same sense, and the outer portions bend over the edge of the cathode which they are approaching (*see* diagram). As regards the electrostatic deflection of cathode rays, which has been explained by Wiedemann and Schmidt as only apparent, and as really due to a displacement of the origin of the rays, Jaumann admits the origin is displaced, but maintains that it is displaced in a sense contrary to the argument of his critics. The rays, he says, are temporarily



bent by electrostatic influence. The origin is displaced by a few millimetres on the cathode, and the point of impact on the glass surface is displaced by about ten times that amount, but in the same direction, resulting in a decided curvature of the whole ray.

[Jaumann, *Wien. Sitzungsberichte*, July, 1897.]

Minute Spark Gaps.—E. Salvioni has been working at the simplification of exciters for electromagnetic waves, and, although not successful in the immediate object of his quest, has hit upon a highly ingenious plan for producing extremely small spark-gaps. The knobs are made of amalgamated platinum obtained by letting the arc play between a platinum wire and a mercury surface. These knobs are of great durability. They are fastened to the ends of a bar of copper bent twice at right angles, but not in contact with it. Minute changes in the size of the gap are brought about by heating or cooling the copper bar. A width of gap is obtained which transmits the current from 300 Daniell cells, and not less. On cooling the bar a point is reached at which 200 cells suffice, and so on down to two cells. The reverse process is not so simple. When the distance is increased by heating, the current is still transmitted long after the critical distance is passed. This does not appear to be due to the disintegration of the cathode, since a shock which temporarily increases the distance still further stops the discharge. The apparatus acts very much like an elementary coherer. When the critical distance for a given voltage is nearly reached a slight shock will start the discharge. Probably there would also be a great sensitiveness to electromagnetic waves. The thermal regulation of the distance is very trustworthy, as was shown by optical measurements of the interval by means of interference fringes.

[Salvioni, *Nuovo Cimento*, October, 1897.]

Contemporary Electrical Science.—We are glad that Mr. E. E. Fournier d'Albe's weekly notes on "Contemporary Electrical Science" are so appreciated in America, that some of our United States contemporaries reprint them *verbatim*. At the same time the compliment would be none the less appreciated if the source and authorship of these useful notes were duly acknowledged.

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OUR KNOWLEDGE OF THE VALUE OF A RESISTANCE.

BY PROF. W. E. AYRTON, F.R.S.

The ohm was the first of the absolute electrical units which it was attempted to realise in practice, and during the past 35 years at least 28 distinct attempts have been made in America, England, France, Germany and Italy, to accomplish this end with greater and greater accuracy.* It is interesting, then, to consider with what degree of accuracy we can at the present time state the resistance of any particular conductor in absolute measure.

The Order-in-Council signed by Her Majesty in August, 1894, says, in reference to the electrical standards of the Board of Trade: "In the use of the above standards the limits of accuracy obtainable are as follows:—

"For the ohm, within one-hundredth of 1 per cent.

"For the ampere, within one-tenth part of 1 per cent.

"For the volt, within one-tenth part of 1 per cent."

The first of these provisions is equivalent to saying that the resistance of a conductor of about one ohm will be certified to one ten-thousandth part of the resistance of the "instrument marked Board of Trade Ohm Standard, Verified 1894." But it is not clear from the Order whether, if a coil of about 100,000 ohms were sent to the Board of Trade laboratory to be tested, its value would be certified to one ohm, or only to 10 ohms, since the latter is one-hundredth of 1 per cent. Still less does the Order tell as to what degree of accuracy the value of a one-hundredth or of a one-thousandth ohm coil could be given, since the limit of accuracy must, of necessity, be diminished the maller the resistance of the coil to be tested.

Of one thing, however, my own experience makes me quite certain, and this is that any enquiry about the resistance of any coil, whether high or low, will be cordially responded to by Major Cardew, and the resources of the Board of Trade will be promptly utilised to enable the fullest information in his power to be given.

Small resistances to carry large currents are coming more and more into commercial demand, for one of the most ordinary methods of measuring large currents in practical use at the present day is to measure the P.D. between the terminals of a low resistance. So that a high-reading ammeter is very frequently a combination of a low-reading D'Arsonval voltmeter with a strip of low resistance, which may be inside the voltmeter case, or may be a part of the actual electric light main in a central station.

Now if a current of, say, 5,000 amperes is to be measured—quite an ordinary current to-day; quite a small current an American street railway engineer would call it—a resistance of one-thousandth of an ohm would be unnecessarily high. For that would mean a drop of five volts in the pressure, whereas the voltmeter can easily be constructed to give its maximum deflection for a fraction of a volt. A ten-thousandth of an ohm, that is 100 microhms, would be quite large enough—would be too large, perhaps, some might even say—hence, the measurement of such a resistance to, at any rate, 1 per cent., that is, to one microhm, will soon be regarded as merely a piece of rough workshop measurement.

Those who have been accustomed only to think of standard resistance coils as top-heavy brass boxes, with long metal legs dipping into mercury cups will, on reading the preceding, immediately feel anxiety about the resistance of the contacts in the mercury cups. Surely a variation of much more than a millionth of an ohm at the terminals will be likely to occur? But the one ten-thousandth ohm of the electrical engineer does not mean a coil which, when attached in a somewhat uncertain way to the terminals of a Wheatstone's bridge, will indicate a resistance of 100 microhms with an accuracy of 1, or some specified fraction, of a microhm, but it means some form of strip which, if constructed to carry 5,000 amperes, is such that a P.D. of half a volt will be set up between two definite points in it when a current of 5,000 amperes is flowing along definite stream lines; these stream lines being determined by the current being led into and out of the strip through specially-constructed massive copper ends.

As far as our knowledge of the values of the units is concerned, such a resistance can be tested in absolute measure by means of electrolysis in combination with a Clark cell not merely to one part in a hundred, but to one part in a thousand. Neither the electrochemical equivalent of silver nor the E.M.F. of any Clark cell, it is true, are known in absolute measure to 0·1 per cent., seeing that there is good reason for believing their reputed values of 1·118 milligrammes of silver per second per ampere and of 1·434 volts at 15°C. are each about two parts in a thousand too small. But the latter value is based on the former and on our much more accurate knowledge of the value of the ohm, hence—as far as our knowledge of units is concerned—we can ascertain the value of a resistance by means of electrolysis and a Clark's cell to a greater degree of accuracy than we know the electrochemical equivalent of silver, on which our current measurement is based, or the E.M.F. of the Clark cell used in the measurement of the P.D.

But the practical difficulty connected with such a determination of a very small resistance is quite another matter. Either the current used must be large, or the P.D. must be small, and each known accurately to 1 or 0·1 per cent., as the case may be, in terms of the international units of current and P.D. respectively. If the resistance be about 100 microhms, and 1 per cent. accuracy will suffice, and if we have a potentiometer arrangement which will divide the *one hundredth* of the E.M.F. of a Clark cell into 100 exactly equal parts, it will be only necessary to electrolytically measure a current of about 100 amperes accurately to one per cent.

But if, on the other hand, this same resistance of about 100 microhms is to be tested with an accuracy of one part in a thousand, then with the same subdivision of the E.M.F. of the Clark cell just referred to we shall have to electrolytically measure a current of about 1,000 amperes correct to one ampere. This, however, would be attended with many practical difficulties, and therefore it would be better to measure the value of some smaller current electrolytically, and then to determine the value of the larger current by some method giving their relative values.

The *direct* comparison of a low-resistance strip with the Board of Trade ohm standard remains to be considered. If the resistance to be measured were a tenth-ohm or a hundredth-ohm this could, of course, be done, but if it were of the order of one ten-thousandth of an ohm, that is 100 microhms, furnished with potential wires, and if it were made of a short piece of thick metal, so as to carry a current of some thousands of amperes without heating, such a *direct* comparison would be extremely difficult, if not impossible, to be carried out, even when an accuracy of only 1 per cent. was aimed at. An indirect comparison, in which intermediate resistances were employed as steps in the process, would be feasible but lengthy.

On the other hand, with a properly-constructed Lorenz apparatus the value of such a 100-microhm strip could be ascertained in absolute measure easily to 0·1 per cent. and with sufficient care to probably two or three parts in ten thousand. In other words, when the centering, &c., of the Lorenz apparatus has been once effected, and the calculation of the coefficient of mutual induction has been once carried out, not only can a very small resistance be measured far more easily with a Lorenz apparatus than by direct comparison with a standard ohm, but, if desired, the result can be obtained in absolute measure to a greater degree of accuracy than that with which the value of the standard ohm will probably be known.

Further, although the probability of variation with time in the resistance of such a coil as the standard of the Board of Trade is small, no molecular change affecting the specific resistance either of the phosphor-bronze of the disc or the copper of the field-coil winding would affect the accuracy of a resistance measurement made with the Lorenz apparatus.

It may, however, be urged against the Lorenz apparatus that only a small resistance can be measured by means of it. This no doubt on the face of it is true, and it may be added

* For the history of these determinations see "Practical Electricity," edition of 1896, Appendix III., pp. 568-600.

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that in the recent determination of the ohm at the Central Technical College, of which the details are given in the article commenced on this same page, the resistance which was measured had a value of about one two-thousandth of an ohm, or 500 microhms. For this the disc had to be rotated at about 600 revolutions a minute, but it could have been run quite safely at double or treble this speed, so that the value of a resistance of about one-thousandth or one seven-hundredth of an ohm might equally well have been measured.

But that is still very small the advocates of coil standards will reply. Yes; but by the employment of the method described by Lord Rayleigh* and used by Prof. Viriamu Jones in his Cardiff determination, as well as in our recent joint determination of the ohm, this resistance of one seven-hundredth of an ohm can be formed, for example, of two one-ohm coils and two 349-ohm coils, each of which, of course, can be compared very accurately with the Board of Trade ohm standard in the ordinary way.

The argument, therefore, which has been advanced from time to time by Prof. Jones, that the ultimate standard of resistance of a country should be defined as the most accurate result that can be obtained with a well-constructed Lorenz apparatus in the possession of the Government is obtaining greater and greater weight. For when once it has been shown that a Lorenz apparatus is capable of giving results of sufficient accuracy, there remains no more reason for defining the Government ohm as the resistance of some particular piece of material than for defining the *true ohm* in a like way.

As at present, an actual coil would doubtless be the every-day working standard; indeed, it would probably be convenient to have a set of secondary resistance standards of various values. But, instead of the Board of Trade ohm being legalised as the resistance of this particular coil, and its being left to outsiders to find out how many true ohms are contained in the Westminster coil, the Government would take possession of the true ohm in the form of the Lorenz apparatus, and their officials would from time to time ascertain with greater and greater accuracy the value in true ohms of the resistances of their various secondary standards.

With what degree of accuracy to-day can the resistance of a conductor be stated in absolute measure was the starting-point of this article, and the answer to that question shall be the finish. We must, of course, carefully distinguish between the accuracy with which a multiple of the Board of Trade ohm can be produced and what we know of its absolute value. Experiment may show that the resistance of a particular coil is exactly 100,000 times that of the Board of Trade ohm, but for aught we know to the contrary, even now at the end of 1897, the value of this coil in *true* ohms may be 100,020 or 99,980, for the following is the result of the last three absolute determinations:—

1891.—Cardiff determination of the specific resistance of mercury in absolute measure. Result, after correcting for the ellipticity of the coil:—

Specific resistance of mercury at 0°C. = 94074 $\frac{(\text{centimetre})^2}{\text{second}}$.

Hence, expressing the *true* ohm in terms of the resistance of a column of mercury 1 sq. mm. cross-section at 0°C.,

One true ohm = **106·300**cm.

1894.—Cardiff absolute determination of coils which had been tested by Mr. Glazebrook. Result, after correcting for the ellipticity:—

One Cambridge ohm = 0·99983 true ohm. Hence, if the Cambridge ohm be really the resistance of 106·30cm. of mercury,

One true ohm **106·32**cm.

1897.—London absolute determination of coils which had been tested by Major Cardew. Result:—

One Board of Trade ohm = 1·00026 true ohms. Hence, if the Board of Trade ohm be really the resistance of 106·30cm. of mercury,

One true ohm **106·27** true ohms.

* *Phil. Trans.*, 1888, A., p. 302.

At the present time, then, we can only say that the resistance of any particular conductor, or the specific resistance of any particular specimen of material, lie between limiting *absolute* values differing from one another by as much, perhaps, as four parts in ten thousand. But we can add that we are certain that these limits could be brought much closer together if secondary standards in the Government laboratory were frequently brought into comparison with a Lorenz apparatus which had been constructed with all the resources and skill now at the command of the mechanical engineer.

ON A DETERMINATION OF THE OHM MADE IN TESTING THE LORENZ APPARATUS OF THE McGILL UNIVERSITY, MONTREAL.

BY PROFS. W. E. AYRTON, F.R.S. AND J. VIRIAMU JONES, F.R.S.

This apparatus, made by Messrs. Nalder Bros., is in general arrangement and dimensions similar to the Cardiff apparatus described in the Philosophical *Transactions* of the Royal Society, 1891, A., pp. 1-42, and in *The Electrician*, June, 1895, Vol. XXXV., pp. 231 and 253. The field coil, in pursuance of a suggestion contained in the Royal Society's Paper, consists of a single layer of wire wound in a helical groove of semi-circular section, cut in the cylindrical surface of a massive marble ring of about 21in. outside diameter, 15in. inside diameter, and 7in. thick. This helical groove has 201 complete turns with a pitch of 0·025in. Bare wire of mean thickness 0·02136in. was first used, and the outside diameter of the coil so wound was measured in the Whitworth machine with the following results:—

Diameter.	Near front face.	Near middle.	Near back face.
0°—180°	21·04772	21·04765	21·04765
10°—190°	21·04795	21·04765	21·04952
20°—200°	21·04763	21·04755	21·04905
30°—210°	21·04805	21·04745	21·04818
40°—220°	21·04785	21·04755	21·04825
50°—230°	21·048 8	21·04730	21·04812
60°—240°	21·04752	21·04765	21·04805
70°—250°	21·04755	21·04755	21·04822
80°—260°	21·04785	21·04795	21·04895
90°—270°	21·04812	21·04780	21·04942
100°—280°	21·04805	21·04815	21·04925
110°—290°	21·04808	21·04825	21·04898
120°—300°	21·04785	21·04840	21·04905
130°—310°	21·04828	21·04835	21·04915
140°—320°	21·04828	21·04815	21·04908
150°—330°	21·04805	21·04805	21·04932
160°—340°	21·04772	21·04795	21·04858
170°—350°	21·04778	21·04785	21·04812
Mean...	.....21·04797	21·04784	21·04872

General mean = 21·04818in.

The temperature, which was taken at each observation, varied between 19·9°C. and 21°C., and had a mean value of 20·4°C. Correcting for the difference between the temperature at which the bars of the Whitworth machine have their specified value and this mean temperature, we have for the mean outside diameter of the coil, when wound with bare wire 0·02136in. thick, 21·04932in. at 20·4°C. From the above measurements it is clear that the wire lay on a very true circular cylinder. With bare wire, however, of the thickness used it was found impossible to obtain sufficient insulation between pairs of convolutions. Hence, after much time had been spent in endeavouring to insulate the successive turns by forcing paraffin wax in between them, &c., the coil was unwound and rewound with double silk-covered wire which had been first dried, then drawn through paraffin wax, and, lastly, baked before the winding was commenced. To wind so large and heavy a ring was not an easy matter, and it was not until the winding had been performed three times that the layer looked sufficiently uniform and quite free from abrasion of the silk. The mean thickness of the double silk-covered wire used in the last winding was 0·01914in., so that the outside diameter of the wound coil, calculated from the value given above for the coil wound with bare wire, was

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21·04488in. at 20·4°C. The coil was then brushed over with melted paraffin wax, bound round with silk ribbon that had been soaked in a solution of shellac, and finally loosely covered up with a wide silk ribbon that had been passed through paraffin wax.

During the time that the ring was unwound the linear coefficient of expansion of the marble was measured by Messrs. Spiers, Twyman and Waters, three of the students of the City and Guilds Central Technical College. The experiment was attended with difficulty, for it was far from easy to bring so large a mass of a badly conducting substance to the same temperature, but ultimately the result 0·000004 per 1°C. was obtained. At the conclusion of the resistance observations, recorded farther on, the silk ribbons and the protecting layer of paraffin wax were carefully removed until the silk covering of the wire appeared, and the diameter of the coil was measured along two directions at right angles to one another. The maximum difference between four measurements was only five hundred-thousandths of an inch, and, after the introduction of the proper temperature corrections, the mean value of the outside diameter of the coil was found to be 21·04687in. at 20·4°C. This result is about one part in ten thousand larger than the calculated value given above, and the difference is probably due to the silk covering of the wire having swollen slightly when the wound coil was brushed over with melted paraffin wax. In the calculation, therefore, of the coefficient of mutual induction we have considered it more accurate to use the value obtained by direct experiment. Subtracting from that value—21·04687—the thickness of the double silk-covered wire—0·01914—we have for the mean diameter of the coil *from axis to axis of the wire* 21·02772in. at 20·4°C.

Shortly before the last set of resistance measurements was carried out, the edge of the phosphor bronze disc was ground in position so as to be made quite true with the axis of rotation, and immediately after the completion of the measurements the diameter of the disc was measured and found to be 13·01435in. at 19·5°C. Messrs. Spiers, Twyman and Waters had previously determined its linear coefficient of expansion to be 0·0000125 per 1°C., so that its diameter was 13·01451in. at 20·4°C.

During 1896, when Mr. W. G. Rhodes was an assistant at the Central Technical College, he carried out the long calculation of the coefficient of mutual induction between the coil, as wound with bare wire, and the disc, by using the method given in the Paper in the *Philosophical Transactions* above referred to, and with the following values:—

Diameter of coil or $2A = 21{\cdot}02673$in.
,, ,, disc ,, $2a = 13{\cdot}01997$in.
Axial length of helix ,, $2x = 5{\cdot}025$in.
No. of convolutions ,, $n = 201$.

he found $M = 18056{\cdot}36$in. $= 45862{\cdot}33$cm.

This calculation was checked by Mr. Mather and independently by one of the authors.

Now it can be shown that for the above values of A, a, x, and n,

$$\frac{dM}{M} = 1{\cdot}246\frac{dA}{A} + 2{\cdot}846\frac{da}{a} + 0{\cdot}0997\frac{dx}{x},$$

and so the value of M for the particular values of 2A and $2a$ given above, viz., 21·02772 and 13·01451, can be calculated. When this is done we find $M = 18{,}037{\cdot}51$in. $= 45{,}814{\cdot}45$cms., and this was the value of M which we employed in our final determination, after allowance had been made for the effect of the central brush, as will be described further on.

The accuracy of the preceding calculations was tested in the following way. Values of 2A and $2a$ differing slightly from those employed by Mr. Rhodes were selected, and by means of the formula for $\frac{dM}{M}$ the proportional change in M was determined by Mr. Twyman. Then the value of M for these changed values of 2A and $2a$ was calculated by the authors from a new formula involving an elliptic integral of the third kind.*

* An account of this new formula, as well as of that for $\frac{dM}{M}$, will shortly be published by Prof. Viriamu Jones.

The centre brush consists of a tube 0·135in. outside diameter, which projects into an axial hole in the disc of 0·144in. diameter. Contact with the edge of the disc is made by three small tangential phosphor-bronze tubes lightly pressed on it at points separated by angular distances of 12·0deg. Through all four tubes a small stream of mercury is kept flowing, as this is found to greatly diminish the disturbances caused by variations in the thermo-electro effects, and the employment of three brushes at the circumference, as suggested by Rowland, eliminates small errors due to imperfect centering of the coil and disc. To prevent the mercury which drops out of the central tube-brush touching the disc at a larger radius than that of the hole in its centre, an ebonite boss is cemented to the disc, and this causes the mercury to drop away quite clear of the metal of the disc.

If we take as the effective outside diameter of the central tube 0·139in.—that is, the mean of 0·135in. and 0·144in.—calculation shows that the coefficient of mutual induction is reduced by 4·50cm., so that, finally, we have $M = 45809{\cdot}95$cm. As the allowance for the central brush only diminishes M by one part in 10,000, it is clear that for that degree of accuracy an error of a few per cent. in estimating the diameter of the central brush is of no consequence.

The method of making the observations was the same as that described in the Papers on the Cardiff apparatus read before Section A of the British Association at Nottingham and Oxford (*vide* Report of the Committee on Electrical Standards, Appendices, 1893 and 1894). The use of an extremely sensitive Ayrton-Mather galvanometer of the D'Arsonval type materially facilitated the readings being taken. Two such narrow-coil galvanometers were specially constructed by Mr. Mather himself for use with the Lorenz apparatus, and the data of the second instrument are contained in the following table:—

Resistance of suspended coil	1·9 ohms.
,, ,, coil and suspension	5·75 ohms.
Periodic time of complete swing	7·6 seconds.
Scale distance actually used	1,412 millimetres. / 1,340 scale divisions.
Deflection in divisions at actual scale distance used	137 per micro-ampere. / 23·8 per micro-volt.
Deflection in divisions at scale distance equal to 2,000 scale divisions	204 per micro-ampere. / 35·8 per micro-volt.

The resistance coils used were those previously employed in the Cardiff determination of the ohm (*vide* Report of the Committee on Electrical Standards; Appendices, II. and III., 1894). They have been tested once by Mr. Glazebrook, and twice by the kindness of Major Cardew in the Board of Trade Electric Standardising Laboratory, with the following results:—

Coil.	A. Mr. Glazebrook, Jan.-March, 1894.	B. Board of Trade, November, 1896.	C. Board of Trade, August, 1897.
No. 3,873	9·9919 at 14·8°C.	9·992994 at 14·86°C.	10·00712 at 19·3°C.
No. 3,874	9·9926 at 14·9°C.	9·993213 at 14·91°C.	10·00775 at 19·3°C.
No. 4,274	0·100050 at 15·2°C.	0·1000595 at 14·77°C.	0·100078 at 19·4°C.
No. 4,275	0·100053 at 15·2°C.	0·1000722 at 15·14°C.	0·100081 at 19·4°C.

The coils Nos. 3,873 and 3,874 were stated by the makers, Messrs. Nalder, to be wound with platinum-silver wire and the two others Nos. 4,274 and 4,275 with manganin. In the following are given the temperature coefficients as supplied originally by the makers, and as calculated from the tests A and C and B and C.

Temperature Coefficients of Resistance per 1°C.

Coil.	As supplied by Messrs. Nalder.	From tests A and C.	From tests B and C.
No. 3,873	0·000276	0·000360	0·000318
No. 3,874	0·000300	0·000344	0·000331
No. 4,274	0·0000127	0·0000667	0·0000399
No. 4,275	0·0000127	0·0000667	0·0000207

These figures show that a redetermination of the temperature coefficients which we are now carrying out is necessary.

Fortunately, the last set of determinations of the resistance of these four coils was carried out at Westminster, within a fortnight of the completion of our absolute measurements, and we are much indebted to Major Cardew for his kind

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promptness in the matter. The temperatures of these 1897 Board of Trade measurements were so nearly those of the coils during our final absolute determinations, which were from 18·8°C. to 19·4°C., as to render the effect of possible errors in the temperature coefficients negligible to the degree of accuracy aimed at by us. We have, therefore, used the August 1897 Board of Trade values for these coils as transmitting the Board of Trade ohm to the laboratory in Exhibition-road.

The standard thermometers used in the investigation were sent to Kew, and their errors were determined at the time by the kindness of Dr Chree, also thanks to Sir J. Norman Lockyer, the Clock in the Mechanical Department of the Central Technical College, which transmitted seconds to the fast-running Bain chronograph, was frequently timed by reference to the current sent hourly to his room from the General Post Office, and at 10 a.m. from Greenwich.

The results of successive measurements of the absolute resistances became very concordant after, little by little, various possible causes of small errors had been eliminated. Nine sets taken on July 30, 1897, gave the following results for the value of the Board of Trade ohm in true ohms without allowance being made for the error in the clock rate :—

	1·000286
	1·000256
	1·000285
	1·000351
	1·000295
	1·000277
	1·000306
	1·000284
	1·000307
Mean...	1·000294

or, since the clock was found to lose during the daytime at the rate of 3 seconds per 24 hours, it follows that, according to this investigation,

one Board of Trade ohm = 1·00026 true ohms.

It is important to consider in which direction this result will be affected by sources of error that cannot be removed by careful adjustment, centering, &c. They may be classified as follows:—

Source of error.	Effect produced.
1. Over-estimation of the diameter of the coil arising, for example, from the stress on the copper wire having caused it to compress the under side of its silk covering	Result would be too small.
2. Under-estimation of the diameter of the phosphor-bronze disc from a neglect of the tips of the circumferential brush tubes being possibly pushed away from the disc by the stream of mercury issuing, &c.	Result would be too small.
3. Presence of iron pipes, girders, &c., in the neighbourhood of the apparatus	Result would be too small.
4. Traces of iron in the phosphor-bronze disc	Result would be slightly too small.
5. Defective insulation between the support of the central brush and the supports of the circumferential brushes	Result would be too large.
6. Defective insulation between the convolutions on the coils	Result would be too large.
7. Traces of iron in the marble ring	Result would be too large.
8. Defective insulation of parts of the circuit from one another	Effect would depend upon position of leaks.
9. Permanent magnetic field at the apparatus	No effect, for the current thro. field coil was periodically reversed.

As regards (4) and (7) special induction balances were constructed and used by Mr. Mather to test the permeability of both the marble ring and the phosphor-bronze disc; but although a deviation from unity of one part in 15,000 could have been detected in the permeability of either, no such deviation was observed. As regards (5) and (8), careful tests were made every day of the insulation resistance of the apparatus, and it was always found to be greater than 1,000 megohms. As regards (6), the insulation between the adjacent convolutions of wire could not be measured when they were silk covered and buried in paraffin wax, since a small leak between a pair of turns would not change the apparent resistance of the copper coil by as much as the variation in temperature of a fraction of one degree. We had, therefore, to content ourselves with the precautions, previously described, which were taken to secure high insulation in the winding of the coil. When the ring was wound with bare wire it was possible to roughly compare the insulation resistance between pairs of convolutions by sending a constant current through the coil and measuring, very accurately, the P.D. between every adjacent pair of the 201 turns. This we did several times, but it was a long and laborious task.

When constructing a new Lorenz apparatus it will be well to consider whether two separate helices should not be cut in the cylindrical surface of the marble ring in which two independent bare wires would be bound, a turn of the one being everywhere (except at the extreme ends) between two turns of the other. The insulation resistance, therefore, between the two windings would measure the insulation between the adjacent turns, while in the ordinary use of the apparatus the two windings would be joined in series so as to constitute a single coil. In this way it may be possible to be more sure of the absence of (6) than by using paraffined double silk-covered wire, and at the same time to entirely remove (1).

The *direction* of our experimental result, which shows that the Board of Trade ohm is between two and three parts in ten thousand larger than the true ohm, could not, however, arise from (1). Nor could it from either (2) nor (3); still many experiments were made to detect any evidence of the effective diameter of the disc being larger than its true diameter, as measured in the Whitworth machine. But no change in the pressure of the circumferential brush tubes nor alteration in the shape of their ends, &c., indicated that, with the brushes as we employed them, the effective diameter of the disc differed from its true diameter.

Our thanks are due to the three students whose names are given above, for much assistance in carrying out the long series of observations; to Mr. Harrison for bringing to bear, from time to time, the experience that he had previously gained in the use of the Lorenz apparatus; and we are especially indebted to Mr. Mather for the suggestive aid that he rendered us throughout the whole of the present investigation.

ELECTRIC LIFTS AND CRANES.*

BY H. W. HAVENSHAW, ASSOC.M.INST.C.E.

(*Continued from page 119.*)

Electric Cranes.

Cranes driven by electric motors are coming into frequent use, the ease by which the power can be transmitted to the movable framework of a travelling or jib crane, and the adaptability and compactness of the electric motor presenting many advantages over other forms of mechanism. In the case of a travelling crane the current can easily be collected from conductors stretched along the walls or gantry supporting the crane. These require no attention when properly fixed, and are preferable to fast-running ropes or square shafts which are running continuously and waste much power. Where electricity is used for other purposes there is little loss of power while the crane is standing, as in those cases where separate motors are used for each motion they are stopped, started and reversed as required. Where mechanical methods of control are employed the motor must naturally be running idle for a large part of the time, but even in this case the attendant can start and stop it when it is not required.

The use of a separate motor for each motion appears at first sight to present many advantages. The power can be applied to the work in the simplest manner, all clutches being dispensed with, and smooth starting, regulating and reversing are obtained. On the other hand, with a single motor, the electrical details are of the simplest kind, and the rush of

* Paper read before the Institution of Civil Engineers.

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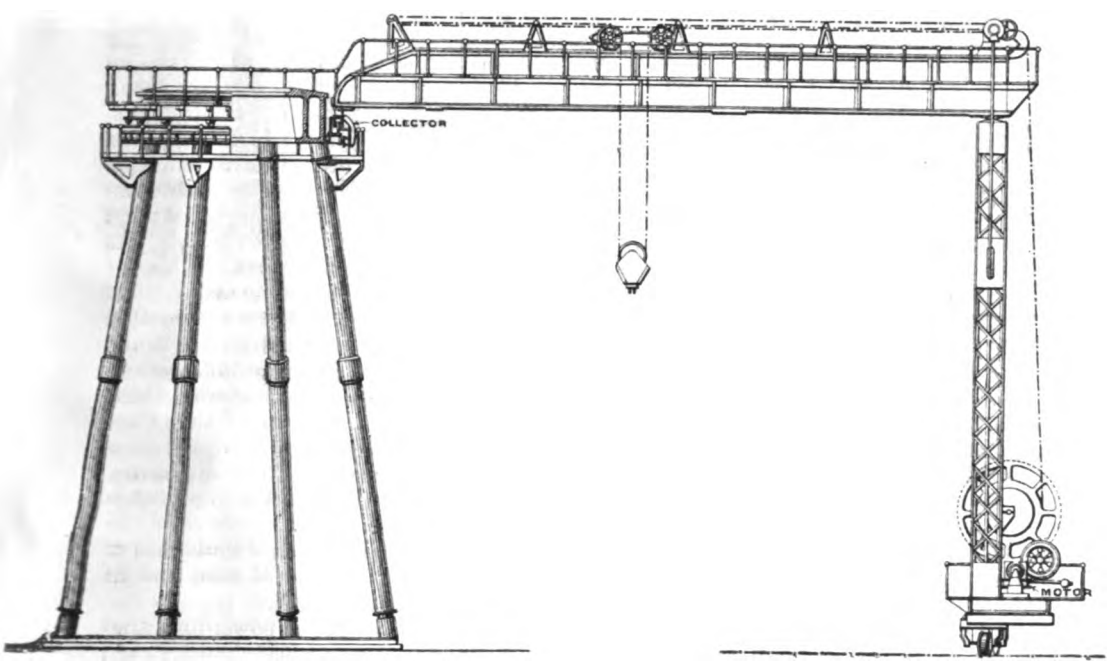
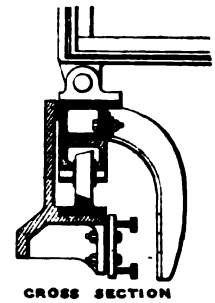
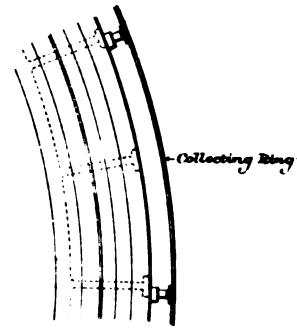


ELEVATION



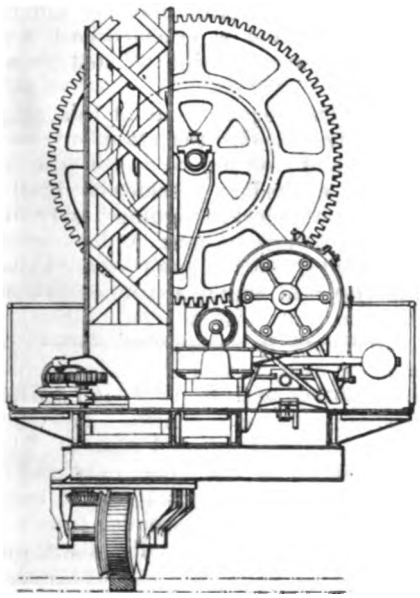
CROSS SECTION



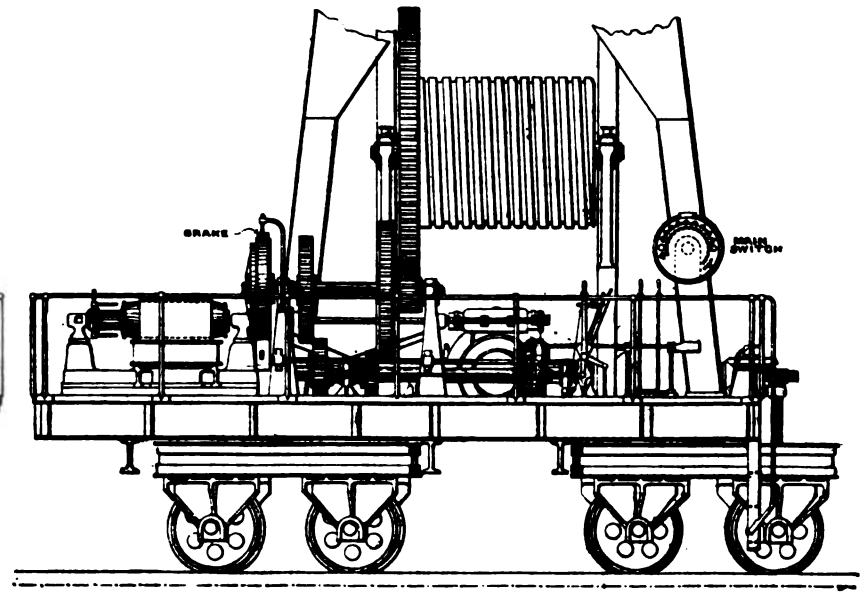
PART PLAN

FIG. 7.—Scale: 1 inch = 1 foot.

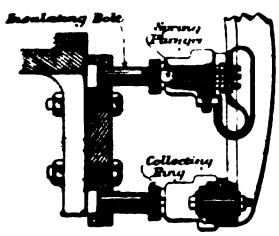
FIG. 5.—Scale: $\frac{3}{16}$-inch = 1 foot.

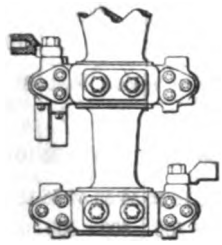


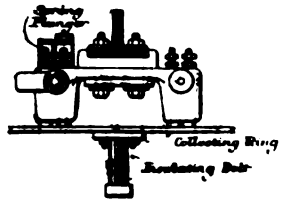
END VIEW



SIDE ELEVATION

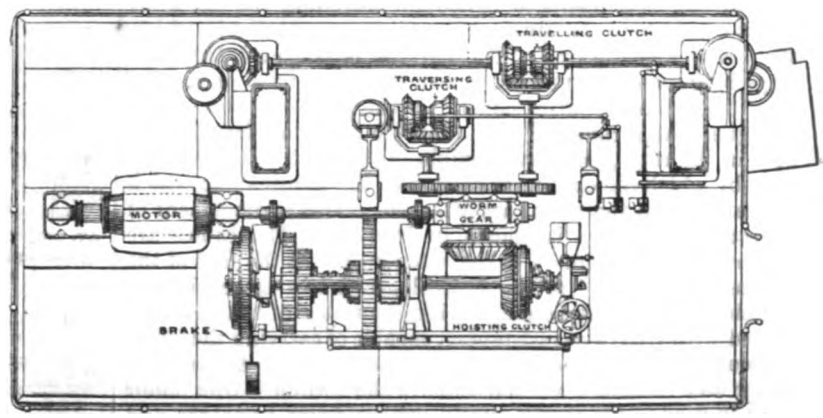






DETAILS OF COLLECTOR

FIG. 8.



PLAN
ARRANGEMENT OF GEARING

FIG. 6.—Scale: $\frac{3}{8}$-inch = 1 foot.

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APPENDIX I.—*Tests of an Otis Electric Lift at 12, Hill-street, W., Nov. 27, 1896.*

No. of test.	1	2	3	4	5	12	7	8	9	14	15	18
Direction	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down
Load ... lb.	648	648	606	504	336	336	171	171	0	0	336	336
Travel ... feet	36·5	36·5	36·5	36·5	36·5	36·5	36·5	36·5	36·5	36·5	24·75	24·75
Time per trip ... seconds	28·0	22·0	25·0	21·0	22·0	23·0	22·0	22·4	22·0	24·0	16·4	16·0
Maximum current ... amperes	13·0	11·0	12·0	12·0	11·0	12·0	10·0	11·0	12·0	12·0	12·0	12·0
Average current ... amperes	11·5	3·0	8·5	4·0	6·5	6·5	4·25	7·5	2·5	9·5	6·5	5·5
Duration of current ... seconds	28·6	23·2	27·2	23·2	25·2	24·0	24·0	24·2	23·4	25·8	17·6	16·4
Energy per trip ... watt-hours	19·8	5·6	15·6	7·08	11·2	9·27	7·8	12·68	5·37	16·35	8·3	6·83
Cost per single trip at 4d. per unit ...	0·079	0·0225	0·0624	0·0283	0·0448	0·037	0·0312	0·0509	0·0214	0·0655	0·0332	0·0273
Cost per double trip ...	0·1015		0·0907		0·0818		0·0821		0·0869		0·0605	
Av. cur. from meter reading ... amperes	12·2	4·25	10·2	5·4	7·9	6·9	5·75	9·20	4·0	11·2	8·3	7·4
Av. speed ... feet per min.	78·0	99·5	87·5	104·0	99·5	95·0	99·5	98·0	99·5	91·0	90·0	92·7

current, which is almost certain to occur at starting with a careless driver, is avoided. The subsidiary motions absorb so little power compared with lifting that the designer often prefers to use simple friction clutches, which are understood by an ordinary mechanic, to the more complicated and often unmechanical electrical gear. There seems little to choose between the two systems, both of which are largely used with good results.

By the permis ion of the authorities at Woolwich Arsenal, and of Messrs. Easton, Anderson and Goolden, the author is enabled to give (Appendix II.) the results of a series of tests of a 20-ton electric crane, Figs. 5-8, the electrical contrivance of which was designed by him. This crane was erected as an auxiliary to the large radial steam-crane in use in the annealing shop at Woolwich Arsenal. It consists of a radial girder supported at the inner end by a cast-iron belt which encircles the upper part of the centre column supporting the steam-crane. The belt is free to rotate, being carried on coned supporting wheels which run on a circular race bolted to the column. The outer end of the girder is supported by a vertical leg, built of lattice girders, carrying the chain-barrel, electric motor and driving gear. The leg rests on two two-wheeled bogies, the wheels running on a single circular line which is also used by the steam-crane. The mechanical details of this crane were designed by Mr. C. H. Moberly, M.Inst.C.E.; the author, however, proposes to describe here only the details of the electrical gear.

The current is supplied from the electrical central-station at the Arsenal, at a potential of about 310 volts. The cables are carried up one of the legs of the centre column, and are attached to two collecting rings fixed on insulators upon the lower part of the race which supports the revolving belt, Fig. 7. These collecting-rings are made of lengths of copper strip, 2ins. by $\frac{1}{16}$in., and, being bent to the correct curve, are fixed by countersunk bolts to small gun-metal blocks, screwed on to the ends of horizontal Aetna insulating bolts. The fixing for these bolts is shown to a larger scale in Figs. 8. The insulators consist of gunmetal bolts screwed at one end and covered for nearly the whole length with a hard fibrous material, giving excellent mechanical support with remarkably good insulation. The insulation resistance of the cables inside the crane house, including the collecting rings and collectors, was found at the time of the experiments to be about 5 megohms—an excellent result considering the atmosphere of steam and dirt in which the crane was working. The current is collected from the rings by gunmetal plungers, $\frac{7}{8}$in. in diameter, fixed on insulating blocks to an arm bolted to the radial girder. The plungers have a range of more than $\frac{1}{2}$in., to allow for unevenness in the rings, and have flexible strips fixed to their outer ends by which the current is carried to the terminals to which the cables from the motor are attached. This arrangement of collectors and rings is shown in Figs. 8. The cables are carried along the girders to the main switch at the foot of the vertical leg. Fixed to the vertical girder is a large circular switch of solid construction, having a number of contacts connected with iron-wire resistances, capable of carrying the working current of the motor without over-heating. An ampere-meter and voltmeter are fixed above the switch. One motor only is used; it is shunt wound, with a drum armature and carbon brushes, and runs at about 900 revolutions per minute at 310 volts. There is no sparking at the brushes with varying load, and little attention is required. The shaft of the motor is coupled direct to a worm-gear by a shaft 4ft. long, large enough to take the torque, but small enough to compensate for any want of alignment between the motor and the worm-shaft. This arrangement works well, and, having no back-lash, is preferable to a flexible coupling. The worm-gear mentioned consists of a treble-thread steel worm, gearing into a worm-wheel, having fifty-one teeth of 2in. pitch, the reduction being in the ratio of 17 to 1.

The direction of rotation being constant, a simple thrust-bearing is employed, consisting of a number of hardened-steel lenses. This was considered to be more suitable than a ball bearing for so large a power, as the motor is only used at full power for a few minutes at a time. On one end of the worm-wheel shaft is fixed a spur-wheel, which transmits the power through a train of gearing and reversing friction-clutches to the travelling and radial motions. On the other end of the worm-wheel shaft is a bevel-wheel, which actuates the winding-barrel through a fricton-clutch and two-speed gear. A self-acting brake is connected to the chain-barrel by pawls and a ratchet-wheel automatically holding up the load, lowering being effected by releasing the brake.

Owing to the special requirements of this crane, and the fact that it was advisable for the attendant to have ready access to the motor and gear, a good deal of gearing was used, and the power was applied in a somewhat indirect manner. In consequence a chain-block, weighing nearly two tons, was used. This weight causes a considerable reduction in the efficiency at light loads; but the loss is easily ascertained, and the ratio of the electrical energy consumed to the work developed in lifting the load, with the falling block, is given in Appendix II. Although it was not possible to test the particular electro-motor used, a table of efficiencies is given of a machine almost identical with it in size and construction, and the estimated power absorbed is shown. The efficiencies may certainly be taken as correct within 1 per cent. With no load on the hook, the weight on the inner race was 14 tons, and on the outer line 46½ tons, the total weight being 60½ tons. During the tests the load was suspended from the middle of the girder, the weight being equally distributed between the ends.

APPENDIX II.—*Tests of a 20-ton Electric Radial Crane at Woolwich Arsenal, 17th March, 1896.*

Hoisting.

No. of Test	15	16	17	18	19	20	21	22	23	24
Gear	Slow	Slow	Fast	Fast	Slow	Slow	Fast	Fast	Slow	Slow
Net load on hook, tons	0	0	0	0	9	9	9	9	20	20
Gross load, inc. block, tons	1·83	1·83	1·83	1·83	10·83	10·83	10·83	10·83	21·83	21·83
Speed of hoist, feet per min.	16·36	16·36	34·35	34·35	15·79	15·79	30·40	31·03	13·84	13·84
Av. poten., volts	306	306	300	300	298	295·5	285	282	267	270
„ current, amps.	18	17	26	25	49·6	49·3	100	100	98·3	101·6
„ work E.H.P.	7·38	6·97	10·45	10·05	19·81	19·53	38·21	37·80	35·18	36·77
Net H.P. deliv. to load	0	0	0	0	9·64	9·64	18·56	18·95	18·79	18·79
Gross H.P. deliv. to block	2·03	2·03	4·26	4·26	11·60	11·60	22·33	22·81	20·50	20·50
$\frac{\text{Net H.P.}}{\text{E.H.P.}} \times 100$	0	0	0	0	48·66	49·35	48·58	50·13	53·42	51·11
$\frac{\text{Gross H.P.}}{\text{E.H.P.}} \times 100$	27·51	29·14	40·79	42·42	58·61	59·45	58·45	60·36	58·28	55·76
Estimated losses in motor, in H.P.	2·80	2·80	2·84	2·84	3·01	3·01	3·68	3·68	3·55	3·62

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Efficiency Electric Motor.

H.P. at shaft	48	36	24·0	12
Efficiency, per cent.	92	91	88·5	81

Circular Travel.

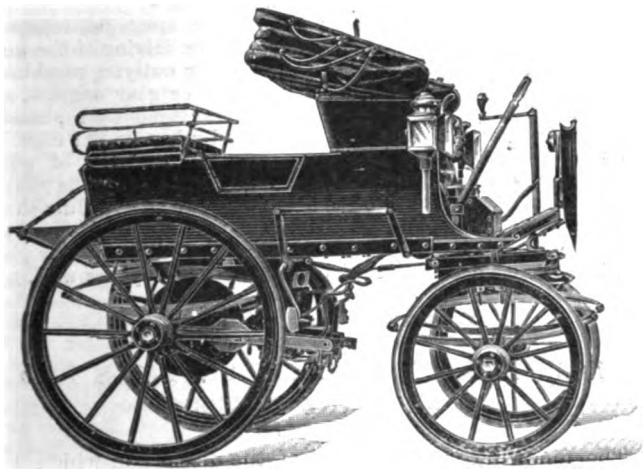
No. of test	53	54	55	56	57	58
Load on hook..... .....tons	Light	Light	9	9	20	20
Speed at racer, feet per min.	55·0	55·0	55·0	55·0	54·0	54 0
Potential .....volts	308·0	312·0	307·0	310·0	300·0	297·0
Current .....amperes	15·3	15·0	19·3	18·0	19·0	21·0
Work .....E.H.P.	6·3	6·3	7·9	7·5	7·64	8·4

Radial Cross Traverse.

No. of Test	79	80	81	82	85	86
Load on hook..... .....tons	Light	Light	9	9	20	20
Speed of carriage, ft. per min.	33·7	33·45	33·45	33·45	32·27	32·4
Potential..... ... volts	307·0	308·0	302·0	305·0	287·0	282·0
Current .....amperes	12·4	13·0	18·75	19·3	26·8	27·0
Work.....E.H.P.	5·1	5·36	7·6	7·9	10·3	10·2

THE HEADLAND ELECTRIC MOTOR CAR.

In the Headland electric motor car, shown in the accompanying illustration, an example is furnished of a very compact and efficient self-propelled road vehicle of somewhat larger pretensions than those hitherto noticed in these columns.



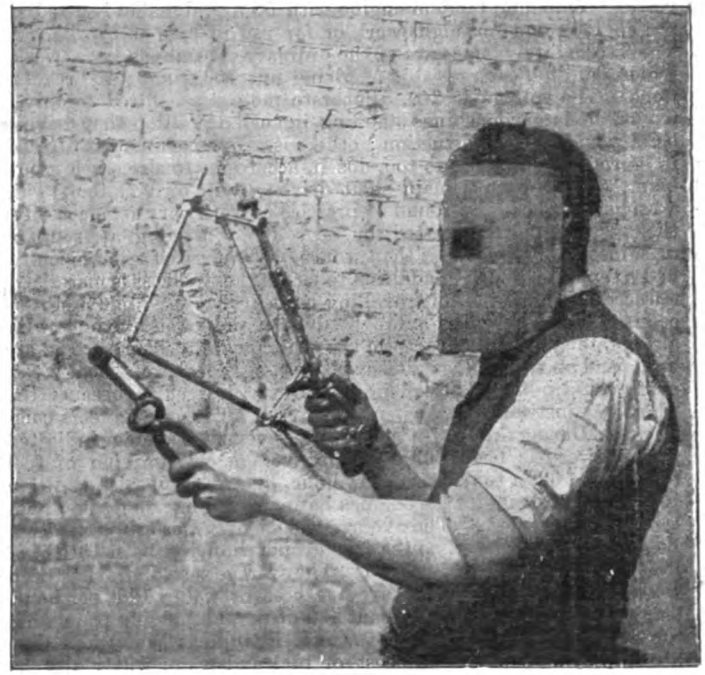
The Headland Electric Motor Car.

The car is constructed to carry from four to six persons, and will travel at from 8 to 20 miles an hour on a good level road. It will also mount stiff gradients and traverse inferior roads at quite a high speed. With a single charge-up it will run, it is said, some 50 miles or more. The electrical equipment comprises a battery of 40 Headland accumulators, arranged in four groups, and a single 4 H.P. series-wound motor. The axis of the motor is placed longitudinally, a bevel pinion on the spindle driving a phosphor-bronze bevel wheel on the axle of the rear wheels. An idle pulley behind the bevel wheel serves to press it into gear with the pinion. In the rear axle is interposed a differential gear to allow of an easy turn round a corner, this permitting the inner wheel to slow down on the curve. No resistances are inserted in the electrical circuit, the whole of the regulation of the speed being effected by various groupings of the four sets of cells. At starting the sets are all in parallel; from this they pass through two-in-series and two-in-parallel to all-in-series.

A lengthy ride on a variety of roads, in company with Mr. Parr, of Headland's Electric Storage Battery Company, gave us recently an opportunity to test this car in regard to smoothness, &c., in running. We found the vehicle run smoothly and almost silently, while it was also under perfect control.

THE "VOLTEX" PROCESS OF WELDING AND BRAZING.

We witnessed on Friday last some applications of a new process of electric welding, which, with the tools to facilitate its use, the Electric Metal Working Syndicate have recently introduced. Briefly, the process consists in the use of an electric arc formed between two special carbon electrodes inclined to each other at an angle for heating to a brazing or welding temperature the joint to be made good. The carbon electrodes are secured in a holder, which, in the usual sizes used, can be easily held in one hand. By means of a push knob and a milled nut handy to the thumb when the tool is held, the arc between the carbons may be initially struck, and the carbons subsequently fed together whenever necessary. The angle which the carbons make with each other is somewhere about 90deg., a disposition which has the useful result that the arc is deflected or blown outwards in a sort of jet from the carbons, on the side remote from the 90deg. angle; thus, without necessitating the special directive force of a blast of air or of a magnet, the arc can be easily played on to any point of the work desired. This phenomenon of the arc between two carbons not in a straight line with each other being driven outwards from the smaller angle seems explicable, as being due to the repelling



The "Voltex" Welding Tool as used for Brazing.

effect which the current experiences under the influence of the unequal density of the magnetic field around the arc and current path, which is greater within the space included by the smaller angle than within that by the larger. Essentially. the arc-forming tool referred to, together with a mask fitted with dark windows, constitute all the outfit required for prosecuting general work in this process, provided an electric supply is available. The carbons used are of a special composition, and are manufactured for the process under the Syndicate's patents. The process is applicable to widely differing classes of work, from welded joints in iron and steel, such as boiler plates, iron bars, waggon tires, &c., to brazed joints of all kinds, where in many cases, as in brazing cycle-frame tubes, it is particularly suitable in consequence of the heat being confined to the particular part. The process thus obviates the damage unavoidably occasioned by ordinary processes of brazing. Another very useful application of the process is the patching and making good of blow-holes and other defects in cast-metal work.

We have seen very neat and substantial specimens of brazed and welded joints made by this process, and an interesting job was the repair of the main body casting of a Worthington pump, which had been broken. For this purpose it may be mentioned a current of about 150 amperes at 50 volts was used. Special tools are being made as accessories to the arc-forming tool for facilitating the making of welded joints in cable sheathing, steel strip, and the repair of overhead trolley wires. Our illustration shows a workman ready to make a brazed joint for forming a T-piece, and we watched with interest, on the occasion of our visit, the making of a similar brazed joint by this handy process.

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RECENT DEVELOPMENTS IN ELECTRIC POWER PLANTS IN ENGINEERING WORKS.

At the annual meeting of the Cleveland Institution of Engineers on the 15th inst. two Papers were read on the above subject. The first was a description by Mr. Westgarth of the electrical driving plant at the new works of Sir Christopher Furness, Westgarth and Co., in Middlesborough. Mr. Westgarth stated that these works are divided in four parts by streets, and that already on acquiring the site it was decided to utilise electric power transmission. A set of vertical triple-expansion condensing engines to work with steam at 200lb. pressure was erected. The cylinders are 14in., 23½in., and 39in. diameter by 24in. stroke, indicating 400 H.P. at 100 revolutions per minute. A Proell automatic expansion valve with high-speed governor is fitted, and a heavy flywheel is placed at each end of the crank shaft, each wheel driving one of the main dynamos through a belt. The air pump, which is on Edwards' principle, and the feed pumps are worked by levers from the centre engine, and a separate feed pumping engine is also fitted. The boiler is of the ordinary marine type, 10ft. diameter by 10ft. long, fitted with Howden's system of forced draught. The power station is so placed that the main machine shops in which the heaviest work is done can be driven by ropes directly from the engines without the interposition of electricity. In addition to the main engines a vertical compound tandem engine with 50 H.P. dynamo is fitted in the engine room for night work or for use in case of breakdown. The two main dynamos are of the ordinary continuous type, working in parallel, each capable of giving out 150 H.P. at 450 revolutions. The voltage is 240. Separate motors are fitted to only a few of the larger machines standing in such a position that driving belts would be an obstruction; otherwise the machinery is divided into groups of from four to a dozen, according to size, each group being worked from a main shaft driven by its own motor. This arrangement has been found in practice to work very satisfactorily; the average power exerted by each motor driving a group of machines being much less than would be required if each machine had a separate motor, in addition to which the first cost is materially reduced. In the case of travelling cranes, they used one motor to each crane. The works are lighted from the same dynamos with a separate system of wires from the switchboard. There are 52 arc lights and about 400 incandescent lamps on the works. Mr. Westgarth could not give any definite figures as to results, because the plant was just completed when the present strike of engineers commenced. During the last few months, however, their average indicated horse-power has been 307, and the average consumption of fuel (costing 7s. 6d. a ton) 541lb. per hour, but the boiler, in addition to supplying steam for the engines has supplied one, and sometimes two steam hammers. The average weight of water evaporated has been 5,110lb. per hour, so that the evaporation has been 10·1lb. of water per pound of coal burned. The average cost of coal has been 1s. 9½d. per hour, and the average cost of water 1⅝d. per hour. They have been employing about 480 men, and judging from what the firm were doing before the strike, it appears that when they are employing 800 men the cost of fuel and water will really be very little more than the figures quoted above; these costs include the lighting as well as provision of power. The cost of maintenance is going to be very light. The total cost of the installation, including the motive power, has been about £10,000, and although this is a very large sum, the figures quoted above are quite sufficient to justify the outlay.

The second Paper was by Mr. D. Selby Bigge, of Newcastle-on-Tyne, on "Modern Practice in Electric Power Work and Recent Developments on the North-East Coast." Mr. Selby Bigge remarked that in no part of the country has the progress made in electric driving been so marked and rapid as upon the North-East Coast; in fact, it may be said that the engineers of the Middlesborough, Hartlepool, and North East Coast districts have to a very large extent been the pioneers of the system in this country. No more forcible instance of the application of electricity can be found than in those cases where it has been applied to the driving of shipyards, or iron and steel works, which contain a number of scattered engines. Such machines as these are frequently very uneconomically driven. In some cases the total coal consumption has been found to be as great as 15lb. to 20lb., and frequently 10lb. of coal per horse-power of actual work done by the various machines throughout the works. From a central power station of modern design the same power can be given out by the machines in any part of the works for an expenditure of 2½lb. to 3lb. of coal per actual horse-power of work done, inclusive of all losses in engines, dynamos, cables, switching gear and motors. In the case of an ordinary-sized works the loss in the transmission of power through the cables should not exceed 3 or 4 per cent. One of the most important and remarkable features of electric power installations is the very low cost of the annual upkeep. When once the plant is laid down the maintenance over a number of years is exceedingly small—2 or 3 per cent. on the original cost of the plant. The repairs to the motors can almost invariably be carried out at the works. Every machine in a shipbuilding yard can be driven electrically with the exception of the steam hammer in the forge. These hammers are a source of great waste. In the case of hydraulic machinery for driving jib cranes, rivetters, manhole punches, &c., it has been found advisable to drive the electric pumps with a motor, leaving the hydraulic system alone as it exists. Special electric winches have been designed for shipyard use and have proved very serviceable. They are as a rule provided with 7 to 8 H.P. motors, and are capable of doing all that the steam winches did before them, and in a very much more economical manner. The steam winches in a shipyard are generally a source of great waste of steam, as the pipes have usually to be laid underground, where it is hard to maintain them in good condition and avoid leakages of steam. All the outlying punches, shears, and this class of machinery can be very simply and quickly adapted from steam to electric driving. The size of motors usually employed are 5, 7 or 10 H.P. A noticeable point about the introduction of electric driving in shipyard work is that the whole of the yard can be changed from steam to electricity without any real stoppage to a single machine in the yard. The motors are placed on their respective foundations, the wires laid to them, the switching gear and registering instruments fixed up, and at the dinner hour the belt is removed, or the connecting rod of the engine taken off, and the motor is set to work. All that is necessary can usually be arranged to be done in the dinner hour or at night time. It may be taken that 300 E.H.P. is capable of driving at least 450 H.P. of motors in connection with regular shipyard work, and much the same proportion may be taken for installations of a similar nature.

The author then gave a list of the various powers absorbed by shipyard and other machine tools when running light and heavy, *e.g.*, the double punch, large plate bending rolls, punch and shear, angle squeezer, rivetting machine, plate planing machine, angle-cutting machine, counter-sinking machine, wood-working machine, stern-frame boring, winch, cold saw, portable drill, &c. In iron and steel works the power must be somewhat heavier, and the size of the plant necessary for driving of the works more powerful. In addition to the ordinary outlying machinery, shops, hydraulic plant, all the small line-roller gear engines, skid engines, capstans, winches, &c., can be advantageously replaced by electric motors. Plate rolls, angle rolls, and other similar machines are easily adapted for electric driving. In the case of purely engineering works consisting of engine and boiler shops the power is generally subdivided up into the driving of the various line shafts, large machine tools, blowers, overhead cranes, jib cranes, &c., while the electric lighting is always embodied in the power plant, Mr. Bigge concluded with a brief reference to polyphase working.

ACCUMULATOR TRACTION ON RAILS AND ORDINARY ROADS.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers on the 11th inst. after the reading of Mr. Epstein's Paper on the above subject. The discussion was continued yesterday evening. Speakers who have returned their proofs revised are denoted by an asterisk.

DISCUSSION.

* Mr. E. MANBY gave particulars of a new accumulator which has been used for the last few months on the Dresden tramways with considerable success. The special feature of this cell was the paste, which acquired a wonderful degree of hardness. It had been subjected to very severe tests at Dresden, and had never cracked or broken up under them. The plates used at Dresden were 11cm. by 27cm. There were 13 plates to each cell, which weighed 13½ kilogrammes. They worked at a discharge of 65 amperes, and on emergency up to 120 amperes without the slightest damage. On one occasion on the Dresden Tramway line they had run for a whole working day over a distance of 130 miles without any charging. On another occasion current from 500 volts was run through the batteries. This set fire to the car, and after the fire had been put out two of the cells were removed, and the remainder were in sufficiently good condition to run the car for several hours, a thing which perhaps very few batteries would do. After seven months' trial the Dresden Tramway Company were so satisfied with this type of cell that they had decided to fit the whole of their cars with them. The maximum discharge per kilo of plate was nearly 9 amperes. The normal discharge was 1 ampere for about 8½ sq. in. of positive plate, and a discharge of 1 ampere per 4·659 inch of positive plate was perfectly safe. He had mentioned these facts because they had caused some considerable sensation on the Continent, and were being adopted in Belgium and would probably be adopted very shortly in France. In fact, experiments were now being made with them in France, and he hoped with satisfactory results.

Mr. R. E. B. CROMPTON said an American invention had been explained to him, and no doubt to others as well, for getting over the great difficulty

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which they, who had had experience with accumulators for fixed purposes, encountered, and that was the difficulty of preventing the active material from crumbling. The American inventor had tackled the difficulty by enclosing the whole of the plates with rubber—not rubber in the hard vulcanite form that they had seen it used before, but rubber in quite a soft and elastic form. He had covered his positive plates with a thick diaphragm of rubber. It was an invention not very easily described, and although it had been explained to him by means of a drawing, he could not repeat it properly, although it struck him as a very clever idea. At first sight a tractive force of 60lb. for a vehicle appeared to be a very small figure, but when they came to work it out it proved to be a very ample figure. He had no doubt that the real tractive force of the cabs that were on the streets of London would be considerably under 60lb., and a good many experiments that had been carried out by Mr. Ravenshaw and other engineers had shown that the coefficient of road traction of pneumatic tyred vehicles need not exceed 28lb. per ton, whereas Mr. Epstein had mentioned 60lb. for 30cwt. If this was so, it appeared that with a vehicle that could be brought down under 30cwt., as he was told the cabs now running can be, with two passengers they would be able to run them at ten miles an hour for one actual horse-power exerted, and he thought there was very little doubt that they could make machinery and gearing efficient enough to do this with about 1,400 watts. These figures were very encouraging.

Major-Gen. WEBBER thought they were very much indebted to Mr. Epstein for this Paper. Mr. Epstein's own accumulators on the Birmingham tramway line had been in existence for seven years, and were the only example of such a form of electric traction in the United Kingdom. It had fallen to his lot about five or six years ago to make a very careful examination of that system, and Mr. Snell (now the engineer to the Sunderland Corporation) remained at Birminham during that time making observations on the results of that line. The conclusions they had come to, but which had not been published, were that the use of accumulators on that system had been very much misrepresented because of the circumstances to which Mr. Epstein had alluded in one part of the Paper. When speaking of what the system of charging and moving the cells should not be, he had little doubt that Mr. Epstein had in his mind the arrangements that were made for charging the accumulators used on the Birmingham line. At that time he had gone further than Mr. Epstein, and had informed him that the tests on these cars proved distinctly that the system had not had a fair chance, because at least 60 per cent. of the electricity that was generated was lost on the way to the cells by various circumstances of faulty construction. He had always been surprised since that the faults in connection with this system had not been brought to light, and had not been held up as conditions to be avoided, and that others, including Mr. Epstein himself, had not been able to induce any of the tramway owners to use accumulators with these faults remedied, because he was sure that if anyone had done so they would have had as good results as now existed at Hanover and Paris.

Mr. E. MANVILLE said there was hardly a point in accumulator traction that had not been referred to by the author, and it really left very little for anyone else to say. In connection with the Birmingham Central Tramways, he had had the fortune, or misfortune, to be responsible for the running of it for the latter years of its life. At the outset he had thought, as most people seemed to think, that the expenses of running that system were due almost entirely to the rapid deterioration of the accumulator plates. If that were so the system would not have been unsuccessful commercially. The real expenses that were incurred in handling a system like the Birmingham system and which made it commercially unsuccessful, were the effects produced by the accumulators. Unless they actually saw the way in which the cells deteriorated through being carried in inclosed places they would not believe how they did so deteriorate, and what they cost to renew. The handling of the plates themselves cost a certain amount, but then the staff required to handle them was also very considerable, and formed quite an appreciable part of the cost of the maintenance of the plates. Ever since he had had anything to do with the Birmingham Company, and got some experience there he had arrived at exactly the same conclusion that Mr. Epstein had been pointing out to them, viz., that the cells should certainly be carried independently of the car and on an entirely separate vehicle not liable to be damaged by the cells or acid. Such a system would have far more chances of a commercial success. At Birmingham also they had believed that the deterioration of the plates was due to the vibration incurred in carrying the cells. He had believed that himself for a time, but lately in connection with the other concern mentioned by Mr. Crompton he had made a number of tests of cells of all descriptions. The tests had been carried on by two methods, viz., they had some of the cells standing still and others violently vibrated all the time during the discharge. In fact he thought he was perfectly safe in stating that they were vibrated more violently than would be the case if they had been carried on a solid rubber tyre on a road. Some proved to be bad and others good, but one fact was patent to everyone and that was that none of the cells that were vibrated were worse than the corresponding cell which was still, and in many cases were even slightly better, although this might have been due to the manufacture of the cell. The chief reason for the rapid deterioration of cells was the stringent electrical conditions under which they were handled—the heavy occasional discharges—and that brought him to the difference between the probabilities of success between a tramcar wholly propelled by accumulators and a light vehicle propelled in a similar manner. As Mr. Epstein had pointed out, the proportion of weight of accumulator to tramcar had been something like 1 to 3½. It was quite feasible without using lighter plates to have a much heavier weight on a small motor car, and thus increase the proportion of accumulator weight to total weight, probably 1 to 3 or 2½. That meant a corresponding difference in the maximum duty that the cell was called upon to perform, and he believed that that difference would have a very considerable effect upon the life of the cells used in that way. With regard to a combined trolley and accumulator system, Mr. Epstein had pointed out that it would be a very good plan to have the cells on separate trucks congregating near the entrance or centre of the town and charged from the trolley wire there. This has had an advantage which the author had omitted to point out, viz., it would materially improve the regulation of the trolley line and decrease the cost of the feeders. He did not think the friction on ordinary London roads would be as much as 60lb., and they were safer in putting it at 40lb. per ton.

*Prof. W. E. AYRTON asked Mr. Manville if he could give some actual figures as to his cabs. Were the motors 1 H.P. or 5 H.P.? Secondly, what was the average power the cells actually gave out? and, thirdly, what was the maximum power they were called upon to give out? He would also like to ask what were the types of the cells Mr. Manville had tested. Were they pasted or non-pasted, and what was the nature of the vibration they had been subjected to?

Mr. MANVILLE said the motors used were those capable of taking an input of three kilowatts, without unduly heating, probably about 4 H.P. The motors had double-wound armatures and fields, which were connected together in various combinations to produce different speeds, the accumulators always being joined up in series with each other. 40 cells were being used, and from his own experience in one cab, the current taken on wooden pavements (approximately) was about 30 amperes at 80 volts E.M.F., which increased to 40 or 45 amperes, on the roughest kind of road. He had even seen the current as high as 120 amperes, but that was when going up the Savoy Hill, off the Strand. The cells tested were practically those of all makers, including Planté and pasted, and the method of vibrating them was somewhat heroic. They had two countershafts in the same plane, and from these there hung a shelf by four eccentrics, and the eccentrics on one shaft were placed out of centre with those on the other. One was driven by the other, and the joggling and jolting was of a most extraordinary kind.

Prof. J. PERRY did not think the vibration was severe enough. It was not the joltiness that would be encountered on a common road.

*Mr. TREMLETT CARTER asked if Mr. Epstein recommended in the case of small motor cars, so small that only a single motor could be used on them, a series-parallel device for the cells themselves; *i.e.*, whether it was advisable to obtain from the battery, by various combinations of the cells, different voltages for different speeds. In a battery where they not only had a permanent E.M.F. but a whole range, could they use these E.M.F.s for different speeds of the motor, or were they obliged to use two motors with a series-parallel device for the motors themselves? One of the elements which had contributed to the great success of electric traction generally was the use of the series-parallel controller, by means of which two motors could be economically made to give a range of speeds for starting and for running. If they were to have vehicles with only a single motor on them could they use the batteries in series for the high speed, in parallel for starting, and might they tap different E.M.F.s when they had thrown them into series?

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 26th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Paper to be read: "Upon the Failure of German-Silver and Platinoid Wires," by Rollo Appleyard.

MONDAY, November 29th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture I. on "Gutta Percha," by Eugene F. A. Obach.

TUESDAY, November 30th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "On the Law of Condensation of Steam," by Messrs. Hugh L. Callendar, F.R.S., and John T. Nicolson.

FRIDAY, December 3rd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Permanent Way: Its Construction and Relaying," by Grote Stirling.

Power Transmission Plants.—There are so many wildcat schemes for the development of water power plants in the Western States of America, especially the Pacific States, that a company of influential technical men has been formed in San Francisco for the purpose of advising and examining and reporting upon the feasibility of such electrical projects. The engineering staff, says our New York correspondent, is thoroughly competent. When satisfied that a proposition is a profitable one they will take steps that will mutually benefit the persons who have water rights or land for sale, and the manufacturing companies who desire to supply electric and hydraulic machinery. The company will make a feature of examination of large transmission projects, and it is stated that leading electrical and hydraulic manufacturing companies on the Pacific coast will co-operate with the new concern.

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SECONDARY BATTERIES.—By E. J. WADE. Fully illustrated. The Author in this work will deal briefly with the theory and fully with the chemistry, design, construction and manufacture of secondary batteries or accumulators.
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CARBONS FOR ALL ELECTRICAL PURPOSES.—A work will shortly be published dealing fully with the manufacture of carbons for all electrical purposes. The book will illustrate the machinery and apparatus used in carbon manufacture on the Continent and in America, and will give the latest practice in this important subject.
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ELECTRIC ROAD VEHICLES.

A year has elapsed since the first famous procession of motor road vehicles took place in this country, and in that brief space of time a notable and satisfactory change has come to pass in the conditions of self-propelled traffic on ordinary roads. Dismal failure as the immediate circumstances of the first historical meet of British motor cars may have seemed to have been at the time, there were not wanting even then indications that the motor car was "come to stay," or that its defects would in time be removed, and the successful vehicle be ultimately evolved. But it would have required a sanguine temperament, in a bold individual to have predicted a development so rapid as that which has been realised by the end of the first twelve months. We suspect it will be a very different show, with a remarkably better record of performance, that will be witnessed next Monday, when the second annual meet is fixed to take place on Northumberland-avenue, and when another trial of the concerted abilities of the latest types of motor car is to be made. Even though the trial be made on no "ordinary road," but on the extraordinary roads we are liable to be favoured with in November—and bad roads seem in the past to have fallen to the lot of motor car processions in all countries—it is practically certain that the result, at any rate for some of the specimens, will be far better than last year. It may be remembered that on the occasion of last year's show the electric cars were "practically nowhere," while the palm was taken by oil-motor vehicles. To-day, however, the relative places are reversed, and it is the electric motor vehicle that holds the premier position. As Mr. CROMPTON observed at a recent meeting of the Institution of Electrical Engineers, it is a matter for great congratulation among the electrical profession that the electric car has been the first to fill a place as a commercial public vehicle.

There are several causes which have operated in bringing about this turn of the tide in favour of electric propulsion. Electricity never had more than two serious competitors—oil and steam. The oil motors were readily constructed to develop

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a given fixed amount of power at a given speed, capable of making a great show on a long, steady run; and they were lighter in weight than either of their rivals; but they suffered, and still suffer, from the serious objections that they cannot be made to give the requisite range of speeds for ordinary work without the use of variable reduction gears, that they are noisy and stink abominably, and that they require the use of an explosive fuel. Steam motor cars, on the other hand, although capable of an indefinitely easy gradation of speed without the use of gears, are defective in that they are not silent, that they require the use of an explosible boiler and that it is impossible for there to be no discharge of vapour or products of combustion. Electric road vehicles eliminate all the demerits of both oil and steam cars, combine all their good qualities and have few defects that are of importance. To begin with, electric power in accumulators furnishes a ready and efficient means of regulating the speed and power of the vehicle, without the use of variable gear; for, as is done, for example, in the Headland motor car described in another column, the cells of the battery may be arranged in various combinations of series and parallel, to give low or high or intermediate voltage for starting and for various speeds. Whatever objection may be raised against this method of regulation, it has the obvious advantages of wasting no power in resistances, and of dividing among several parallel sets of cells the extra heavy current on starting and hill climbing—instead of throwing an increased load on each cell, as must be done where all the cells are maintained in series. Even where the cells are never paralleled, it is still possible to obtain a gradation of speed without the use of gears. This may be done by using a series-parallel controller and two distinct motors, or, if only one motor be required, the armature may be wound with two distinct sets of coils, as in the Bersey electric cabs, with which London has grown familiar; or, again, adopting an effective but less efficient plan, the motor and battery cells may always be kept all in series, the speed being varied by means of resistances. Other advantages of electric power over oil and steam lie in the absence of noise, smell and emitted gases, as well as of combustion, with its attendant risks of fire and explosion; in the ease with which the normal power of the driving plant may be doubled or trebled at a moment's notice, if for a short time only; and in the simplicity of the parts as regards repairs. Against these immense advantages are to be set the only practical disadvantages, lying in the somewhat heavy weight of the batteries, in the uncertainty of their life, and in the definite limit imposed on the length of each journey between consecutive battery charges.

This last defect, in our opinion, is the most serious of all, as it is the only one that it is hopeless to expect can be entirely removed. All that can be done is to improve the capacity of cells as much as possible, and to provide frequent charging stations. In these ways the prejudicial effect of the disability may be somewhat removed, though battery cars will always be under the risk of getting completely discharged at an out-of-the-way place where electricity is not to be had at any price. We are speaking, of course, of a class of vehicles that may be required to go anywhere at any time; for the regular electric omnibus and hackney cab the difficulty practically need not exist. We hope that electric supply concerns throughout the land will turn their attention to the matter of providing means for promptly supplying random motor vehicles with a charge-up. To do this economically it will be necessary to have ready to hand plant for supplying currents from three or four up to 50 or more amperes at pressures ranging from, say, 20 to 90 or 100 volts. It will be too much to expect at first that all builders will standardise their vehicles, for charging off 100-volt mains; nor will it be commercially feasible to use resistances to bring the pressure down to the right amount. Two simple ways of attaining the desired end suggest themselves. Stations might be provided either with motor-generators, capable of running on the usual 'bus bars and of giving a range of volts, or with a shunt-wound dynamo provided with a field regulator operating to the same end. At any rate, if electric road vehicles are to be largely used by the public, ready means for a prompt charge-up ought to be available in every important town in the United Kingdom.

REVIEWS.

Bibliography of X-Ray Literature and Research, 1896—1897. By CHARLES E. S. PHILLIPS. (London: "The Electrician" Printing and Publishing Company, Limited.)

An important element in the art of book-writing and book-publishing is that of production at the right moment—when the public palate is ready and waiting. Mr. Phillips and his publishers have certainly in this instance realised the above element. Whether the public interest in X-rays is likely to slumber it is impossible to say, owing to a natural human fickleness: but it is assuredly at a very high pitch just now—when almost everyone worthy of the name of "photographer" has dabbled in the subject. Here we have the first complete bibliography on Röntgen rays, and if it is kept up-to-date (as promised) from time to time, there can be no possible need for another. The number of lectures during the closing year on X-rays probably even exceed those on the Queen's reign; and a glance through the pages of this little volume reveals an enormous quantity of printed matter on the subject, even after the wheat has been separated from the chaff. Without doubt the task was a trying one, and the result reflects credit on editor and publisher, for the book is arranged with much method and clearness; and, moreover, with an understanding of the right proportion of cross references.

In all humility, the main title of this volume suggests only a bibliography; but it is something more, for Mr. Phillips has here given us—as an introduction to the subject—some excellent "Practical Hints" on matters pertaining to X-ray work. These are regarding the air-pump, drying tubes, air-tight cement, the cementing flame, air-tight joints, stop-cocks, experimental tubes, varying the vacuum in a sealed tube, sealing a platinum star or cross into glass tubes, and a special method for sealing aluminium windows to Lenard tubes. Some of these hints, apparently, result from Mr. Phillips' own work in the direction of X-rays. The two latter seem to be entirely novel as well as promising.

As a preliminary to the above hints, the author gives a clear and complete retrospect of the history of the subject, starting from Otto von Guericke's first vacuum experiment of 1650 and extending to a brief statement of the medical applications of X-rays to-day. Judging from the number of experiments and experimenters, we can but agree with Mr. Phillips that the so-called electric egg has been, indeed, well hatched. This retrospect and the brief preface which precedes it are well written. Altogether, the book not only fills a gap, but does so in a satisfactory manner. Its style is well up to the standard of "The Electrician Series," and leaves nothing to be desired. C. B.

What is Fire Protection? By EDWIN O. SACHS. (London: The British Fire Prevention Committee.)

At a moment when two disastrous conflagrations, almost at antipodes of the earth, are calling public attention to the pressing need for protection from fire risk, the action of the British Fire Protection Committee in issuing this little *brochure* is exceedingly timely. From an electrical point of view, however, except for a few good notes on fire calls and the use of the telephone, the pamphlet possesses little special interest for the electrical profession. It may, indeed, have

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been regarded as superfluous to say anything about the immunity from fire risk effected by the electric light, as compared with other illuminants, for *cela saute aux yeux*. Owners of electrical works and other property will find in this handy *brochure* many useful hints in fire prevention.

ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.*

BY J. ELTON YOUNG.

(*Continued from page 8.*)

Overlap Tests.—The "*free overlap*" method of fault localisation, by measurements made from each end of the line alternately whilst the other is insulated, is practically never used, but is in theory as follows:—Let the resistances observed from A and B (Fig. 58) be respectively a and b; then

$$a = x + z$$
$$b = y + z,$$

and, since $l = x + y$,

we have
$$x = \tfrac{1}{2}(a - b + l), \quad . \quad . \quad . \quad . \quad . \quad (10)$$
$$y = \tfrac{1}{2}(b - a + l),$$

and the fault's resistance

$$z = \tfrac{1}{2}(a + b - l).$$

The essential condition of accuracy is that z shall remain the same during both the measurements a and b. As in the Blavier test, this cannot be reliably ensured, but one of the means towards it consists in sending the same current strength through the fault from both ends. To do this both stations should use the same battery power and bridge ratio, and that nearer to the fault should add resistance to the line in such quantity as to bring the fault nearly in the centre of the line so formed. Then in formula (10) l will stand for line plus added resistance. If x_1 be a first approximation to the fault's distance from the nearer end, the required added resistance (r) will be roughly $l - 2x_1$. A closer approach to the proper value of r can be made after finding a second approximation to x. Should the adjustment and tests be continued until the readings from both ends become identical, we get

$$x = \tfrac{1}{2}(l - r) \text{ and } y = \tfrac{1}{2}(l + r), \quad . \quad . \quad . \quad (11)$$

the fault being exactly centralised.

The "*earth overlap*" is a much more reliable test, being less affected by changes of fault resistance than either of the foregoing. Readings a and b are obtained from the ends A and B of the line when the opposite end is earthed. Then, if the fault resistance remains steady,

$$a = x + \frac{yz}{y+z},$$

$$b = y + \frac{xz}{x+z};$$

and since $l = x + y$

we get distance of fault from A

$$x = \frac{a(l-b)}{a-b}\left\{1 - \sqrt{\frac{b(l-a)}{a(l-b)}}\right\}, \quad . \quad . \quad (12)$$

and
$$y = \frac{b(l-a)}{b-a}\left\{1 - \sqrt{\frac{a(l-b)}{b(l-a)}}\right\}.$$

As in the previous method, in order to equalise the currents through the fault, equal batteries and bridge ratios should be used by both stations, and the fault should be approximately centralised—at any rate in the case of submarine cables—by the addition of resistance at the nearer end A (Fig. 28).

When this is done A must earth through this added resistance (r) for B's measurement, and in formula (12) l will stand for the C.R. of the line plus r. When the latter is gradually adjusted till identical readings are observed from both ends, we have simply

$$x = \tfrac{1}{2}(l - r) \text{ and } y = \tfrac{1}{2}(l + r). \quad . \quad . \quad . \quad (13)$$

This improved form of the earth overlap test was introduced by Messrs. Anderson and Kennelly.*

Example.—Taking the case of Fig. 26, and supposing z to be a cable fault, of which the resistance under test varies between 2,000 ohms and 3,000 ohms, A will first observe when B earths, say, 2,200 ohms; and when A earths B, using the same current to line, gets, say, 3,700 ohms. If A now adds $r = 1{,}500$ ohms at his end, and both stations measure again, their readings will be, perhaps, 4,000 ohms and 4,200 ohms. A then makes $r = 2{,}000$ ohms, and gets about 4,200 ohms, whilst B's balance is 4,150 ohms. Should this be the nearest approach to equality obtainable under the circumstances, the position of the fault would be taken as

$$\tfrac{1}{2}(3{,}950 - 2{,}000) = 975 \text{ ohms from A.}$$

After r has been nearly adjusted, the change required to be made in it when a small disparity δ remains between A's and B's readings is

$$\delta \times \frac{y+z}{y + \frac{yz}{y+z}}.$$

Applying this to the above example, we should find the required change in r was about 60 ohms, provided that $\delta = 50$ ohms were a real disparity and not merely due to errors of observation and inconstancy of fault resistance.

Both stations should use Z. to line only, and test alternately as rapidly as possible, so that pairs of readings may be secured whilst the fault undergoes as little change as possible. If no corrections for leakage are intended to be made, it is better in overlap tests to take l as the *apparent* instead of the true C.R. of the line.

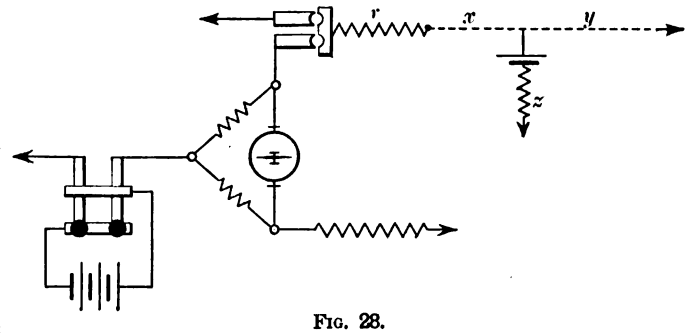

FIG. 28.

The earth overlap test is especially valuable for the localisation of high-resistance faults; indeed, experience tends to prove it the best practical method for this purpose, provided that no second leak exists. When the fault's resistance is *high* we may find its position by simply dividing the line in the inverse ratio of the square roots of the differences between the overlap readings (a, b) and the true C.R. (l). Thus, let

$$l - a = d$$

and
$$l - b = d_b;$$

then
$$\frac{x}{y} = \frac{\sqrt{d_b}}{\sqrt{d_a}};$$

whence
$$x = \frac{l\sqrt{d_b}}{\sqrt{d_a} + \sqrt{d_b}}. \quad . \quad . \quad . \quad (14)$$

But with high-resistance faults the result usually needs subsequent correction to be made for leakage.

The fault's resistance during an earth overlap test is, roughly,

$$z = \frac{y^2}{d_a} - y, \quad . \quad . \quad . \quad . \quad . \quad (15)$$

where y is the distance of the fault from station B, and d_a the difference between A's reading and l or $l + r$.

Formulæ (14) and (15) are due to Murphy, and are deduced from a theorem of his—given elsewhere—relating to high resistance faults. The same authority—to whom belongs credit for several recent advances in cable testing—suggests that when the C.R. of the line (l) is not reliably known in an

* Extracted from a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights reserved.

* *The Electrician*, July 17, 1885. *Journal* of the Institution of Electrical Engineers, Vol. XVI., p. 581.

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overlap test, we may arrive at it approximately by calculating the shunting effect of the fault's resistance (z) on the portion (y) of the line beyond it, assumed roughly known at first; then, from the value of l thus obtained, a closer approach to y is found, and corrected again for z, and so on. This gives us the apparent C.R. of line without fault, which (as was stated above) is the best value for l when no leakage correction is applied.

Loop Tests.—When another wire of normal insulation is available, an earth fault should be localised by the loop test, which is on the whole the best of all modes of localisation, being largely independent of variations in the fault's resistance.

In *Varley's* loop method the two lines ll_1 being joined together at the distant station (junction insulated), are connected to the bridge terminals as in Fig. 29. The arms a and b are made equal, and r is adjusted till equilibrium is obtained on g; then

$$r+x=l_1+y,$$

and since

$$l=x+y$$

$$x=\tfrac{1}{2}(\mathrm{L}-r), \quad . \quad . \quad . \quad . \quad (16)$$

where

$$\mathrm{L}=l+l_1.$$

If the C.R. of the faulty line l be not greater than l_1 the former will always be connected to the lower bridge terminal as in the figure, whatever the position of the fault. When, however, l is less than l_1 it may be found necessary to

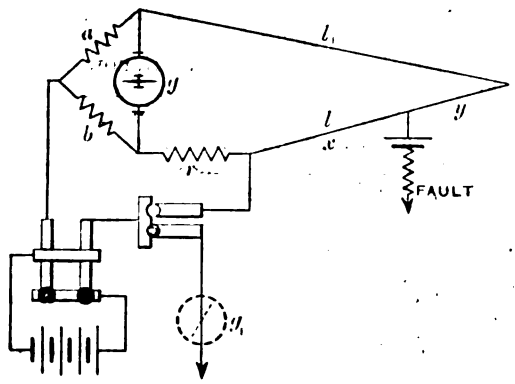

Fig. 29.

reverse their positions before a balance can be got, when the fault lies far from the testing station. The formula becomes in this case

$$x=\tfrac{1}{2}(\mathrm{L}+r)$$

from the testing station.

The value of L should be measured, by ordinary bridge connections (equivalent to shifting the plug in the diagram), and not calculated from records, since it will be shown later that the leakage error is less when L is the apparent than when it is the true C.R. of the loop. In measuring L on a long loop care must be taken that the battery is very well insulated, or an error will be made which will vary as the fault's distance from the bottom of the bridge. There will be no error introduced into r from this source unless uneven values of a and b be used.

Mr. Kingsford has pointed out* that, by testing with uneven values of a and b, two balances may be obtained, first with the faulty wire on the lower end of the bridge, and then with the lines reversed; thus giving the distances of the fault from both ends of the loop. These check one another, since their sum should equal the C.R. of the loop, provided leakage be negligible. Calling x and y the distances of the fault from the ends of the loop, r and r_1 the two readings,

$$x=\frac{\mathrm{L}+r}{n+1}, \quad y=\frac{\mathrm{L}+r_1}{n+1}, \quad . \quad . \quad . \quad . \quad (17)$$

where

$$n=\frac{b}{a}.$$

* *Journal* of the Institution of Electrical Engineers.

In *Murray's* loop method the lines are connected to the terminals of the resistances a and b (Fig. 30), which are varied till the galvanometer shows a balance; then

$$\frac{a}{b}=\frac{l_1+y}{x}=\frac{\mathrm{L}-x}{x},$$

whence

$$x=\frac{b\,\mathrm{L}}{a+b}. \quad . \quad . \quad . \quad . \quad . \quad (18)$$

A slide resistance having its index joined to the battery, forms a convenient means of adjusting the ratio $\frac{a}{b}$. This method has the advantage over Varley's of enabling a higher degree of accuracy to be attained in localising a fault in a very short loop, such as a piece of cable. Thus, by making $a+b=10{,}000$ ohms, x can be determined up to $\frac{1}{1000}$ of L, using the slides apparatus.

Since the earth and fault currents in a loop test do not affect the galvanometer when balance has been arrived at, it follows that measurements may be taken to true zero, provided no other natural currents be present besides those which enter the loop from the earth. On long lines, however, this may happen, and a slight current will be seen on the galvanometer even when the earth is off, *i.e.*, when joined up for observing L, in which case it becomes necessary to balance to false zero.

It will be shown later that in Varley's loop method the most correct results will generally be those obtained by observing from the end of the loop *nearest* the fault, provided L be the *apparent* value of the loop C.R. (not its true value), and that the fault's resistance be low. Also that, in dealing with a fault on an overland line of uniform gauge, the loop result should be divided by the apparent (not true) C.R. per mile to find the fault's distance in miles.

In another way of using the Varley test, sometimes adopted on long cables, L is left out of account, and the fault's distance

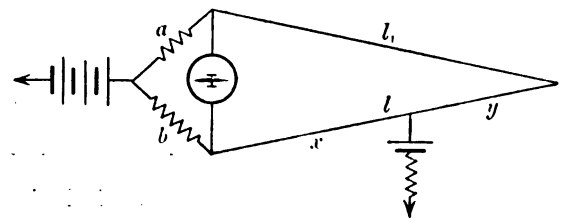

Fig. 30.

called $\frac{r}{2}$ from the *apparent conductive centre* of the loop. The distance of this point is half the apparent C.R. of the loop before the appearance of the fault. In *this* case it is best to observe r from the station *furthest* from the fault, the conductive centre having previously been observed from the same end.

When the resistance of the fault is high relatively to the insulation of the looped lines, and at the same time varies much, it will be found that r undergoes serious variations. This is due to the fact—to be dealt with later—that in this case we are localising the resultant of the fault and the leakage. Under these circumstances it is advisable to insert a second galvanometer between the battery key and earth (*see* Fig. 29), the deflection of which will rise as the fault's resistance falls, and to watch for the time when the latter is shown to be least, at which opportunity r should be observed. At the same time, the reading on g_1 should be recorded, and the resistance of the fault (of which it is the measure) ascertained from it, either by reproduction or calculation.

Clark's Potential Test.—So far localisation has been carried out by measurements of resistance. It may also be effected by observations of potential, on the principles indicated in a former chapter. One great advantage of these potential methods is that they are independent of our knowledge of the C.R. of the line. In respect to accuracy in presence of leakage they are about equal to loop tests. Though not employed on aërial lines they are theoretically as applicable to them as to cables, on which they are used with excellent results. The following descriptions refer to cable practice.

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In *Clark's potential* method, the distant end of the faulty cable is insulated, and a battery applied at the end A (Fig. 31) through a resistance R. A "fall of potential" is established along the resistances $(R+x)$ up to and (z) through the fault, which may be represented by the straight line $Vv v_1 E$. The potential at the battery is A V, at the cable terminal it is Cv, and Dv_1 at the fault and the distant end, assuming no leakage along y. Drawing the dotted lines, it follows, by similarity of triangles, that

$$V - v : v - v_1 :: R : x;$$

$$x = R\frac{v - v_1}{V - v}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

Thus the fault can be localised by the observation of the three potentials V, v, v_1. The differences between them depend on the steepness of the slope of potential; this is determined by the resistance of the circuit, and thus limited by that of the fault. Excepting, however, in its influence on the rate of fall of the potential, which merely affects the sensibility of the

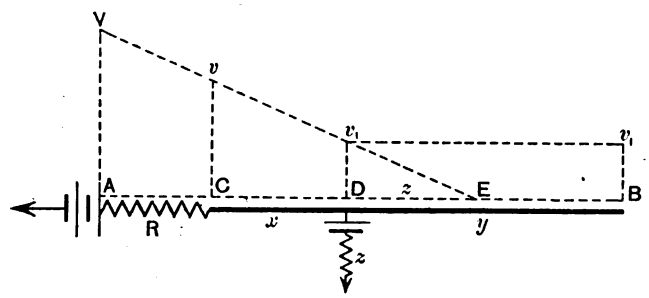

Fig. 31.

method, the fault's resistance (z) does not enter into consideration; and it is only necessary that it should continue constant during the observation of the three readings. These are taken as nearly as possible simultaneously, station A observing V and v, while B reads v_1. When testing on board ship it is advisable to employ a null method for observation of the potentials, such as will be described presently; but ashore the galvanometer and high resistance plan may be more conveniently adopted. The practical execution of the test then proceeds as follows:—

One station, preferably that nearer to the fault, joins up (Fig. 32) a battery of low resistance to a key connecting with the cable through a resistance R; the latter is best made roughly equal to x, or more if the fault's resistance be high, so that the potential readings may differ conveniently. A

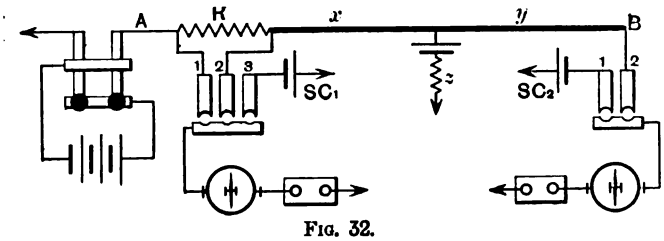

Fig. 32.

three-way commutator has two of its bars connected to the terminals of R, and the third to a standard cell or series of cells (SC_1), the other pole of which is earthed; whilst the opposite side of the commutator leads to earth through a sensitive galvanometer and a resistance so high that its presence does not sensibly disturb the potential by leakage—say not less than half a megohm. A plumbago resistance is commonly employed, since its exact value is immaterial. Station B joins a similar high resistance and galvanometer to one side of a two-way commutator of which the opposite bars lead respectively to the cable end and to another standard battery or cell (SC_2). The object of the standard cells is to furnish the means of converting the potential readings into volts.

Having pre-arranged the period for application of the battery, before this is done both stations insert plugs 2 and observe the earth or fault current potential, recording its amount and sign as "E.C. with" or "E.C. against" the subsequent readings, as the case may be. A now applies the battery at the preconcerted time, and proceeds to take readings of V and v by plugging 1 and 2 alternately, whilst B records the value of v_1. Provided the battery be of constant E.M.F. and low resistance, the full potential V will be very nearly invariable, and one or two observations of it will be sufficient. The potentials v and v_1 will, however, vary with the fault, and must, therefore, be watched closely and their changes recorded during the test. After a few minutes' observations A breaks battery contact (this is seen on B's galvanometer), and after waiting long enough to allow the line to discharge—say a minute on a long cable—both stations again note their E.C. potentials. They also carefully determine the deflections given by their standard batteries, by plugging accordingly. B having telegraphed his results to A, the latter selects certain simultaneous values of V, v and v_1 from the series, and corrects those of v and v_1 by addition or subtraction of E.C. as required. Both these corrected readings and the V reading are then divided by the deflection which represented one standard cell on the respective galvanometers. The three values thus arrived at are then inserted in the formula given above. This will not, however, be strictly accurate if there be much difference of temperature between the two stations, for then the E.M.F.s of the standard cells (assumed to be Clark's) will differ; under these circumstances the values of the readings in "cells" must be multiplied by the respective E.M.F.s per cell, and thus converted into volts.

Discretion must be exercised in selecting the readings to be used for the calculation of x. Those taken immediately before breaking battery contact, if steady, are perhaps the best, when corrected for the E.C. potential observed afterwards at a pre-arranged interval of, say, a minute. If, however, the fault appeared to be in a more favourable state at the end of the 1st, 2nd or 3rd minute of observation (noting the approximate times of the readings), then other simultaneous readings may be selected from the series, and a mean E.C. value used for their correction. Or, lastly, when unsteady, the means of all the deflections may be taken, and corrected for the mean of the E.C. values before and after battery contact. With a variable fault many series have to be taken, those results being preferred which are obtained whilst the fault's resistance is fairly low; this can be judged by the magnitude of the potential differences $(V - v)$ and $(v - v_1)$, which diminish as the fault seals.

(To be continued.)

TORQUAY ELECTRIC SUPPLY PLANT.

Through the courtesy of Messrs. Easton, Anderson and Goolden and Messrs. Willans and Robinson we visited the new and extensive works of the last-named firm at Rugby, last week, in order to be present at a trial of the first of three steam alternators now being constructed for the electric supply station at Torquay. A view of this generating set is shown in Fig. 1. We found the set ready for trial on a steam bed in the spacious electric light and power house belonging to Messrs. Willans and Robinson's works. Before describing the tests to which the set was subjected, however, we may first describe the details of its construction.

The generating set, as shown in the accompanying illustration (Fig. 1), consists of a 125-kilowatt Fynn alternator, built by Messrs. Easton, Anderson and Goolden, direct-coupled to a 225 I.H.P. Willans engine, of the 3-H.S. type. It is designed to run at about 375 revolutions per minute, with steam at 130lb. pressure, and to develop 62·5 amperes at from 2,000 to 2,200 volts on the terminals, the frequency of alternation being 50 cycles per second.

Describing first the electrical side of the set—the alternator is constructed according to the designs of Mr. V. A. Fynn and exhibits several features of interest. It consists of an outer fixed circle of armature coils, an inner fixed exciting coil, and a set of revolving magnets. Figs. 2 to 4 clearly show the general construction of these parts, and are taken from photographs of the actual machinery. Within the armature (Fig. 2) which forms the outer frame of the machine

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the magnet coil (Fig. 3) is supported by brackets, as shown in Fig. 2, this coil being an annulus occupying the central part of the width of the armature. The main bearings of the generator carry a shaft upon which are mounted the magnet

The effect of this disposition of the poles is to produce a complete *reversal* of the magnetic flux through the armature coil in each cycle or alternation, while at the same time the magnetic flux in the iron at any part is never

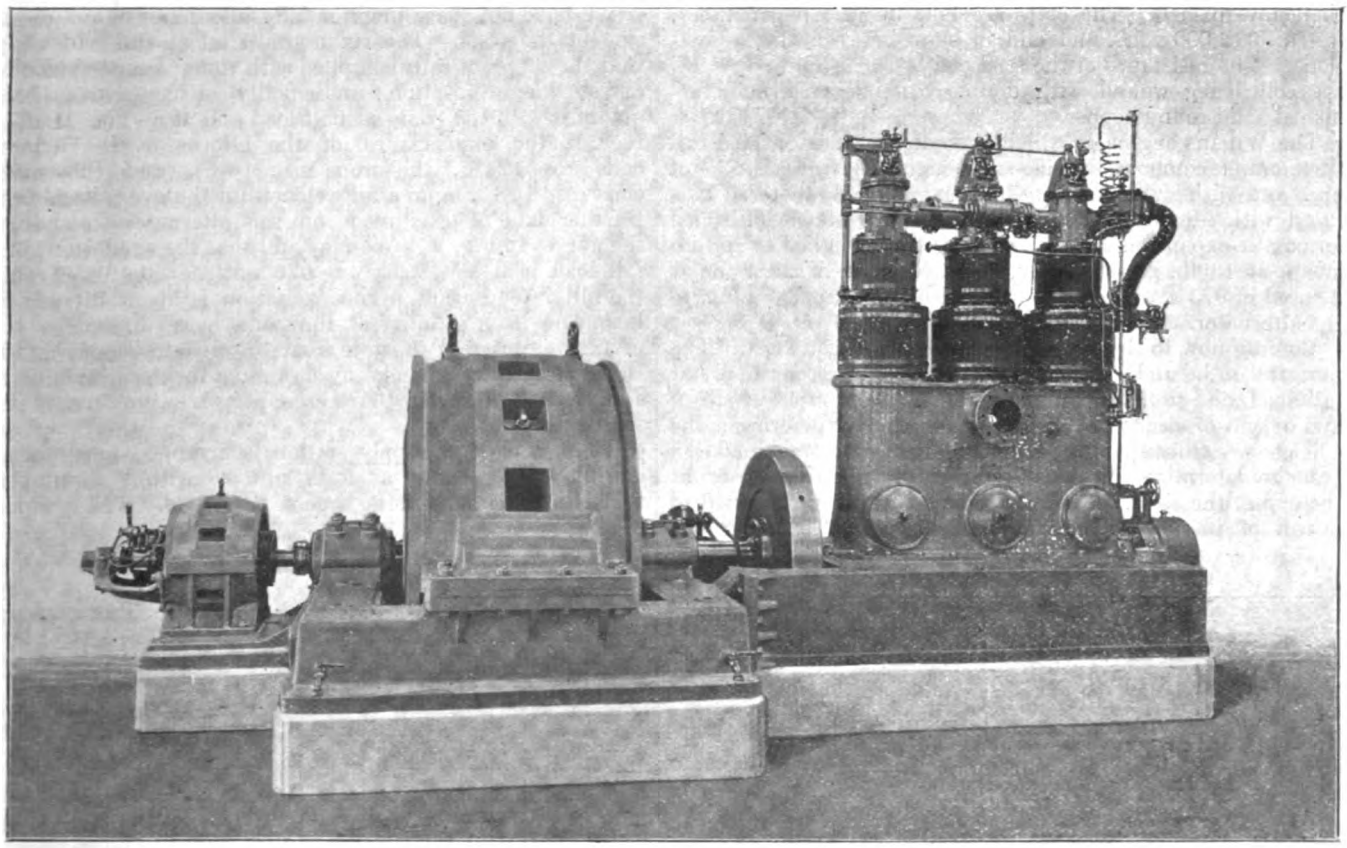

Fig. 1.—125-Kilowatt Steam-Alternator for Torquay Electric Supply Station. Alternator, built by Messrs. Easton, Anderson and Goolden, direct-coupled to Steam Engine, built by Messrs. Willans and Robinson.

core and two circles of magnet poles, the poles on one circle being displaced so as to be opposite the polar gaps of the other circle, as shown in Fig. 4. In the completed machine the space between the two sets of poles is occupied by the

reversed, but fluctuates no more than from zero to a given maximum. This, as will be readily seen, is brought about by the fact that, through the "staggering" of the poles, poles of opposite polarity come alternately immediately opposite any

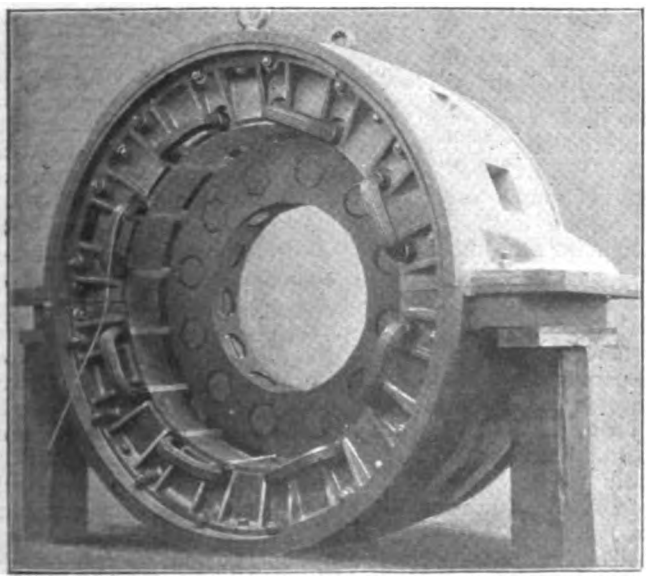

Fig. 2.—Armature of the Fynn Alternator, with field coil mounted in position inside.

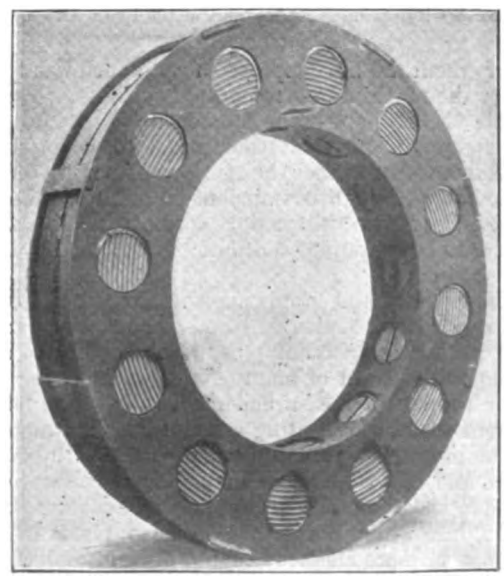

Fig. 3.—Field Magnet Coil of the Fynn Alternator.

annular field coil, there being ample clearance at all the surfaces, and thus the one set of poles is maintained at N polarity, the other set being always of S polarity.

given coil, while, on the other hand, poles of opposite polarity never pass in front of the same part of the iron core of the armature.

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In the Torquay alternator the diameter of the armature is 4ft. 6in. inside the polar circle, and the over-all width is 40in. There are eight armature coils and eight poles on each field-pole circle, or 16 field poles in all. The armature has a resistance of 0·261 ohm at 120°F., and is wound with 61/20 stranded double-cotton-covered and braided copper cable, shellac varnished. The coils are laid in ⅛in. paper tubes, tested to 12,000 volts, and laid in slots between the laminations. The resistance of the field coil is 1·39 ohm at 125° F., the coil being wound with double cotton-covered and varnished solid round copper.

The Willans engine to which this alternator is coupled is a three-crank compound condensing engine, having a stroke of 8in., and with cylinders of 17in. and 12in. diameter. It is fitted with Messrs. Willans and Robinson's steam-controlled automatic expansion gear. The engine is designed to run on steam at 130lb. pressure, and, with a vacuum of 26in. and at a speed of 375 revolutions, it will readily deliver 200 B.H.P. to the alternator.

Coming now to the tests which took place last week. The first test to be undertaken was to run the set for six hours at full load, and to take frequent readings of the input of steam and output of electrical energy, with a view to determine the efficiency. Subsequently a temperature test was made in order to determine the rise of temperature of various parts at the end of the six hours' trial. The set was also subjected to a test of its performance at half load. On entering the machinery room the first impression we gained was that for an alternator the machine ran remarkably quietly. We found it impossible to distinguish the moment when the full load was cut off by stopping the excitation, and even when the set ran at a considerable over-load the moment of cutting off load was only detectable through a transient increase in speed. Such small noise as the alternator does make appears to be due more to the ample ventilation than to any magnetic effect.

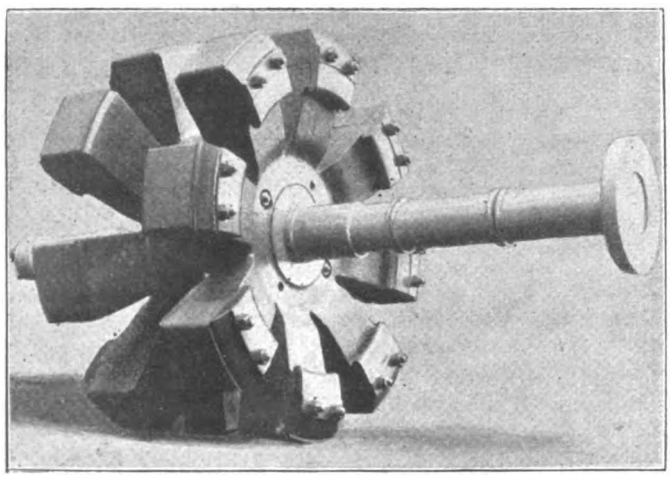


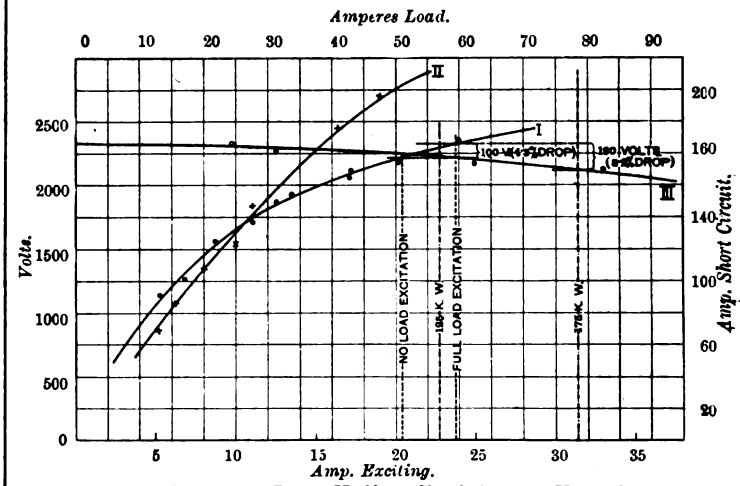
FIG. 4.—Revolving Field Magnets of the Fynn Alternator.

Messrs. Willans and Robinson's works stand in the first place in regard to the splendid, almost luxurious arrangements of their testing department. Standing beside the recording table, one sees in front of one the steel yards of the weighing tanks for the steam measurements; while to the left are the transparent scales of reflecting ammeter and voltmeter instruments, the instruments themselves, together with standards of resistance and E.M.F., and means for ready calibration, being contained in an adjoining dark room. Outside are the weighing tanks, into which the condensed steam pours in a robust stream that is more eloquent than a professor's lecture; and beyond the tanks are the generating set and the condensers, while farther away, upon one of the walls, is an immense standard non-inductive resistance of manganese steel strip in series with a water resistance, the manganese steel strip acting as a potentiometer, the voltage on which is perpetually shown on one of the transparent screens in the testing-room. Every now and then an electric bell rings beside the operator in the testing room, as a pre-arranged weight of condensed steam makes the steel yard "kick the beam." The time is duly noted, the voltmeter and ammeter readings are entered, and signals are passed to the engine attendant to quicken or reduce speed, &c., as may be necessary.

We have not space to enter fully into detail in our description of the tests. The six hours' trial at full-load showed that the set practically complied with the guaranteed efficiency and steam consumption; and equally satisfactory results were obtained with the trials at half load and at an over-load. As regards the temperature of the alternator, the armature coils rose 24°F, the iron rose 15°F., and the magnet coils rose 15°F., figures all well within the guaranteed limits. Further data of tests made on this alternator are shown by the curves in Fig. 5. We may add that the excitation for the full load trial last week was 675 watts, or 0·49 per cent. of the full rated output. The excitation is about 19 per cent. less at no load, running at the same speed and volts. It is of further interest to state that the alternator withstood a short circuit test, made by bridging the terminals with a short length of No. 16 B.W.G. copper wire, the current rising to 160 amperes.

Torquay electric supply station is arranged more for hard work than for show, as it is situated within a number of inartistic and unassuming arches or cellars. The equipment contemplated for the outset of operations comprises three generating sets of the size and type described above. Steam for these is generated in a battery of Babcock-Wilcox water-tube boilers. The feed pumps, supplied by Messrs. Babcock and Wilcox are of the Worthington duplex type, and are of ample capacity to supply all the feed water, with a reserve against the contingency of a breakdown. The engines are fitted with Ledward's ejector condensers. By means of these handy and compact condensers several advantages over older patterns are obtained, not the least of which is that the vacuum is produced close to the place where it is most wanted, viz., beside the engine. Each separate low-pressure cylinder may have its own separate ejector condenser mounted beside the cylinder. The effect of this method of arranging the plant is to give a much better vacuum inside the cylinder, which is really the only place where a vacuum is required. A description of Messrs. Ledward and Co.'s ejector condenser will be found in *The Electrician*, Vol. XXXIV., p. 331.

The station will principally supply current for arc and glow lighting, but in anticipation of a certain demand for electric motive power the frequency of the alternations has been fixed at 50 cycles. For the street arc lamps—an almost indispensable item at a seaside resort—Ferranti rectifiers will be used, it being intended to erect three rectifiers, of which one will serve as a stand-by.



I. Saturation Curve at 375 Revs. II. Short Circuit Curve. III. Load Curve. Excitation at full load = 635 watts.

FIG. 5.—Test Curves of 125 kw. Fynn Alternator.

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CORRESPONDENCE

TEMPERATURE VARIATIONS IN CLARK CELLS: A CORRECTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I trust you will allow me to correct a mistake in your report of the last meeting of the Physical Society. In the discussion I wished to draw attention to the fact that when using a Board of Trade form of Clark cell under ordinary working conditions, rapid changes of temperature being avoided, it is unnecessary to trouble about "lag" if the absolute value of the E.M.F. is in question, because this is not known to a greater accuracy than one-tenth per cent. (not *one* per cent., as reported); and, even if the accepted value of the volt be taken as correct, the E.M.F. in this form of cell is not reproducible to a greater accuracy than one-tenth per cent. When, however, we are not concerned with the actual value of the E.M.F., but only with its constancy, the question of "lag" may be a serious one. The importance of "lag" depends simply on the experimental conditions—a fact which does not seem to be always appreciated.—Yours, &c.,

W. R. COOPER.

Nov. 22, 1897.

THE "INVERTED" FORM OF THE BOARD OF TRADE STANDARD CELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I regret that our colonial isolation has caused some delay in replying to the communication from Dr. Kahle, published in your issue of Oct. 22nd. The cells to which he refers, although of an inverted type, differ so completely in all essential details from those described by Mr. Barnes and myself that it would hardly be necessary to make any reply on the question of priority; but a comparison of the two forms of cell may not be without interest in itself, as an illustration of the many important points in which the German practice differs from ours. We should therefore be glad, if there is space in your columns, to avail ourselves of this opportunity of making our position clear.

It appears that the reference given by Dr. Kahle should read "*Instrumentenkunde*, 1893, p. 298," instead of 1892, as printed. We did not happen to possess a copy of this paper, thinking that the subsequent article in Wiedemann's *Annalen*, Jan., 1894, was a reprint of it. A copy of the *Instrumentenkunde* for this date was very kindly lent us by the librarian of Harvard College. The cells referred to by Dr. Kahle as an anticipation of ours are "*dry*" cells of a compact "cylindrical" form, filled with mercurous sulphate paste for portability, and with *external* electrodes fused through the walls of the tube. The mercurous paste in these cells was *in direct contact* with the zinc amalgam, and caused, as might have been expected, sudden and irregular changes in the E.M.F. In the cells made here we have invariably followed the usual practice of covering the zinc with crystals of zinc sulphate, and have found no such troubles. It is difficult to understand why such an obvious precaution should have been neglected.

Dr. Kahle's object in making the cells dry was merely to secure portability. Dryness is, however, by no means an essential condition for this purpose, and although we have had no trouble as yet with some of our own cells of a different type, which were made dry (filled with moist crystals) for the purpose of avoiding diffusion lag, we agree with Mr. Fisher that a cell containing more liquid is to be preferred, as being likely to have a longer life. For this reason, among others, but more particularly because the same method of construction exactly fits the cadmium cell, we are inclined to prefer the "Inverted" type recently described to any of the practically dry forms given in our Paper in the *Proceedings* of the Royal Society, Vol. LXII., p. 117.

This "cylindrical" type of cell, of which only four specimens are mentioned, appears to have been subsequently abandoned by Dr. Kahle, since the paragraph describing it is simply omitted in the later article above referred to, which is otherwise an almost verbal reprint. The H-form is represented as being the only reliable type, and the "English" form cannot be too severely condemned For ordinary purposes almost any kind of Clark or cadmium cell is good enough. For the most accurate scientific work, or for a National Standards' Laboratory, a much higher order of excellence is demanded. Judged from this standpoint, there are many grave objections to be urged against the forms of standard cells described by Dr. Kahle, and adopted by the Reichsanstalt. Many of these objections are associated (1) with the use of *external electrodes*, which appear to be universally adopted in Germany, and (2) with the form chosen for the cell. With the stumpy form of cell there in vogue, and with naked platinum wires fused through the walls, the cell cannot be directly immersed in a water bath, which is generally the most accurate and expeditious method of determining its temperature. The internal electrode of the English form was specially devised to meet this difficulty. It is further desirable that the cells should be set up *in long tubes*, so that the vital parts may be completely immersed to a depth of an inch or more below the surface of the liquid. The diameter of the tube should also be small, so that the cells may very quickly follow any changes of temperature. Paraffin baths or air baths are from every point of view far inferior to water baths for accurate work.

The importance of these details for accurate work will be best appreciated, especially by those unfamiliar with experiments requiring the exact measurement of temperature, by the following illustration. A few years ago the determination of the rate of variation of the temperature coefficient of a Clark cell would have been considered a formidable piece of work.* In 1893 Dr. Kahle undertook this investigation for the German form of cell, using the best apparatus and appliances at the disposal of the Reichsanstalt, and sparing no pains and ability in the determination. As the result of a most laborious series of measurements, extending over more than two months, be deduced a value of the temperature coefficient about 4 per cent. too small at 15°C., and a value of the rate of variation about 60 per cent. too large. This comparative failure was undoubtedly due in the main to the difficulty of quickly and certainly determining the temperature of the German type of cell, and to the time required for changing from one temperature to another. With the type of cell which we have described, a *certainty* of one part in 10,000 may be obtained *within ten minutes* of any temperature change, however sudden, between the limits 0deg. and 30°C.; and an accurate determination of the temperature-variation of the E.M.F. may be made by an average student in the course of a single afternoon's work, with comparatively simple apparatus.

Another point of some importance was raised by Prof. Carhart at the meeting of the British Association with regard to the use of external electrodes in zinc amalgam cells. It is well known from Lord Rayleigh's observations that the zinc amalgam has a habit of spreading along the wire and cracking the seal, especially if the cell is subjected to frequent alterations of temperature. Prof. Carhart gave this as his objection to the use of zinc amalgam, but admitted that in the type of cell described by us, the catastrophe was for all practical purposes indefinitely retarded by the use of the *internal* electrode. With the German method of construction, the life of the cell may, doubtless, be prolonged by special methods of sealing, or by avoiding excessive changes of temperature, but the failure of the seal is probably only a question of time, and it would appear preferable to adopt some other construction for the standard form.

Among minor differences of construction between our cells and those of Kahle, which were carefully considered in the design, and should not therefore be omitted in the present comparison, we find that a flattened and amalgamated platinum wire exposes ample surface to the paste, and that it is not necessary to weld on a piece of foil. Here, again, the separate tube for the electrode is an advantage, as it permits the amalgamation of the wire to be effected by the simple method of heating and plunging into mercury, in place of resorting to the process of electrolytic amalgamation recom-

* Glazebrook and Skinner, *Phil. Trans.*, Vol. 183 A, p. 615, 1892.

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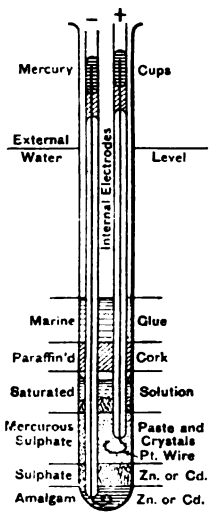
mended for the construction of the German cells. Again, the upper ends of the pair of glass tubes containing the internal electrodes serve naturally, in our method of construction, as mercury cups for making and changing connections with the maximum of ease and celerity. The advantage of this method in accurate work is very great, as it ensures the most perfect insulation and freedom from thermal effects, and precludes all possibility of creeping or corrosion.

It will have been observed that the present tendency of German workers has been to exaggerate the value or the H-type, and to throw the single-tube form into disrepute. We contend, on the contrary, that the English B.O.T. form can be readily cured of diffusion lag in a variety of ways, by simple means, and that it is then obviously superior in simplicity, convenience, and accuracy to the H-form. Uniformity of temperature, for instance, can evidently be secured with greater ease and certainty in the single tube. Even in the case of the cadmium cell, where the temperature coefficient is so small, uniformity of temperature is still a matter of importance. It has been shown that a difference of temperature between the two limbs of a cadmium H-cell has a much greater effect on the E.M.F. of the cell than an equal change of temperature in the cell as a whole.* Moreover, diffusion lag, which the H-form was invented to cure, scarcely exists in the cadmium cell, as the change of solubility with temperature is so slight. There is all the less reason in this case to cling to an unnecessary complication.



Callendar and Barnes' "Inverted" B.O.T. Standard Cell; Laboratory Form for Immersion in Water-Bath.

We should like to add that we have no patent or commercial interest of any kind in any of the forms of standard cell which we have described. They are comparatively easy to make, and we hope that our conclusions may soon be verified by independent observers.—Yours, &c.,

H. L. Callendar.

McGill University, Montreal, Nov. 10, 1897.

P.S.—I enclose a sketch showing details of construction of one of our laboratory cells of the Inverted B.O.T. type.

CARBON COHERERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In reference to Mr. Jervis Smith's and Mr. A. A. C. Swinton's letters, in your two recent issues, I beg to state that the use of carbon granules or powder for coherers was described and claimed in the writer's patent (specification No. 28,955) of 1896, in conjunction with a telephone used as a receiving instrument. I must say, however, that only in this connection do I find carbon to be of any service for cohering purposes.

Where a relay is used in the circuit metallic granules are more sensitive and better because they cohere much more completely for a given electrical impulse, although requiring a more energetic tapper to decohere or tap back. Carbon reduces its resistance—or increases its conductivity—a *little* for a given impulse, and continues to do so in successive increments for succeeding impulses, as Mr. Jervis Smith finds; but metals, especially tin and easily-fusible alloys, break down their contact resistance suddenly and completely from infinity to almost nothing for the first small impulse that would only have varied similar contacts made of carbon to a small extent. This property of carbon is, therefore, useful where *very rapidly*-produced impulses are required to be individually received on a coherer telephone combination, as, for instance, impulses corresponding in number to moderate-tone sound waves, because it allows of receiving a number in succession without decohering between each—the latter being performed at a much slower rate. The more complete reduction of resistance given by metallic granules with a slight film of oxide is much more effective, however, for operating a relay when they can be decohered between each impulse.

Incidentally, I would mention that where sharp decohering is not required for signalling, but only single responses to minute electric radiation, a coherer of most extreme sensibility can be made in the single contact form by delicately and lightly balancing or suspending a very small platinum point, so that it just touches the surface of a piece of blued or straw-tempered steel. Of course, any other metal that can be covered with a *very thin* and controllable film of oxide will also answer, and the oxidisable metal may be made the point instead of the surface; but the above is a very convenient arrangement, and permits of the easy adjustment of the thickness of the oxide film by watching the colouring during the heating of a highly-polished steel or iron surface.

The writer has also tried many other varieties of coherer, including electro-capillary and grease-film forms; but, taken all round, finds the Branley tube of filings, with certain modifications, to be the most effective of all for continuous Morse signalling.—Yours, &c.,

A. C. Brown.

London, E.C., Nov. 23, 1897.

THE INSTITUTION OF CIVIL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In his Presidential Address to the members of the Institution of Civil Engineers, Sir John Wolfe Barry took for his theme the Institution of Civil Engineers, referring, among other things, to the new regulations for the admission of associate members, the Engineering Conference and the new buildings of the Institution, which, though in use last session, were not then quite completed. In closing his address, Sir Wolfe Barry remarked that although the lecture theatre was sufficiently large for the ordinary meetings yet on some occasions more room was required. The annual conversazione had to be given on two nights, as all those who accepted the invitations could not be accommodated at one time; the Engineering Conference had to be held outside the Institution for the same reason, and the annual dinner was in like manner usually eaten in one of the halls of the London companies. We may also remark that many of those present at this opening meeting of the session had to stand, owing to lack of seating accommodation. He pointed out that the Institution is as wealthy as most of these guilds, and if they had their large halls why should not the Institution of Civil Engineers have one also. In connection with this hall, either over or under it, a museum could be established, where members could see the successes and failures of other engineers. Such a museum would, he thought, be of vast usefulness. As things are now, the Institution has to refuse almost all the models, &c., offered to it.

This idea of a museum is not new, for in 1880 Mr. Vernon-Harcourt referred to the models of almost all movable weirs in existence at the École des Ponts et Chaussées, and lamented that there was not such a model room in connection with the Institution of Civil Engineers in this country.

In his Inaugural Address to the Iron and Steel Institute in 1877, Dr. Siemens suggested having a building of sufficient capacity to represent the societies cultivating various branches of Applied Science, and a committee was appointed to

* Dearlove, *The Electrician*, Vol. XXXI., p. 645. (We have frequently had occasion to confirm this observation.)

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promote that object. In 1879, Dr. Siemens moved that that committee be re-appointed, and he offered to give £10,000 in aid of the construction of such a building on a suitable site in Westminster.

The Institution of Mechanical Engineers will soon be in its new home at Storey's-gate, but the Institution of Electrical Engineers and the Iron and Steel Institute, both of which hold their meetings at 25, Great George-street, are homeless. Why, therefore, do these not combine with the Civil Engineers to build this hall and found this museum, and at the same time make for themselves a home adjoining the Civil's? No doubt it could be easily arranged that the present lecture theatre would still be at their disposal. The three societies would still remain quite independent, but would, as it were, all nest on the same tree, and although the nest would be proper to its own institution, the branches would be for the use of all. This proposed museum would then be thoroughly representative of all branches of engineering.

With a few offers similar to that made by Dr. Siemens, mentioned above, the thing could be done. Sir Wolfe Barry, instancing the McEwan Hall in Edinburgh, went so far as to hope that someone might be so generous as to give them the hall he mentioned, but, as Sir Frederick Bramwell afterwards said, "Where is the man?" If this scheme could be carried out it would tend to bring the members of different branches of engineering more in touch with one another, for a man nowadays is too apt to meet only those who are in the same branch of the profession as himself.

No doubt joint meetings could occasionally be held, with a reception afterwards, similar to those now at times held at the Institution of Civil Engineers.—Yours, &c.,

"PENDRAGON."

LEGAL INTELLIGENCE.

Holophane Company (Limited) and Others v. O. Berend and Co. (Limited).

This case came before Mr. Justice Kekewich on Friday last on the application of the plaintiffs that the defendants, their servants and agents might be restrained until judgment in the action or further order from manufacturing, selling, or offering or supplying globes manufactured in the manner described in a specification granted to Speridan Psaroudaki and André Blondel, and vested in trust for the plaintiff Company, or in any manner only colourably differing from the same, and generally from infringing certain Letters Patent.

Mr. WARRINGTON, Q.C., for plaintiffs, said the patent granted in 1893 being a recent one its validity had not been established. He asked for an injunction because at the time the action was commenced the plaintiff Company were selling, and had for some time been selling, a considerable number of their own goods, and working up a considerable trade, whereas the defendants when the action was begun had not commenced, but merely advertised their intention to commence their trade. Although it might turn out at the trial the plaintiffs were not entitled to the injunction on the balance of evidence, it would be better to stop the incipient trade—the plaintiffs, of course, giving an undertaking in damages—than to allow it to go on. He did not think that it would be right to give his lordship a long lecture on the science of optics. He might, however, tell his lordship that the plaintiffs' globes were meant to be used with powerful lights such as arc and other forms of electric lights, and they were so contrived that instead of showing a bright point as was obtained from an ordinary globe, whether clear, crystal or opal, the light was diffused over the entire surface of the globe. The defendants had pleaded anticipation, and their alleged anticipation consisted of a patent taken out by Mr. A. P. Trotter some years ago. That patent consisted of contrivances for lanterns such as those which were often to be seen on the stations of the Underground Railway or on lamp-posts—that was to say with flat sheets of glass meeting at the bottom and with a shade at the top. That had both inner and outer ribs, and was so far like the plaintiffs' patent. But there were two points in which that differed from the plaintiffs' patent. With regard to the inner ribs, there was not the contrivance for preventing the interior reflection and loss of rays by that means. With regard to the outer ribs, they were so contrived that there was no reflection, and they could only be used effectually with the light above them. The object of the Trotter patent in such lanterns was to make the light even, and both to diffuse and reflect the rays of light. The defendants had advertised that they were about to introduce, and he (the learned counsel) thought they had since introduced, into this country globes called or marked "Heybrock Opterophane." Witnesses would tell his lordship that those globe were made substantially in accordance with the plaintiffs' patent—that was to say, they had the inner ribs concave or convex, and the outer ribs so contrived so to bring about the conditions brought about by the plaintiffs' patent. The view taken by the plaintiffs' witnesses was that if those globes were put on the market the plaintiffs would be damaged, inasmuch as the defendants' globes looked exactly like the plaintiffs', and their name was very like that of the plaintiffs'. Again, it was felt that if the defendants were allowed to put their globes upon the market the plaintiffs would lose the reputation they were now acquiring, and therefore they would suffer damage which could not be estimated in the ordinary way in cases of infringement of patent. On these grounds he asked for an *interim* injunction.

Mr. SCOTT, Managing Director of the plaintiff Company, made an affidavit in which he stated that the Heybrock opterophane globe appeared to be an infringement of the holophane globe, although it did not get the same effects. He said that the plaintiff Company had a very large sale for the holophane globes throughout the country, and they had become very well known, and had become the subject of numerous articles written by great authorities throughout the scientific world. He thought that the defendants' globes would be mistaken for the plaintiffs'.

Mr. TERRELL read an affidavit made by Mr. Berend, in which he said that the Heybrock opterophane globe was quite dissimilar from the holophane globe, although there was a similarity of appearance, and further exhibited a catalogue, dated 1889, containing illustrations of globes alleged to be similar to the holophane, and which, it was alleged, had been fully advertised and circulated in England by Messrs. Campe and Co., of Berlin, during that year and since. Mr. Terrell said that his lordship would see that there was nothing new in fluting globes inside and ribbing outside. The defendant further stated that he believed the patent of the plaintiff Company was invalid, as the means used for the diffusion of light were well known in England before the date of the patent. Mr. Trotter had clearly disclosed the idea of internal flutings and external ribs.

Mr. WARRINGTON said that at the trial there would be a conflict of testimony as to whether one patent was anticipated by the other. It would, however, be a very difficult thing to examine those specifications in detail now. He understood that his learned friend objected to the description which he (Mr. Warrington) gave his lordship of the plaintiffs' patent, but there were those two material and important features, viz., the outer ribs so contrived as to direct and distribute light in a given direction by effusion. The controlling of the light and saving of loss were, it is claimed, two important features of the plaintiffs' specification. Mr. Trotter's specification, he urged, did not point to either of those two elements, but the object of his invention was to effuse the light horizontally over a given area. He did not ask for an established trade to be stopped. He came there before the trade was started, and asked that the defendants should not be allowed to start it in such a way as to damage the plaintiffs.

Mr. JESSELL, following on the same side, asked his lordship to hold that the defence which had been set up was not a real defence, but a sham.

His LORDSHIP, without calling upon Mr. Terrell, in giving judgment, said that he had tried during his time many cases where anticipation was alleged. These cases were very difficult to decide, and required a large amount of expert evidence before doing so. He could not see any reason for supposing that the defence in the present case was a sham got up to get rid of the action and to defeat the plaintiffs on this particular application. It seemed to him—although it might turn out hereafter that the defendants were wrong—that it was a case in which the Court should listen to evidence. That being so, it seemed to him that he had no right to interfere at the present time, and to say that the plaintiffs should have an injunction restraining the defendants from manufacturing and selling the goods in question, which after all might turn out to be legitimately put on the market. The plaintiffs said that they were doing a considerable business, and had established themselves on the market; that the defendants had come forward, but not having yet sold any of their goods, it would not be a serious interference with them if the injunction were granted. On the other hand, the plaintiffs said that they might be seriously damaged if the defendants' business were allowed to grow and increase during the next six months or a year before the case was ripe for trial. The answer to that was, it seemed to him, that the Court had power to give damages for the infringement from the start. Forty years ago a motion for an injunction had to stand over while the validity of the patent was established at law. Fortunately they had got rid of that now, and the injunction and the validity could be determined and disposed of in one and the same action. He quite followed the argument that it would not do for a defendant coming there, as against the proprietor of letters patent, simply to say that he challenged the validity of the patent. There must be something more than that. The Court must be satisfied that there was an honest intention to try the question, and not only an honest intention to try the question, but that there was something to be tried. The question was whether there was an issue to be tried as regarded the validity of the patent. The defendants' affidavit had set up two defences, the first being "common knowledge," and the second anticipation by a prior patentee. He had heard arguments which ought, perhaps, to convince him that the anticipation by Mr. Trotter ought to fail. That, however, was a matter for very careful investigation, and it must be taken for granted that in such a case the plaintiff would get a verdict for such damages as ought to be paid by the defendant if the infringement were established against him. For those reasons he could not see that there was any balance of convenience in granting the injunction in that case, whereas it would be a great hardship on the defendants if they were not allowed to carry on a trade which might turn out to be legitimate. Of course the defendant would undertake to keep an account, but what that ought to be it was difficult to say. He (his lordship) had never seen the great advantage of an undertaking by a defendant in such cases as that to keep an account, because he was bound to keep it for his own protection, as if he did not do so, and he was afterwards held to be in the wrong, he might find himself in great difficulties by reason of not being able to prove what he had sold. He should refuse the application, and make the costs costs in the action.

Order accordingly.

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Wood v. B. Veritys, Limited.

On Monday an action was brought in the Chancery division by Mr. Henry Raymond Wood, late manager in the employ of Messrs. B. Verity and Sons, of London and Birmingham, to recover damages for alleged wrongful dismissal, and to obtain an account of the commissions alleged to have been earned. By an agreement entered into in September, 1893, the plaintiff was to have the management of the accessories department of defendants' business for three years at a salary of £250 per annum and commissions. He was dismissed on Nov. 12, 1895, for alleged misconduct, but this he denied. He denied that it was ever suggested that he took too long for luncheon. As a boy he had been accustomed to field sports and horses, and he had ridden and driven regularly ever since. It was true that he "backed his fancy" at times, and had shared in a book with a friend on the Stock Exchange. In that book he participated in a fourth of the gains or bore a fourth of the losses. The maximum bet he had made in the whole of his lifetime was £5, and his liability under the book named never exceeded £30. He denied that he received complaints of his working, either from Mr. Verity or others, nor was any charge of incapacity made against him. Pressed as to certain specific charges of neglect of duty, witness denied them categorically.

Ultimately the parties came to terms, the action being dismissed without costs.

Thorpe v. Dublin Corporation.

In the Queen's Bench Division, Dublin, on Monday, an application was made, on behalf of the defendants in an action to recover damages for alleged injury from electric shock, for an order to stop all further proceedings, or to remit the action for trial before the Recorder of Dublin at the next Civil Bill Sessions. Mr. Macinerney, Q.C., read an affidavit made by the Town Clerk (Mr. H. Campbell) to the effect that the Corporation had a valid defence to the action, and that the plaintiff had no visible means of paying costs. Plaintiff alleges that on the night of Oct. 30 last, while crossing the end of Nassau-street, as he stepped up on the footway he sustained an electric shock. An affidavit by the engineer and manager of the electricity station (Mr. Mark Ruddle) stated that at about 9:30 p.m. on the night in question a man, whom he believed to be the plaintiff, came to the station and said he had been struck down by a shock at the corner of Grafton-street. His hands and clothes were muddy, and he asked for compensation. He referred him to the City Hall. The man did not appear to be at all injured. He afterwards inquired at Mercer's Hospital whether the plaintiff had been there, and was informed that he did call, that he got a draught, was seen by the resident pupil only, who did not think it necessary to have him examined by a doctor, and that there was nothing wrong with him. After reading further affidavits by medical men and hearing counsel their lordships remitted the action to the Recorder as asked.

Nicholson and Tyler v. Lawrence.

Recently, in the Official Referee's Court, London, an action was heard before Mr. Verey, in which Messrs. Nicholson and Tyler, of New Bridge-street, London, E.C., sued Mr. J. Lawrence, chairman of the Linotype Company, Oaklands, Kenley, Surrey, for the sum of £206. 5s. 6d , balance of a sum of £605. 5s. 6d. cost of an electric lighting installation at defendant's residence. Mr. G. L. Addenbrooke gave evidence for the plaintiffs that the installation was a high-class one, and that the number of lamps and their candle-power had been greatly increased beyond that mentioned in the specification to which the work was done. Mr. Timmis, Mr. A. H Preece, and Mr. Gorham, gave evidence for the defendant. and expressed the opinion that the original accumulator set supplied was not large enough for the installation, but that otherwise the specification had been worked to. The Referee found that the plaintiffs had supplied the installation which had been contracted for to specification, and that there was no negligence or want of skill on their part. The plaintiffs were awarded the claim in full, with costs. A counterclaim was also decided in favour of the plaintiffs.

A Substitute for Inverted Arc Lighting.—The lighting of large rooms by means of inverted arcs has been adopted with considerable success, and, in a certain class of room, is found to give good and efficient results. Our contemporary, *Electricity* of New York, informs us that a similar system of lighting by diffusion is being tried experimentally in the library of the Columbia University, having been suggested by Prof. Hallock. Suspended in the centre of the great hall is a large hollow globe 7ft. in diameter, and painted a dull white. This is not a receptacle of the light, intended to diffuse the rays by transmission, but is opaque and intended to diffuse the rays by reflection. Upon this sphere are directed the concentrated beams of light from eight hidden arc lamps located at intervals along the gallery pilasters. "The moonlight effect," says our contemporary, "is heightened by the background of blue which constitutes the ceiling, and the effect is described as fine in the extreme." A moonlight effect does not seem to be quite what is wanted in a library.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES" Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. New and enlarged edition, 3s. 6d. net.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. *New Edition now ready.* These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

Notice.—There will shortly be ready a cheaper Edition of these popular "Notes and Forms," for the use of students at the Polytechnics and other teaching institutions throughout the country. The price of the new forms will be 2d. net, post free, or 2s. per dozen assorted forms.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins can be supplied, price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

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"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced, and all the usual important articles, &c., which have made the book indispensable to the industry, will be brought up-to-date and amplified where necessary.

Tenders Invited.—The Corporation of Barrow-in-Furness invite tenders for the supply and erection of (*a*) boilers, pumps, steam and wates pipes, tank, crane, economiser, and ironwork; (*b*) engines, generators, switchboards, instruments, accumulators, motor transformers, and substation equipments; (*c*) high- and low-tension feeder and distributor cables and house-connection boxes; (*d*) conduits and drawing-in boxes. Our advertisement columns contain some further particulars, and specifications, &c., can be obtained at the Town Hall, Barrow-in-Furness, or at the offices of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. Tenders must be sent in to the town clerk (Mr. C. F. Preston), Town Hall, Barrow-in-Furness, by noon on Wednesday, Dec. 15.

——— From our advertisement columns it will be seen that the Dundee Gas Commissioners invite tenders for an economiser for their electricity supply works, Dudhope-crescent-road. Specifications may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), and tenders must be sent in to the clerk to the commissioners (Sir Thomas Thornton), City-chambers, Dundee, by Friday, Dec. 3.

——— The Londonderry Corporation invite tenders for the supply of electric-light carbons for one year from Jan. 1, 1898. Tenders to Mr. John Christie, Guildhall, Londonderry, by Thursday, Dec. 9.

——— The Electric Lighting Committee of the Canterbury (Kent) Corporation invite tenders for the supply of: (*a*) boiler-house plant, (*b*) engine house plant, (*c*) overhead travelling crane, (*d*) switchboard and instruments, (*e*) accumulators, (*f*) mains, (*g*) public lamps, and (*h*) meters. Tenders to Mr. Henry Fielding, Town Clerk's office, Canterbury, by Monday, Dec. 20.

——— The Blackburn Corporation Tramways Company invite tenders for eight tramcar bodies, with trucks, motors, controllers, trolley pipes, &c. Tenders to Mr. J. W. Baker, Railway-road, Blackburn, by noon (to-morrow) Saturday.

——— The Sanitary Committee of the Leicester Corporation invite designs and tenders for motor vehicles for house refuse collection. Proposals to the Borough Engineer and Surveyor (Mr. E. George Mawbey, C.E.), Town Hall, Leicester, by Monday, Jan. 31 next.

——— The Directors of the Great Northern Railway Company require tenders for the supply of new, and the purchase of old, stores for twelve months from Jan. 1 next. A list of the contracts and other information can be obtained on application to Mr. Martin, Stores Superintendent, Doncaster. Tenders by 10 a.m. of Saturday, Dec. 4, to the Company's Offices at King's Cross, London, N. Mr. William Latta is secretary.

——— The Metropolitan Asylums Board invite tenders for the execution of certain additions and alterations to the electric fire alarm system at the South-Eastern Fever Hospital, Hatfield-street, S.E. Tenders must be sent in to the offices of the Board, Norfolk House, Norfolk-street, London, W.C., by 10 a.m. of Thursday, Dec. 2. Mr. T. Duncombe Mann is secretary to the Board.

——— The Plymouth Corporation invite tenders for the erection of electricity supply works at Prince Rock. Tenders are also required for the construction of six underground transformer chambers. Specifications, &c., from the borough engineer (Mr. John H. Rider), East-street. Tenders, in both cases, must be in by Dec. 2.

Tenders Accepted.—The Tramways Committee of the Bradford Corporation have accepted the tender of the Leeds Steel Works (Limited) for the supply of rails for the new electric tramways to Horton and Bolton.

——— The Bradford Board of Guardians have accepted the tender of Messrs. H. Scholes and Co. for wiring the Nurses' Home at the Infirmary at £186. 5s

Free-Wiring Contracts.—The contract for the electric wiring and fittings for the New Liverpool Head Post Office has been placed with the National Electric Free Wiring Company. There are 1,125 incandescent and 58 arc lamps. The West Ham Town Council have also accepted the Company's tender for the wiring of the New Technical Institute. About 1,400 lights will be required in this installation. We are informed that the Company have, during the past two months, carried out 60 installations with an aggregate of over 1,000 lights, in all of which their patent system of wiring is being used.

Sales by Auction.—Messrs. Fuller, Horsey, Sons and Cassell notify in our advertisement columns that, by order of Mr. Justice Vaughan Williams, they will offer for sale at the Waverley Typewriter Works, Handforth-road, Clapham, London, S.W., *on Thursday and Friday next*, Dec. 2 and 3, at 11 o'clock each day, a costly collection of modern machine tools, including screw-cutting and other lathes, milling machines, a 6 H.P. Otto gas engine, a complete electro-plating plant (including two dynamos, two plating backs, tanks, polishing lathes, &c.), as well as the office furniture, stock and stores, consisting of about 250 Waverley typewriters, &c. Catalogues, when ready, may be had of the Receiver, Mr. James Harris, F.C.A., 8, Old Jewry, E.C.; Messrs. John H. Mote and Son, solicitors, 11, Gray's Inn-square, W.C.; and of the auctioneers, 11, Billiter-square, E.C.

——— Messrs. Percy Huddleston and Co., of 72, Finsbury-pavement, London, E.C., have received instructions to sell by auction, in one lot, at the Mart, Tokenhouse-yard, E.C., *on Wednesday next*, Dec. 1, at one o'clock, the leasehold premises known as the Copper Depositing Works, West Ferry-road, Millwall, E. Some particulars will be found in an advertisement elsewhere, and all other information can be had from Mr. E. Wilding, 2, Clement's Inn, W.C.; Messrs. Ward, Perks and McKay, 85, Gracechurch-street, E.C.; Mr. William Bullock, Bushbury, Wolverhampton; Messrs. Morley and Shirreff, Gresham House, London, E.C.; and of Messrs. Percy Huddleston and Co.

Appointments.—Mr. J. Palfreyman, C.E., the superintendent of the ventilation and lighting department of the Royal Courts of Justice, has been appointed resident engineer at the Houses of Parliament in place of Mr. W. J. Prim, who retires on Dec. 1.

——— Mr. J. P. Roberts has been appointed resident electrical engineer at the Durban (Natal) Corporation electricity supply works at a salary of £450 per annum.

Appointment Vacant.—The Lighting Committee of the Wolverhampton Corporation invite applications for a junior assistant in the office of the borough electrical engineer, Mr. F. Harman Lewis. Salary £80 per annum. Applications on forms to be obtained from Mr. Harman Lewis, Town Hall, Wolverhampton, must be sent in by Dec. 8. See advertisement.

Vacancies.—Messrs. W. Denny Bros., of Leven Shipyard, Dumbarton, want a foreman electrician, used to the wiring of ships and houses for incandescent lighting. An advertisement elsewhere gives some further particulars.

——— An electrician is wanted to take complete control of a central station in the South of Ireland. Some further particulars are given in an advertisement on another page.

Business Notices.—Mr. J. H. Greenhill, M.Inst.E.E., of New King-street, Belfast, has sold his business to Mr. Edwin E. Craig, and the firm will be in future carried on under the style of Greenhill and Craig at the old address. Mr. Craig served his apprenticeship under Mr. Greenhill, and after working at Messrs. Johnson and Phillips' at Charlton, has for some time past acted as manager of the business at Belfast. Mr. Greenhill will in future confine himself entirely to consulting work, electrical and mechanical, in Belfast and London.

Bankruptcies.—The public examination of Wm. Marshall, electrical and mining engineer, took place at the London Bankruptcy Court last week. Total liabilities are returned at £15,390, assets valued at sufficient to yield a surplus of £54,560. Debtor stated that he commenced business with a capital of £1,500. He had financed certain electrical patents, and expended between £6,000 and £7,000 thereupon. In May, 1896, he promoted the London Electrical Omnibus Company (Limited), with a capital of £250,000, to acquire certain patents and plant. His consideration as vendor was agreed at £100,000, payable as to £20,000 in cash and £80,000 in shares. The initial expenses were about £14,000. The subscriptions from the public fell short of the expected sum, and he therefore returned £13,816 of the cash consideration, and took up the unsubscribed balance of 27,633 shares. He recognised that these shares would not realise their full value until the 'busses started running. He had every confidence that the full value would eventually be realised.

——— The creditors of S. Bousfield Tatham, electrical engineer, 26, Thurloe-place, South Kensington, met on Monday. The statement of affairs shows liabilities £2,558. 15s. 7d., assets £65. 5s. 10d. Failure is attributed to extravagance, betting losses,

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and law costs. Prior to 1889 the debtor was employed as salesman by a firm of electrical engineers at a salary of £200, which included royalties on an electrical appliance he had patented. In that year he entered into partnership with others in a business carried on at 16, Davies-street, Berkeley-square, as Girdlestone, Tatham and Co. He withdrew from the business in August, 1896, owing to disagreements having reference to his excessive drawings, and in the following January started in business for himself. No offer was submitted on the debtor's behalf, and the chairman (Mr. Wildey, Official Receiver) said he would, acting as trustee, wind up the estate in the ordinary course. Public examination of the debtor is fixed for Dec. 14.

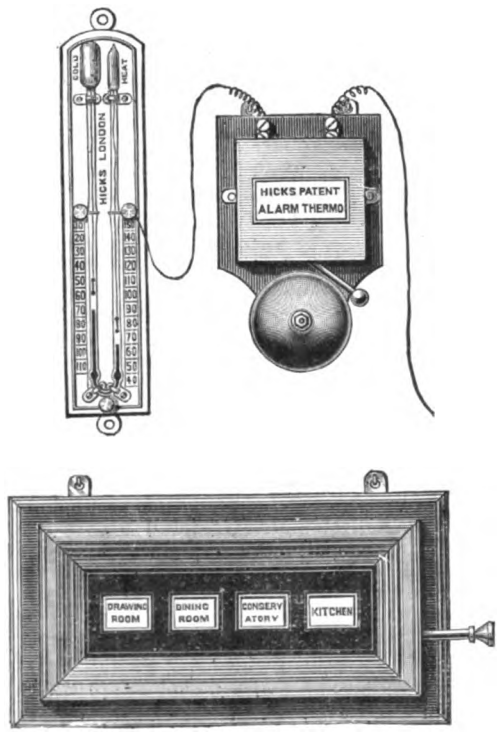
Bankruptcies.—At the London Bankruptcy Court the public examination of Arthur Bagshawe, engineer, &c., was conducted. Unsecured liabilities £36,129, assets given as £50,121. Examination adjourned for three weeks.

——— The first meeting of creditors of John Orme, trading as J. Orme and Co., electrical and scientific apparatus manufacturer and dealer, 6, Cross-street, Finsbury (late 65, Barbican), and 62, Compton-street, Goswell-road, E.C., was held last week at the London Bankruptcy Court, Carey-street, W.C. The accounts show total liabilities £2,453. 13s. 9d., assets £118. 18s. 1d. No proposal was submitted, and the Official Receiver acts in the matter. Public examination Dec. 17.

Liquidation.—At a recent extraordinary general meeting of the members of the New-Mayne Electric Rudder-Motor Syndicate (Limited) it was decided to wind up the Company voluntarily, and Mr. D. F. Basden, 33, St. Swithin's-lane, London, E.C., was appointed liquidator.

Dissolution of Partnership.—The partnership business of electrical engineers hitherto carried on by Alice Westray and Mr. James Heber Ormerod, at Church-street, Blackpool, and the Masonic Buildings, Hall-street, St. Helens, under the style of Westray and Ormerod, has been dissolved. Debts by Alice Westray, who continues under the style of Westray and Co.

Alarm Thermometer.—The illustration below shows a form of alarm thermometer patented and manufactured by Mr. James J. Hicks, of 8, 9 and 10, Hatton-garden, London, E.C., for the protection of buildings of all kinds from fire and for regulating temperature in ships, buildings, cold stores, &c. These thermometers are designed for erection in suitable positions, and are then electrically connected with a loud-sounding bell in the watchman's or other office, to give timely warning that something is wrong. The indicator shows at once the quarter from which the notification comes. One of the chief features claimed for this thermometer is that it can be set to any temperature by the aid of a magnet provided to move the index. For fire indication the thermometer is graduated to moderately high heats, and for cold stores is graduated to show low heats, and, as described above, gives the alarm when these temperatures are reached. The large increase in the number of cold stores which are being erected in all parts of the country to deal with the effective storage of imported produce of all descriptions will doubtless cause a large demand for apparatus of this description. The thermometers are also made for very high temperatures for use in bakehouses and places where such temperatures prevail.



Lubricating Oils.—The Reliance Lubricating Oil Company send us a neat little catalogue of their special brands of "Reliance" lubricating oils, oil cabinets, viscometers, &c. A long list of testimonials from users of these oils is included in the catalogue. We have also to thank the Company for a very useful and novel inkwell, which we may call the first of the Christmas novelties, 1897. Being well-made and unspillable it forms a useful inkwell.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 17 to Nov. 23, with the ports of destination :—

Australasia—Brisbane, £8,803 (telegraph material); Fremantle, £4,597; Melbourne, £1,114 (£820 telegraph and £294 telephone material); Sydney, £769 (including £333 telegraph cable); Townsville, £330; Wellington, £1,408 (including £550 telegraph material). *Belgium*—Antwerp, £694 (including £574 fuses; Ostend, £400. *Ceylon*—Colombo, £379. *China*—Shanghai, £15. *Colombia*—Panama, £17. *Egypt*—Alexandria, £58 (telephone stores). *Germany*—Cologne, £15; Hamburg, £289. *Gibraltar*, £94. *Holland*—Amsterdam, £40; Flushing, £15; Rotterdam, £47 (telegraph material). *India*—Bombay, £10; Calcutta, £51; Madras, £50. *Italy*—Naples, £45. *Japan*—Yokohama, £230. *Jersey* and *Guernsey*, £12. *Malta*, £60 (telegraph material). *Mexico*—Vera Cruz, £20. *Siam*—Bangkok, £51. *South Africa*—Cape Town, £1,057; Durban, £464; East London, £810; Port Elizabeth, £33. *Spain*—Barcelona, £10. *Straits Settlements*—Singapore, £85 (including £24 telegraph material). *Sweden*—Gothenburg, £42. *United States*—Boston, £26 (carbons). Total, £22,140, against £35,647 in the corresponding week last year (Nov. 18 to Nov. 24).

Electrical Trades Union.—We are asked to state that a branch of this Union has been established at Leeds.

Patent Application.—The Judicial Committee of the Privy Council have appointed the 9th Dec. for hearing the petition of Mr. I. A. Timmis, for the extension of the term of the letters patent granted to Mr. S. C. C. Currie, 21, Clarges-street, and I. A. Timmis, 17, Great George-street, London, for an invention relating to "Improvements in the means of working and interlocking railway signals by electricity," on Dec. 12, 1883.

Awards.—The Thomson recording wattmeter has obtained the diploma of honour at the Brussels Exhibition, and is the only meter that has received such a distinction.

Mercier's Patents (Limited) were awarded the diploma d'honneur at the recent Brussels Exhibition for their patent water-tight bells.

Electro-Harmonic Society.—A "ladies' night" entertainment will be given this (Friday) evening, at the St. James's Hall Restaurant, at 8 o'clock.

Aberdeen.—The Town Council have received the sanction of the Secretary of State for Scotland to borrow an additional sum of £10,000 for electric lighting purposes. Inclusive of the present loan the expenditure on the Corporation's electricity supply undertaking amounts to £52,000.

Acton.—Apparently the ratepayers do not approve of the present attitude of the District Council on the question of the erection of electricity supply works. The final result of the recent canvass is now to hand, and of the 1,147 replies 715 (131 shops and 584 private houses) approve of the introduction of the electric light, and will probably take current, and 193 (11 shops and 182 private houses) approve, but will not at the outset take current. The subject has been again discussed by the Council, and it was finally agreed that at the next meeting steps should be taken to obtain expert opinion and further information in regard to the project.

Aldershot.—Mr. Reginald P. Wilson has been appointed consulting electrical engineer to the District Council.

Bethnal Green (London).—The Board of Guardians are discussing a report on the relative cost of lighting the infirmary by electricity and gas, which has been prepared by the architect. By putting down an independent electricity generating plant the annual cost is given as £1,035, against £1,593. 15s. if current were obtained from any other source. The capital cost of the installation would be £3,850. Gas lighting would cost £1,275 per annum, and the cost of laying down gas plant £1,775. The report is to be further considered.

Bo'ness.—At the last meeting of the Harbour Commissioners the engineer presented a report on the proposal to light the docks electrically. The consideration of the matter was, however, deferred to the next meeting.

Bournemouth.—The proposal to construct a system of electric tramways in this district was again discussed at Wednesday's meeting of the Town Council, and after full debate it was decided to oppose the scheme, several members expressing themselves in favour of the work being carried out by the Council.

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Buxton.—The District Council have decided to carry out the terms of their Provisional Order.

Dublin.—Troubles never come singly. Following upon Prof. Kennedy's adverse report as to the suitability of the Pigeon House Fort as an electricity generating station comes the refusal of the Local Government Board to sanction a loan of £20,000 for renewing the electric light cables. The reason for this refusal, which apparently was quite unexpected, has not been made public; but we believe it is owing to the fact that the Corporation's borrowing powers are nearly exhausted. Prof. Kennedy is stated to have declared that the present station in Fleet-street can never be made a financial success.

Dundee.—The Town Council having approved of a scheme for the extension of the area of public electric lighting, it is proposed to erect 30 additional arcs in High-street, Nether Gate, Reform-street, Murray Gate, Panmure-street, Albert-square and Meadowside. It is anticipated that the work will be completed by the end of January.

Edinburgh.—The Electric Light Committee recommend the Town Council to rent a plot of ground from George Heriot's Trust at Macdonald-road as a site for a new electricity supply station, and to accept offers for the supply and erection of additional plant, amounting to nearly £20,000.

Electric Lighting Notices.—The following further official notices of intention to apply for electric lighting powers have appeared during the week:—The *Aston Manor* District Council; the *Batley* Corporation; the County of London and Brush Provincial Company (for *Bethnal Green*, *Poplar* and *Whitechapel*, *London*); the Urban District Council of *Birkdale*; the Chelmsford Electric Lighting Company (Limited) (for the parishes of Writtle, Great Baddow, Broomfield, Springfield, and Widford, in the Rural District of *Chelmsford*); the *Chichester* Corporation; the Chislehurst Electric Supply Company (for the parish of *Chislehurst*); the *Darlington* Corporation; the *Dartford* District Council; the *Gravesend* Corporation; the Hastings Corporation (who are seeking powers to enable them to supply electric current within the borough of *Hastings*, and to purchase the undertaking of the Hastings and St. Leonard's-on-Sea Electric Light Company, Limited); the *Haworth* Urban District Council; the British Insulated Wire Company (for the Urban District of *Huyton-with-Roby*, Lancs., and for power to take a transfer of the *Prescot* Electric Lighting Order of 1895); the *Hornsey* and *Ilford* Urban District Councils; the Midland Electric Light and Power Company are seeking confirmation of their existing and a grant of further powers for the supply of electric current in *Leamington*; the *Lewes* and *Lowestoft* Corporations; the Great Western Electric Light and Power Company, Limited (for the *Lewisham*, London, district); the Central Electric Supply Company and the County of London and Brush Provincial Company (for the parish of *Marylebone*, London); the Corporations of *Middlesborough*, *Perth* and *St. Albans*; the Penarth Electric Lighting Company) for *Penarth*, Glamorgan); the Salterton Gas Company (for *Budleigh Salterton*); the Midland Electric Corporation for Power Distribution, Limited (for portions of the counties of *Stafford* and *Worcester*); the Weston-super-Mare Electric Light and Power Syndicate (for the district of *Weston-super-Mare*).

The *Blackpool* Corporation are promoting a Bill to enable the Council to supply electric energy or gas "in bulk" to any Local Authority within or beyond the jurisdiction of the Corporation. The Chelsea Electricity Company are promoting a Bill to empower the Company to acquire or lease certain premises in the parish of *Chelsea* for the purpose of erecting an electricity station or stations. The *Enfield* Gas Company are "seeking powers to enable the Company to make applications for power to supply electricity." The General Power Distributing Company are applying for powers to incorporate a company to construct electricity supply works, and to supply electrical energy in the county of *Derby* and parts of the counties of *Nottingham*, *Lincoln* and the *West Riding* of *Yorkshire*. Some further particulars of this scheme were given in our last issue. The Isle of Thanet Gas Light and Coke Company are seeking powers to arrange a transfer of the Provisional Electric Lighting Order (1896) of the *Margate* Corporation. In the Southend Gas Company's Bill powers are sought to enable the Company to manufacture, purchase and deal in electrical or gas apparatus, to authorise the erection of electricity supply works, and to take a transfer from the *Southend-on-Sea* Corporation of their Electric Lighting Provisional Order (1891). The Tottenham and Edmonton Gas Light and Coke Company are promoting a Bill authorising them to engage in the generation and supply of electric current in the districts of *Tottenham* and *Edmonton*. The *Yeovil* Corporation (who seek powers to acquire the undertaking of the Yeovil Gas and Coke Company) also ask powers for the generation and supply of electric current. The Metropolitan Electric Supply Company are promoting a Bill authorising the use of lands at Willesden and Acton for the purpose of erecting electricity generating stations and for supplying electric current in the districts of *Willesden* and *Acton*, and, further, to enable the Company to provide for the supply of current from the Company's station at Amberley-road, Paddington, mains being laid along Acton-lane, Minet-avenue, Harley-road, Bramshill-road, Station-road, Tubbs-road, High-street, Harlesden, Harrow-road and Amberley-road. The Company also propose to lay a cable along the towing path of the Grand Junction Canal from the Company's works in Willesden and Acton through Willesden, Acton, Hammersmith, St. Mary Abbott's (Kensington) and Chelsea, terminating at Amberley-road station.

Electric Traction Notices.—We give below particulars of applications to Parliament and the Board of Trade in the ensuing session for powers to construct electric railways and tramways. In all cases electricity or other mechanical motive power is to be used:—

The Charing Cross, Euston, and Hampstead Railway Company apply for powers to construct a short line of railway from the Charing Cross-road (near the yards from the Garrick Theatre) to Craven-street, Strand, and to enter into working and other agreements with the South-Eastern and North-Western Railway Companies.

In the Great Northern and City Railway Company's bill, powers are sought to make extensions of the line authorised by their 1892 Act, and for the purchase of additional lands for electricity generating station, &c. The Company are also seeking an extension of time.

The Metropolitan Railway Company seek power to use electric traction on the joint lines of the Company and the Metropolitan District Railway Company, and on any railways of the District Company over which the Metropolitan Company hold running powers. Power is also sought to purchase certain lands adjoining the present Edgware-road station, for erecting an electricity generating station.

Power is sought to incorporate a company to construct an underground electric railway between Paddington and Charing Cross, and with powers to authorise the company to carry the line over the Baker-street and Waterloo Railway, and to alter and lower the level of that railway between Vigo-street and Regent-street, and the eastern end of Cockspur-street, Charing Cross. The generating station will be erected at Paddington on lands at present occupied by the Great Western Company, with whom as well as the South Eastern a working agreement is to be entered into.

A Bill for the incorporation of a company to construct an electric railway from the City and South London line in the parish of St. Saviour's, Southwark, to Brixton-hill. Working and other arrangements are to be made with the City and South London Railway Company, with power to that Company to guarantee and subscribe to the capital, &c.

The Corporation of London seek authority to construct four lengths of railway in the parishes of St. Nicholas and St. Paul, *Deptford*, to connect the Cattle Market with the London, Brighton and South Coast Railway.

Powers are sought for the incorporation of a company to construct an underground railway at *Brighton*.

Powers are also sought to construct, extend, work and convert tramways by the various municipal authorities and public companies set out below. In these cases, also, electricity or other mechanical motive power is to be employed:—

The London and United Tramways Company propose to construct additional tramways in the district of Hammersmith, Acton, Chiswick, Richmond, Kew, New and Old Brentford, Heston, Isleworth, Hanwell, and Ealing.

The Bristol Tramways and Carriage Company have alredy issued particulars of the extension of their system, powers for which they propose to seek from Parliament. Particulars of the scheme have already been submitted to the Town Council, and the company also intend to apply for authority to equip their existing horse lines electrically.

It is proposed to establish a system of tramways in *Hastings* and *St. Leonard's*, and power is being sought to incorporate a company for the construction of the lines and other purposes.

The Woolwich and South-East London Tramways Company (Limited) apply for a Provisional Order to construct tramways in the parishes of *Woolwich* and *Plumstead*.

The *Blackburn* Corporation desire to obtain powers to purchase the undertaking of the Blackburn Corporation Tramways Company, and to construct additional lines.

A Bill is being promoted by the *Portsmouth* Corporation for the acquisition and working of the tramways authorised by the Landport and Southsea Tramway Act (1863) from the Portsmouth Street Tramways Company.

A Bill will be presented for the incorporation of a company to construct a network of tramways in *Folkestone*, *Sandgate* and *Hythe*.

A Bill is being promoted for the incorporation of a company to construct tramways in *Llandudno* and from Llandudno to *Orme's Head*.

Powers are being sought to incorporate a company to construct electric tramways in *Plymouth*, *Devonport* and *Stoke*, and to enter into arrangements with the Corporations of the two former towns for a supply of electric current.

A Bill will be lodged to authorise the incorporation of a company to construct tramways between *Clontarf* and the *Hill of Howth* (Dublin).

For *Blackpool* the Corporation ask power to construct and equip tramways in the borough, and the Blackpool and Fleetwood Tramroad Company to construct additional tramways: the *Burnley* Corporation want powers to work and improve the local tramways; the *Bury* Corporation desire to work or construct tramways within the borough; the Corporation of *Cardiff* apply for powers to construct additional tramways; the Eccleshall District Council to construct tramways in *Eccleshall*, Bradford; the *Keighley* Corporation seek powers to confirm and legalise the construction and to provide for the maintenance of the existing tramways in the borough; the *Leyton* District Council ask

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powers to work the tramways in the district; the *Liverpool* Corporation apply for powers for the construction of 63 additional lengths of tramways in *Liverpool* and suburbs. The *Manchester* Carriage and Tramways Company ask Parliamentary permission to introduce electric traction upon the lines owned or worked by the Company; powers to construct additional tramways in *Norwich* are applied for by the Norwich Electric Tramways Company; the *Oldham* Corporation ask for powers for working the local tramways; the *Plymouth* Corporation desire Parliamentary permission to construct an additional length of tramway; the *St. Helens* Corporation require powers for the construction and working of tramways in the district; and the *West Ham* Corporation seek similar powers for their district.

Exhibitions.—The Marquis of Londonderry, K.G., opened the Sunderland Electrical, Engineering and General Trades Exhibition on Monday. The Marquis said that the historian of the nineteenth century would declare electricity to be the greatest of modern inventions. The past 30 years have shown quite remarkable progress, and it was because they should recognise that this progress was one in which the community at large was interested. It was upon these grounds that they trusted the Exhibition would prove a success, and of great advantage to the district. The Sunderland Forge and Engineering Company were entrusted with the lighting of the Exhibition. The installation consists of 50 10-ampere arcs, 30 100-c.p. and about 250 16-c.p. incandescents. The Sunderland Forge Company also exhibit on the stand of Messrs. William Doxford and Sons a 25-B.H.P. enclosed electric motor driving a joggling machine.

Official notice is given that there will be an exhibition of arts and industries in Barcelona, commencing on April 23rd next.

The Honorary Secretary of the Austro-Hungarian Chamber of Commerce notifies that extensive preparations are being made by the Hungarian Government in connection with its participation in the forthcoming Paris Exhibition, an important display being contemplated in the machinery and electricity sections.

Glasgow.—The Electricity Committee, having considered the proposals of the Kelvinside Electricity Company as to the proposed application for a Provisional Order for Partick, recommend the Corporation to oppose the granting of the Order.

A meeting of the Electricity Committee was held on Tuesday for the purpose of further considering the appointment of chief electrical engineer in succession to Mr. W. Arnot. The Sub-Committee submitted the names of 11 out of the 34 applicants, but it was decided to further reduce the list to 6, and the Sub-Committee were also empowered to obtain the fullest information about the capabilities of the candidates, whom they are to interview personally, and report to the Committee. Amongst those selected we find the names of Mr. Arthur Wright, of Brighton; Mr. John Rennie, who was formerly Lord Kelvin's secretary, and is now electrician at the Board of Trade's Electrical Standards Laboratory; Mr. John M. M. Munro, of Anderson and Munro, Glasgow.

The Corporation have decided, on the recommendation of the Tramways Committee, to adopt single-deck cars on the Springburn–Mitchell-street electric tramway route.

Great Fire in London.—Man's old enemy, Gas, had another big innings in London last week. Owing to an explosion of gas in a small meter in Well-street, in the city of London, on Friday, property variously valued at from £1,000,000 to £8,000,000 (!) has been destroyed. A well-known surveyor for fire insurance risks in London writes us:—"Electricity is no longer the bogie it was, and I wish there had been more of it and less gas in Well-street on Friday afternoon last." This latest London blaze is, we are glad to record, directing attention to the quite remarkably backward condition of this great city in all matters relating to a complete and comprehensive fire alarm system and efficient means of dealing with huge conflagrations. It is not altogether out of place to point out at this moment that if fires occasionally are caused by fusing electric wires, the presence of other wires in the neighbourhood of the fire do not constitute a further serious cause for alarm, as in the case of gas pipes. It was, we learn, owing entirely to the bursting of the gas pipes that the fire in Well-street extended beyond the premises in which the fire originated. The disturbance to trade consequent upon the fire was not limited to the area of the conflagration, as owing to the breaking of the overhead telephone wires communication north of the City was interrupted for some time, causing much inconvenience. Which points to the urgent necessity for placing these wires underground. The fire was mentioned at the meeting of the London County Council on Tuesday, and Colonel Rotton, Chairman of the Fire Brigade Committee, said "an enormous amount of gas was consumed, and it was impossible to get at the mains to cut it off. That, of course, would have been avoided by the use of the electric light."

Fire.—A fire broke out in the National Telephone Company's stores in James-street, London, early on Wednesday morning. The fire was confined to the first floor, the contents of the other floors being only slightly damaged by water. The material burnt included a number of subscribers' sets and small wall-pattern switchboards.

Hornsey (London).—Mr. H. E. Kershaw contributes to the local papers a well-timed criticism on the opposition locally displayed to the proposed application of the District Council for a Provisional Electric Lighting Order. Mr. Kershaw points out that the objection that Hornsey is chiefly a residential district does not hold, as there are numerous towns and districts in the kingdom where the electric light under similar conditions has proved popular and successful, and he adduces the important testimony of Mr. Arthur Wright at Brighton that dwelling houses rank with the most profitable customers of the Brighton Corporation electricity works. But an example of successful working is, as Mr. Kershaw says, to be found much nearer home, as the adjoining district of Islington has a municipal installation which promises to be quite as successful as any in the kingdom. This should settle once and for all the opposition which the proposal of the Council has met with in certain directions.

Huyton.—The British Insulated Wire Company recently submitted terms to the Council for the supply of electric current in the district, and a special meeting has considered these terms. The Company offer to supply current at 6d. per unit, less a discount of 33 per cent. On the recommendation of the Lighting Committee it was decided to accept the terms offered.

Klondyke.—Already there is talk of lighting Dawson city electrically. Coal is said to be abundant in the neighbourhood and conveniently situated for mining. Water power is also, it is stated, available.

Newport.—The Town Council have received the sanction of the Local Government Board to borrow £35,665 for additions and extensions to the electric light plant and mains. In connection with the scheme for the extension of street lighting the consulting engineer (Mr. Robert Hammond) has been instructed to fix, test and report upon various types of arc lamps, viz., Davy, Electric Construction, General Electric, Brockie-Pell, Crompton-Pochin, and Brush lamps.

Northampton.—Major-General Scott, one of the Board of Trade arbitrators, again attended at the Town Hall last week for the purpose of further arbitrating on the dispute between the local Electric Light and Power and Gas Light and Coke Companies as to the position of the service pipes of the Gas Company in certain streets where the culverts of the Electric Light Company are to be placed. The interests of the Electric Light Company were looked after by Mr. E. M. Browne, solicitor and secretary, and Dr. Faulkner appeared for the respondent Gas Company. Evidence was given by Mr. R. E. B. Crompton and Mr. W. E. Heenan, the manager of the Electric Light Company, and by Mr. Eunson, the manager of the Gas Company. Decision reserved.

Nottingham.—A syndicate recently submitted an offer to the Corporation for the working of the existing tramways, the construction of new lines, and the working of the entire system by a combined system of electric and cable haulage, the cable system being adopted for the city routes. The syndicate required a lease of not less than 21 years, and they guaranteed to give a service varying from five to ten minutes on the town and suburban routes, and a two and a-half minute service from the Gregory Boulevard, *viâ* the Market Place, to Trent Bridge. They offered the Corporation 7½ per cent. per annum for the use of the roads, including rent, interest and sinking fund, upon the cost of construction of the routes up to £250,000, and further offered a proportion of the surplus net profits, after providing for reserves and sinking fund and the payment of 6 per cent. dividend upon the entire share capital of the Company. This offer has not, however, met with the approval of the Corporation, who are applying to Parliament for necessary powers to themselves carry out the work.

Portsmouth.—The Electric Lighting Committee have decided to appeal against the assessment of the electricity works. The Committee recently received a demand for income-tax on the £4,320 profit realised last year. It has been decided to resist the demand on the ground that the money belonged to a body of small ratepayers, this principle applying in the case of the Co-operative Society, which did not pay income-tax as it belonged to small proprietors.

The Electric Lighting Committee has decided to erect the new engine which was ordered some time ago for the electricity works. The parts of the machine have been at the station for some weeks, but owing to the engineering strike the makers had been unable to put them together. The Committee now take the work in hand, and employ the necessary labour. It is hoped the engine will be completed early in December, so as to be ready to meet the increased demands on the station at Christmas. The Committee will then be able to supply the numerous fresh customers who have been for some time past awaiting connection.

Redditch.—The District Council have decided to establish electricity supply works, and Mr. J. G. McMullen has been authorised to proceed with the preparation of plans and estimates. Already the Council have received promises to take electric current for the equivalent of over 2,000 16-c.p. incandescents.

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Reigate.—A communication from a firm of electric light engineers offering to establish and maintain electricity supply works at a fixed annual rental has been referred to the Electric Lighting Committee.

Shoreditch (London).—At the last meeting of the Vestry a debate took place on an application by the Hydraulic Power Company for leave to lay their mains in certain additional streets in the district. Mr. H. E. Kershaw, the able chairman of the Electricity Committee, in moving that the application be not acceded to, said that thousands of pounds were being taken out of the parish every year through a privilege granted in 1896, for which they received nothing in return. The Vestry was not then in a position to supply power, and consequently ought not to refuse ratepayers a necessity in the working of their businesses, but they could now supply electric current, and they had their own electric lifts working, as well as two or three others in the neighbourhood. When the current was 4½d. per unit, an electric lift cost £19 or £20 per annum, while £47 was the cost of a hydraulic lift under similar conditions and doing the same work. The charge at Shoreditch being only 2d. or 2½d. per unit for power, these figures could be reduced by half. Mr. W. H. Preece had, he said, given the cost of hydraulic lifts at the G.P.O. at £47, against £7 for electric power under similar conditions. Mr. Kershaw's motion was carried by a substantial majority.

Shrewsbury.—At a special meeting of the Town Council on Monday it was unanimously decided to apply to the Board of Trade for a Provisional Order, and for power to purchase the undertaking of the Shrewsbury Electric Lighting Company (Limited) for the sum of £21,500.

Taunton.—The Town Council have sealed the agreement with the National Free Wiring Company (Limited) for the "free wiring" of premises in the borough.

The Midland Light-Railway and Tramway Scheme.—A numerously-attended meeting of ratepayers, convened by the Rowley Regis District Council, was held at Old Hill on Monday to discuss the present position of the above scheme. A resolution was unanimously passed deprecating the attitude of the Dudley Corporation, and urging the Light-Railway Commissioners to sanction the proposed line to Cradley Heath and Old Hill. The Brierley Hill Council have decided to agree to the proposal to construct tramways in their district provided the British Electric Traction Company will erect and maintain an electric generating station within the district for the generation of electric current for working the tramways in the district.

The Strike.—There is little to report this week in connection with the strike and lock-out in the engineering trade. At a meeting early in the week the fourteen representatives of the masters and men respectively were selected and the names are as under :—

Federated Employers.

Colonel DYER (Messrs. Armstrong, Whitworth and Co., shipbuilders, machine gun manufacturers, and general engineers, Elswick and Manchester).

Sir BENJAMIN BROWN (Messrs. Hawthorn, Leslie, and Co. (Limited), Newcastle).

Sir BENJAMIN DOBSON (Messrs. Dobson and Barlow, engineers), Bolton).

Mr. C. E. ALLEN (Messrs. Workman, Clark and Co. (Limited), shipbuilders, engineers, and boilermakers, Belfast).

Mr. GEO. CLARK (Messrs. George Clark and Co. (Limited), marine engineers and boilermakers, Sunderland).

Mr. JOHN DONALDSON (Messrs. Thornycroft and Co. (Limited), shipbuilders and engineers, Chiswick).

Mr. W. H. ELLIS (Messrs. John Brown and Co. (Limited), steel and armour-plate manufacturers, Sheffield).

Mr. A. P. HENDERSON (Messrs. D. and W. Henderson and Co. (Limited), shipbuilders and marine engineers, Glasgow).

Mr. GEORGE JESSOPS (Messrs. Jessops and Appleby Bros. (Limited), engineers and boilermakers, Leicester).

Mr. J. HAWTHORN KITSON (Messrs. Kitson Bros. (Limited), locomotive engine makers and general engineers, Leeds).

Mr. JOHN LAIRD (Messrs. J. Laird and Co. (Limited), shipbuilders, Birkenhead).

Mr. S. R. PLATT (Messrs. Platt Bros. and Co. (Limited), machinists, Oldham).

Mr. R. SINCLAIR SCOTT (Messrs. Scott and Co., shipbuilders, Greenock).

Mr. ALEXANDER SIEMENS (Messrs. Siemens Bros. and Co., telegraph and electrical engineers, London).

Men's Representatives.

Mr. ALFRED SELLICKS (chairman of the Executive Council of the Amalgamated Society of Engineers).

Mr. GEORGE N. BARNES (general secretary of the Amalgamated Society of Engineers).

Mr. GEORGE FERGUSON (organising delegate of the Amalgamated Society of Engineers for Scotland).

Mr. FRANK ROSE (organising delegate of the Amalgamated Society of Engineers for the North-West Coast District).

Mr. JAMES RATCLIFFE (organising delegate of the Amalgamated Society of Engineers for the North-East Coast District).

Mr. JOHN WHITTAKER (organising delegate of the Amalgamated Society of Engineers for the Manchester, Oldham, Bolton, &c., districts).

Mr. ALFRED GOLIGHTLY.

Mr. ALBERT TAYLOR.

Mr. JAMES HODSON (Executive Council, Amalgamated Society of Engineers).

Mr. ALBERT BIGBY (Organising Delegate of the Amalgamated Society of Engineers for the London and South of England Districts).

Mr. JAMES SHEA (United Society of Smiths and Hammermen).

Mr. M. CRAVEN (London United Society of Brass Finishers, engineering section).

Mr. JAMES SWIFT (Steam Engine Makers' Society).

Councillor M. ARRANDALE, J.P. (United Machine Workers' Association).

The opening sitting of the full conference took place on Wednesday, when the 28 delegates met at 11 o'clock at the Westminster Palace Hotel, and proceeded to the discussion of the questions at issue, as set out in the "amended draft" of the Board of Trade. A report is to be prepared each evening for communication to the Press, that for the first sitting being to the effect that the opening subject for discussion was the question of the employers' freedom of management. Last evening the report of the second days' proceedings was to the effect that this subject was still under consideration by the Conference. Large sums of money have been received by the Amalgamated Society of Engineers during the week from all parts of the world. This is doubtless intended to strengthen the position of the men's representatives at the Conference, as it will certainly be urged that the appeal for £10,000 per week to continue the struggle has met with a ready response. Meanwhile several trade organisations associated with the engineering trades complain that their funds are being seriously depleted, the Boilermakers Society having already lost nearly £100,000 as a result of the dispute. The funds of the Ironfounders Society have been decreased by between £3,000 and £4,000, although only 21 members of the Society are on dispute pay.

The Telephone in Birmingham.—The telephone lines in this city are being placed underground, the mileage of wire being given as 14,965 miles laid in about 66 miles of cast-iron pipes. There are in addition 830 miles of overhead wire connecting the distributing poles, the Company's offices, and the outlying suburbs. When the reorganisation of the service is completed Birmingham will have, it is considered, as perfect a service as is possible.

The Telephone in Government Establishments.—For some time past telephonic communication between the various Government establishments in the western district has been worked under difficulties. A committee appointed by the Admiralty has recently made a survey of the existing system, and has now reported upon the alterations necessary to make the system efficient. The report states that, owing to the primitive manner in which several of the telephone circuits have been laid down, further troubles will ensue unless an absolutely new system is adopted. This can be done at a cost of about £6,000, either by the Post-Office staff or by the Director of Works (Admiralty Department). It has practically decided to make provision in next year's Navy Estimates for completing the work.

The Telephone in Manchester.—It is stated that the Royal Exchange, Manchester, has now the largest telephone call-box arrangement in the country. There are 22 call-boxes for trunk lines and nine for local communication. There are about 70,000 trunk line messages from the exchange annually.

Torquay.—The Bath Saloons and the Town Hall are being wired for the electric light by Messrs. Massingham and Mann.

Tower Bridge.—It has been decided to light the new southern approach to the Tower Bridge by electricity.

Walsall.—The Board of Guardians are inquiring as to the cost of lighting the workhouse electrically.

Wolverhampton.—The Corporation's electric lighting undertaking makes satisfactory progress. On the 31st ult. there was an equivalent of 12,248 8-c.p. lamps (representing 187 customers) connected, an increase of 28 per cent. over Oct., 1896.

Dinner.—We are informed by Mr. G. Braulik that Messrs. Korting and Mathiesen, whom he represents in London, gave a dinner at Leipzig on Friday last to several hundred of their employés to celebrate the sale of the 50,000th arc lamp manufactured by the firm.

BOOKS RECEIVED.

"Steam Boilers Constructed by Messrs. Yates and Thom.' Written and compiled by William H. Fowler. Price 5s.

"Sixth Report of the Bureau of Mines, 1896." Printed by order of the Legislative Assembly of Ontario. (Toronto : Warwick Bros. and Rutter.)

"The *Mechanical World* Pocket Diary and Year-Book for 1898." (Manchester : Emmott and Co., Limited. Price 6d.)

"Official Gazette of the United States Patent Office." Nos. 10, 11, 12 and 13, Vol. LXXX.; and Nos. 1 and 2, Vol. LXXXI. (Washington : Government Printing House.)

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

October 22, 1897.

21,441. H. NUNNS and E. SYKES. Halifax. Improvements in electric switches.

21,470. J. SHIPP and THE TELEGRAPH MANUFACTURING COMPANY (LIMITED). Warrington. Improvements in joint boxes for electric cables.

24,496. V. LORENC and V. LORENC. London. Improvements in or relating to electric generators or motors.

24,519. P. DAWSON. London. Improvements in the construction of overhead lines of electric railways or tramways.

24,520. P. DAWSON. London. Improvements in overhead lines of electric railways or tramways.

24,521. P. DAWSON. London. An improved frog for overhead conductors or trolleys of electric railways or tramways.

24,522. P. DAWSON. London. Improvements in overhead lines of electric tramways or railways.

24,531. I. LANDAUER. London. An improved process of producing impressions or prints by the aid of electrolysis.

October 23, 1897.

24,591. A. HEIL. London. Improvements in galvanic cells.

October 25, 1897.

24,665. H. WIGGIN AND CO. (LIMITED) and G. A. BOEDDICKER. London. Improvements in anodes and in the electro-deposition of nickel and other metals.

24,669. C. MCCANN. London. Improvements in electric bells or gongs.

October 26, 1897.

24,715. P. H. EMANUEL. Southsea. The improved universal electric lamp for cycles and other vehicles, military and other field work.

24,723. W. G. KIDD. Leith, N.B. Pneumatic electric system of communication between railway passengers and guards or other railway servants.

24,754. G. HOOKHAM. London. Improvements in electricity meters.

24,782. STEPHENS, SMITH AND CO. (LIMITED) and J. STEPHENS, Junr. Improvements in and connected with electric arc lamps.

24,792. D. LYNCH. London. Telegraphic transmitter for ocean cables.

24,829. S. SIMPSON. London. Improvements in coin-freed mechanism applicable to gas, electricity, and the like meters.

24,833. J. ROUTIN and C. E. L. BROWN. London. Improvements in and relating to electricity meters.

October 27, 1897.

24,854. H. J. SPENCER and W. FENNELL. London. Improvements in electric arc lamps and other mechanisms.

24,884. A. F. HARRIS. Birmingham. Improvements in electro-deposition apparatus.

24,913. H. J. SPENCER. London. Improvements in connection with electric traction systems.

24,925. E. GIGLIO. Liverpool. Improvements in primary batteries.

October 28, 1897.

24,950. A. C. BROWN. London. Improvements in circuit arrangements for wireless telegraphy.

24,958. C. W. G. LITTLE. London. Improvements in electric tramway and electric transmission of power systems.

October 29, 1897.

25,061. H. H. TURNER, A. TURNER, A TURNER and G. S. AVEYARD. Manchester. Improvements in switches for motors.

25,141. F. DEIMEL, J. LEHMANN and A. SYLTEN. London. A decorative reflector for incandescent electric lamps.

25,151. M. MARGOWSKI. London. An improved system of automatic telephone exchange. (G. Seligmann-Lui, France.)

October 30, 1897.

25,205. G. POORE. London. Improvements in coin-freed electric shock machines.*

25,210. M. RÖHSER. Halifax. Improvements in the method of and means for transmitting electric currents in tramways.*

25,212. J. IMRAY. London. Improvements in grapples for submarine cables. (La Société Industrielle des Telephones, France.)

25,235. The HON. R. T. D. BROUGHAM. London. A roller-bearing locking or under-carriage applicable especially to electrical and other motor vehicles.

25,243. N. STANILAND and O. P. MACFARLANE. London. Improvements in controlling the supply of electric energy and in apparatus therefor applicable, more especially for varying the power or brilliancy of electric lamps.

25,244. P. MERSCH. London. An improved arc lamp. (Date applied for under Patents, &c., Act, 1883, Sec. 103, October 11, 1897, being date of application in France.)

25,245. H. H. LAKE, London. An improved method of varying the speed of electric motors or the electromotive force of dynamo-electric machines. (E. Cantono, Italy.)

25,246. H. VON DER LINDE. London. A process for the electrolytic separation of metals.

November 1, 1897.

25,299. A. J. V. RAPKIN, R. H. D. RAPKIN, and A. D. WILSON. London. Improvements in electrical rain gauges.

25,302. W. JUDD. Surbiton. Improvements in electrical conductors.

25,307. V. A. FYNN. London. Improvements in or connected with drum armatures for dynamo electric generators and motors.*

25,335. M. T. MAKIN, J. LEE, and S. KNOTT. Manchester. Improvements in electric stop motions for drawing frames used in the preparation of cotton and other fibres for spinning.

November 2, 1897.

25,364. V. G. LIRONI. Sheffield. Improvements in electric switches.

25,369. W. G. HEYS. Manchester. Improvements in electromagnetic circuit breakers. (D. C. Spruance and M. Waddell, United States.)*

25,386. H. K. HESS. London. Improvements in chemical-electric generators.*

25,388. L. PARVILLÉE. London. Improved compositions for use in the construction of electrical heating apparatus and resistances, and the processes for their manufacture.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price o 8d. each.

1896.

26,249. DOWSING. Electrical heating apparatus.

26,303. WISE (Aktiebolaget de Lavals Augturbin). Dynamo-electric machines.

28,193. SANDER AND CLIFFORD. Caps for incandescent electric lamps.

30,113. PIEPÉR FILS. Means for varying the speed of electric direct-current motors.

26,427. BRYMER AND TODD. Electrical switches.

26,627. BELFIELD (Lamme and Mershon). Alternating-current systems of distribution and regulation.

26,774. EDMUNDS. Conduit pipes for electric conductors.

26,965. BOARDMAN. Means or apparatus for use in electrically lighting incandescent and other gas burners.

27,446. CROMPTON. Electrical resistances.

NEW COMPANIES, STATUTORY RETURNS, &c.

T. COOKE AND SONS (LIMITED).—This Company was registered on Nov. 17, with a capital of £70,000, in £10 shares, to acquire the business carried on at York, and Victoria street, London, under the style of T. Cooke and Sons, and to carry on the business of engineers, optical and scientific instrument makers, electricians, electrical engineers, &c.

ELECTRIC STEAM SYNDICATE (LIMITED).—This Company was registered on Nov. 17, with a capital of £25,000, in £1 shares, to carry on the business of manufacturers of and dealers in apparatus for producing and for superheating steam by means of electricity. The subscribers are: W. Weston, C. R. Sims, W. T. Lineham, J. Chinn, C. Cropper, D. W. Ackery and W. J. Treleaven.

HEATH, SNOXELL AND COMPANY (LIMITED).—This Company was registered on Nov. 18 with a capital of £10,000 in £1 shares, to acquire the business of an electrical engineer carried on by William H. Heath at Birmingham, under the style of W. H. Heath and Co., and to carry on the business of mechanical, electrical, scientific and general engineers, electricians, designers, illuminating contractors, iron and steel workers, &c. The first subscribers are: William H. Heath, electrical engineer; G. E. Snoxell, engineer; W. K. Heath, electro-plater; C. H. Fisher; A. C. Jaques; G. W. Elcock; J. J. Ogley, and C. Richards. The first Directors are: William H. Heath, G. E. Snoxell, and C. H. Fisher.

ROSE AND BIRD (LIMITED).—This Company was registered on Nov. 20, with a capital of £10,000, in £1 shares, to enter into an agreement with Rose and Bird (Limited), and Mr. Christopher Walker, its liquidator, and to carry on the business of electricians, mechanical engineers, and manufacturers of and dealers in all apparatus, appliances (including all glass and chemical work) and things required for and capable of being used in connection with the generation, distribution, supply, accumulation and employment of electricity. The first subscribers are: Thomas A. Rose and Alfred H. Rose, electrical engineers, G. Battinson, H. W. Shadwell, E. H. Jones, G. E. Webb and V. Radcliffe. The first Directors are: Alfred R. Harvey, James Chadburne, George Battinson, Thomas A. Rose, Christopher Walker and Alfred H. Rose (Managing).

WOODLANDS ELECTRIC COMPANY (LIMITED).—This Company was registered on Nov. 16 with a capital of £1,000, in £1 shares, to carry on the business of electrical engineers, fitters and metal workers, and to buy, sell, manufacture and deal in electrical and other machinery. The subscribers are: Robert Hope-Jones, electrician, J. G. Jones, A. E. Woodland, scientific instrument maker, J. E. Hird, A. Foxworthy, W. M. Jones, and J. H. Nuttall.

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ELECTRICAL COAL-CUTTING CONTRACT CORPORATION (LIMITED).—The annual return to Nov. 16 has just been filed. The capital is £402,000 divided into 60,000 Ordinary and 20,000 Deferred shares, of £5 each, and 2,000 Founders' shares of £1 each. 9,531 Ordinary, all the Deferred, and all the Founders' shares have been taken up, and 4,000 Ordinary and the Deferred shares have been issued as fully paid. £5 per share has been called on 5 531 Ordinary, and £1 per share on the Founders'.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 27½d. per oz. (Nov. 25). Consols (2¾ per cent.) $113\frac{3}{16}$—$113\frac{5}{16}$ for money, $113\frac{5}{16}$—$113\frac{7}{16}$ for account; 2½ per cent. 105⅝—106¼ (Nov. 25). Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Days, Dec. 13 and 28; Ticket Days, Dec. 14 and 29; Pay Days, Nov. 26 and Dec. 15; Mining Share Carry-over Days, Dec. 11 and 24.

ALLGEMEINE ELECTRICITATS GESELLSCHAFT.—The capital of this Company is to be increased from 35,000,000 to 47,000,000 marks.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended Sept. 30 last, payable on the 21st prox. The transfer books will be closed from the 14th to the 20th prox. inclusive.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The Directors of this Company have decided to make a further issue of 10,000 Ordinary shares at the price of £18 per £10 share, and to give to all holders of the existing 50,000 fully paid Ordinary shares the right to apply for the new issue in the proportion of one share for every five old shares.

DINGWALL AND STRATHPEFFER ELECTRIC LIGHTING COMPANY.—A meeting of the Provisional Committee of this Company was held last week under the presidency of Sir W. J. Scatwell, when the preliminary details connected with the scheme for the electric lighting of Dingwall and Strathpeffer were discussed. The capital of the Company has been fixed at £12,000, the first issue not to exceed £10,000. Mr. R. F. Yorke, of Glasgow, is consulting electrical engineer.

DIRECT WEST INDIA CABLE COMPANY (LIMITED).—This Company notifies that the scrip of the £120,000 Four and a-Half per Cent. Debentures is now ready for delivery in exchange for letters of allotment.

EASTERN TELEGRAPH COMPANY (LIMITED).—Legal notice is given that application is intended to be made to Parliament next session by this Company for leave to bring in a Bill authorising the conversion and consolidation of Preference shares into Preference stock with a cumulative dividend, the creation and vesting of converted Preference shares in holders of existing Preference shares, the surrender and cancellation of existing certificates and issue of new certificates in exchange, further money powers, powers to trustees and others, provisions as to transfer and transmission of shares and stock, and amendment, alteration, or repeal of memorandum and articles of association.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—This Company will shortly issue £190,000 Four per Cent. Perpetual First Mortgage Debenture stock, to redeem £150,000 of Six per Cent. First Mortgage and £40,000 of Six per Cent. Second Mortgage Debentures, thus effecting a saving of £3,800 per annum. The exchange is to be made on Jan. 15th next, and for every £100 debenture the Company will give £100 of Debenture stock and £3 in cash, besides the interest due. The Company have commenced making further extensive additions and alterations to their large works at Bushbury. Mr. H. Gough, of Wolverhampton, has secured the contract for the extension works. Between 700 and 800 hands are now regularly employed at the works, which number will be raised to 1,000 when the extensions are completed.

ELECTRO-CHEMICAL COMPANY (LIMITED).—The annual general meeting of this Company was held last week at St. Helens. The Chairman (Colonel Holland, C.B.) stated that though the commencement of their business had been impeded owing to the inefficiency of the first machinery supplied, they now had excellent engines and dynamos, and good working plant, giving the best possible results. The machinery, amounting to 3,500 H.P., was in position, and arrangements had been made for a further 1,600 H.P. They were now turning out in considerable quantities by their electrolytic process excellent 70 per cent. caustic soda, and bleach ranging from 37·5 per cent. to 38 per cent., as well as the purest chlorate of potash, 99·8 per cent., all of the highest quality that could be made in the kingdom, at a cost for manufacture that left them a fair margin for profit. The business generally was being carried on profitably, and there was a ready sale for all their products at good prices. The Company had sold its Japan patent for £6,000, half of which amount had already been received in cash, and the balance was payable in January. They had also sold their French, Belgian and Russian patents for £37,000, and arrangements were being made for the sale of other foreign patents.

GATESHEAD AND DISTRICT TRAMWAYS COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company will be held on Dec. 9 for the purpose of considering a proposal for the adoption of electric traction on the Company's lines. Negotiations have been proceeding for some time past between the Directors of the Company and the British Electric Traction Company, and an agreement has been entered into between the respective Companies by which, subject to certain formalities being complied with, the British Company will purchase the existing shares of the Gateshead Company at the price of £4. 15s. each; but unless three-fourths of the shares are so purchased within a specified time, this Company is to sell to the British Company the whole of its undertaking for such a sum as (after discharging liabilities) will leave the shareholders £4. 15s. per share. The shareholders will have the option to receive the amount in 6 per cent. Preference shares at par, either in the Company or in some other company which may be formed to acquire its undertaking. In the event of the proposal being approved, considerable extensions of the lines will be carried out.

IMPERIAL TRAMWAYS COMPANY (LIMITED).—The shareholders of this Company have confirmed the resolution recently passed increasing the capital of the Company. At the meeting the Chairman said that the Company's lines in Stockton and Thornaby were near completion, and a start with the track would be made at Middlesbro' forthwith. The building of the power station at Middlesbro', where the local authorities were helping the Company in every possible way, was well in hand, and the Directors thought that the whole of the lines would be opened in April next.

NEW GERMAN FINANCIAL COMPANIES.—A new company for the erection of electric light and power works has been formed in connection with Messrs. Siemens and Halske, the Deutsche Bank and the Banque de Paris et des Pays-Bas. The capital will be 30 million marks in shares and a similar amount in 4 per cent. obligations.—We hear also that it is intended to form a similar Company in connection with the Allgemeine Elektricitäts-Gesellschaft.

RIVER PLATE ELECTRIC LIGHT AND TRACTION COMPANY (LIMITED).—Messrs. G. von Chauvin and W. T. Western have joined the Board of this Company, and the former gentleman has been elected chairman.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to £125,000 Five per Cent. Debentures of the Amazon Telegraph Company (Limited), and 20,000 Six per Cent. Cumulative Preference shares (Nos. 34,001 to 54,000) of the New General Traction Company (Limited).

SULPHIDE CORPORATION (ASHCROFT'S PROCESS), LIMITED.—A cable has been received from the Local Board in Australia announcing that the electrolytic works re-started on the 16th inst. under the direct supervision of Mr. Ashcroft. Although in the period between March 29 and the end of July, during which work was carried on with some interruptions, 150 tons of zinc of the highest quality were produced, the results were commercially unprofitable. It is stated that Mr. Ashcroft attributes this to remedial defects in the plant, and the board have sanctioned a further run for a period not exceeding three months, with such modifications of the plant as have now been effected in accordance with Mr. Ashcroft's suggestions.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Nov. 19 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited) were £3,069.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half-month ended Nov. 15 is £2,093, against £2,346 in the corresponding period of 1896.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Nov. 20	3,609	+507	...	...	...
Bristol Trams & Carriage	„ 19	2,554	+681	20	53,626	+7,967
City & South London Ry.	„ 21	1,063	+ 46	21	19,724	− 118
Dover Tramways	„ 20	99	...	11	1,338	...
Dublin United (Southern)	„ 19	381	− 31	20	13,550	− 586
Liverpool Overhead Rly.	„ 21	1,326	+143	21	30,039	+4,046
Sheffield Tramways	„ 21	977	+130	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Nov. 17.		Price Wednesday, Nov. 24.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 20. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.					£ s. d.			
£19,125	£10	3/0	Central London Ordinary	9¾	10¼	9¾	10¼	2 17 2	June and December	9¾	..
143,100	10	1/3	Do. (6s paid)	5¼	5¾	5¼	6	3 0 0	„ „	5¾	6
£600,000	Stock	2	City and South London Railway Con. Ordy.	69	71	69	71	2 12 10	January and July	70½	69¾
3,419	£10	5%	Do. 5% Perpetual Preference	15½	15¾	15½	16	3 2 6	„ „	15¾	..
£'95,700	Stock	4%	Do. 4% Perpetual Debenture	138	140	138	140	2 17 2	May and November	..	..
54,000	10	2/8½	Waterloo and City Ordinary	12¼	13	12½	13	2 6 1	June and December	13¼	12½
37,500	10	3	Liverpool Overhead Railway Ordinary	11⅞	11¾	12½	12⅝	2 7 6	February & August	..	..
10,000	10	5%	Do. 5% Preference	16	16½	16	16½	3 0 7	„ „	..	..
125,000	Stock	4%	Do. 4% Debenture	110	112	110	112	3 11 5	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 17.	Price Wednesday, Nov. 24.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 20. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£923,960	Stock	14/0	Anglo-American	58 60	58 60	4 12 6	Feb., May, Aug., Nov.	58	..
£3,038,020	Stock	23 0	Do. Preferred	104 105	104 105	5 6 6	" "	105½	104
£3,038,020	Stock	5/0	Do. Deferred	12½ 12¾	12¾ 13	..	..	12 15/16	12½
£ 37,400	£100	4%	*African Direct Telegraph (Red)	101 105	101 105	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	5½ 6½	5½ 6½	..	..	5/16	5½
130,000	10	5/0	Brazilian Submarine	16 16½	16 16½	4 4 10	Mar., June, Oct., Dec.	16 1/16	16¼
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	114 118	114 118	4 5 10	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	182 187	182 187	4 6 2	Jan., Apr., July, Oct.	..	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105 107	105 107	3 14 9	" "	106½	106¾
16,000	10	8/0	Cuba Submarine	8½ 9½	8½ 9½	8 8 5	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18½ 19½	18½ 19½	5 2 7	" "	..	..
12,981	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103% 106%	103% 106%	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10 10½	10 10½	5 14 3	Jan., Apr., July, Oct.	10½	10⅝
400,000	£10	2/6	Eastern	17 17½	17 17½	3 14 4	" "	17½	17
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18 19	18 19	3 3 8	" "	18⅜	18½
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131 134	132 133	3 0 2	May and November	133	131
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101 104	101 104	4 14 9	February & August	..	..
250,000	10	2/6	Eastern Extension	18 18½	18¼ 18¾	3 17 9	Jan., Apr., July, Oct.	18 5/16	18 5/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	131 134	131 134	3 0 0	February & August	132½	131½
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	100 104	100 104	4 17 4	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	100 104	100 104	4 17 4	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103 106	103 103	3 15 8	February & August	105¾	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108% 111%	108% 111%	3 12 1	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	11½ 12	11½ 12	3 15 0	Jan., Apr., July, Oct.	11⅞	11⅝
180,042	10	6%	Do. 6 per Cent. Preference	17 17½	17¼ 17¾	3 7 7	" "	17½	17½
150,000	10	5/0	Great Northern of Copenhagen	26 27	26 27	3 14 1	January, April, July	..	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	103 105	102 105	4 15 3	March & September	..	..
17,000	25	12/8	Indo-European	52 55	52 55	4 10 11	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	107 110	107 110	5 9 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	107 110	107 110	3 13 5	June and December	..	..
11,889	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	136 141	136 141	4 5 1	" "	139	137
15,609	10	6/0	West African Telegraph	4½ 5½	4½ 5½	5 0 0	..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103 106	103 106	4 14 4	March & September	..	..
30,000	10	2/0	West Coast of America	⅜ 1½	⅜ 1½	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	106 103	106 108	3 14 10	June and December	..	..
88,321	10	1/0	West India and Panama	⅝ ⅝ xd	⅝ ⅝	..	May and November	15/16	15/16
34,563	10	6/0	Do. 6 per Cent. 1st Preference	8½ 8¾ xd	7¾ 8¼	7 5 5	" "	8¼	8¼
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5 7 xd	5 7	8 11 5	" "	6¼	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107 110	107 110	4 12 2	January and July	108⅜	..
64,256	15	3/0	Western and Brazilian	9½ 9¾	9½ 9¾	3 1 6	May and November	9¼	9 5/16
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7⅜ 8	7⅜ 8	3 15 0	" "	7⅝	7½
33,129	7½	1/6	Do. Deferred Ordinary	2¼ 2⅜	2¼ 2⅜	..	" "	2⅜	..
£382,250	..	4%	Do. 4 per Cent. Debenture Stock	106 109	105 109	3 14 1	June and December	106½	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	103 107	103 107	6 10 10	Feb., May, Aug., Nov.	..	..
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	..	..
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	3½ 3¾	3½ 3¾	5 6 8	August	..	..
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1 1/16	15/16	..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2 2½	2 2½	8 0 0	October	..	..
484,597	5	3/0	National	6½ 6¾	6½ 6¾	4 12 4	February & August	6 5/16	6¼
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15 17	15 17	3 10 7	" "	15 1/16	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14 16	14 16	3 15 0	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6 6½	6 6½	3 16 11	" "	6 1/16	..
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104 109	104 109	3 5 0	June and December	106	..
171,504	1	0/4	Oriental	1/16 1/8	1/16 1/8	4 2 4	April and October	..	..
58,000	5	5/0	United River Plate	3¾ 4¼	3¾ 4¼	5 17 8	July	..	..
£146,733	Stock	6%	* Do. 5 per Cent. Debenture Stock (red.)	102 107	102 107	4 14 4	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.						
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	12	11¼	..	March	..	..
£50,000	5	..	Do. (New Issue) £3. 10s. paid	..	..	..	..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	27½ 28½	27 28	2 10 0	February & August	27⅞	27½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17 18	17 18	3 6 8	January and July	17⅝	..
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131 134	131 136	3 14 3	June and December	132½	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12 13	12 13	2 0 0	February & August	12 13/16	12½
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6 6½	3 6 8	" "	6¼	6 1/16
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	.. ..	.. ..	..	January and July	..	..
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	10¼ 10¾	10¼ 10¾	3 9 9	March	10 5/16	10⅜
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	111 114	113 116	3 14 7	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	13¼ 13⅝	13⅝ 14¼	..	..	14¼	13½
20,000	£10	6/0	Do. 6% Cumulative Preference	15¼ 15½	15½ 15⅝	3 16 2	March & September	15 1/16	15⅛
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9¼ 9½	9⅜ 9¾	..	..	9⅜	9⅜
10,000	£5	7%	Do. 7 per Cent. Preference	11 11½	11 11½	3 0 11	March & September	11½	..
111,000	£5	..	London Electric Supply Ordinary	2⅛ 2⅜	2⅛ 2⅜	..	..	..	..
48,050	£5	..	Do. Preference	5⅜ 5⅝	5⅜ 6⅛	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	17½ 18¼	18⅜ 19½	2 16 5	April and October	18 1/16	18
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	17¼ 18½	18 19	..	" "	18 5/16	18½
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119 123	119 123	3 13 6	June and December	..	..
6,452	10	8/0	Notting Hill Electric Ordinary	15½ 16½	16½ 17½	2 5 9	March	16¾	16½
275,000	1	..	Rand Electric	1⅜ 1⅝	1⅜ 1¾	..	..	..	..
£125,000	Stock	..	River Plate Elec. Lt. Trct'n, Ltd., 5% 1st Mor. Deb.	93 98	93 98	..	..	..	..
150,000	$100	..	Royal Electric Company of Montreal Shares	148 150	148 150	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	104 106	104 103	4 5 4	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	16½ 17½	16½ 17½	3 5 9	February & August	17½	16¾
20,000	5	3/6	Do. 7 per Cent. Preference	9½ 10½	10 11½	3 3 6	" "	10 1/16	10½
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	103 106	103 106	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	14½ 15½	15 16	3 2 6	March & September	15	14½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	£3	1/6	Brush Electrical Engineering	1⅛ 1⅜	1⅛ 1⅜	..	..	1⅛	1⅛
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	1⅜ 2⅛	2⅛ 2⅜	..	..	2	..
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	107 111	107 111	4 1 8	February & August	..	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	98 102	98 102	4 9 7	June and December	101	..
10,000	£10	..	British Aluminium Ordinary	.. ..	.. ..	..	..	..	..
20,000	10	..	Do. 7% Cumulative Preference	.. ..	.. ..	..	..	..	..
£100,000	£5	int. 4/0	Callender's Cable Construction, Limited, Shares	7 8	7 8	6 5 0	June and December	..	..
£90,000	Stock	4½	Do. 4½% Mort. Deb. Stock	108 113	103 113	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½ 1¾	1½ 1⅝	..	..	1½	1 7/16
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1½ 2	1½ 2½	..	..	..	..
£52,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	89 94	89 94	5 6 5	January and July	..	..
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 2¾	2½ 2¾	6 0 0	February & August	2½	..
17,139	5	2/9½	Do. (£5 paid)	4 5	4 5	5 10 0	" "	..	..
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101 103	101 103	3 17 8	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2 2¼	2⅝ 2⅞	4 1 6	February & August	2 1/16	2⅛
16,313	2	7%	Do. 7 per Cent. Cumulative Pref.	3½ 3⅝	3½ 3⅝	4 3 4	August	3½	3 5/16
91,196	1	10/0	Elmore's Patent Copper Depositing	⅜ ⅝	⅜ ⅝	..	..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	20 21	20 21	4 15 3	February & August	20½	19⅝
3,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 12 0	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 10	" "	114	..
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	21½ 22½	22 23	4 6 11	" "	22¼	21⅞
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103 107	103 107	3 14 9	March & September	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	36 39	36 39	4 12 4	March and July	37⅜	37
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102 105	102 105	4 15 3	January and July	..	..
£22,500	£5	3/6	Willans and Robinson Ordinary	8½ 8¾	8 8½	4 2 4	April and October	..	..
£22,500	£5	3/0	Do. 6% Cumulative Preference	7½ 7¾	7 7½	4 0 0	" "	7⅛	7⅛
£100,000	Stock	36/7	Do. 4½% First Mort. Debs.	106 108	106 108	4 4 1	May and November	107¼	..

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THE ELECTRICIAN:

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NOTES.

We have already referred in these columns to the unfortunate differences that have arisen between the Commission of Sewers, the Post Office, and the National Telephone Company with regard to the placing of telephone wires underground in the City. A volume of over 100 pages is now before us, containing the minutes of the meetings of the former body and its Streets Committee, and the correspondence that has passed on the subject. The facts of the case are briefly these: the National Telephone Company have from time to time applied to the Commission of Sewers for leave to run their telephone wires underground in various parts of the City. Unless the Company are prepared "to make any concession for the public benefit," or, in other words, to reduce their rates to subscribers, the Commissioners refuse to grant the necessary "easements." The Company found a temporary way out of their difficulty by renting wires for some of their inter-exchange lines from the Post Office. The Commissioners resented this, and, on the Post Office subsequently asking leave to break open the streets to lay pipes for new wires, consented to grant the permission only on the Post Office undertaking not to rent these pipes to the National Company. Refusing to accept any restrictions, the Post Office deemed that a difference had arisen under the Telegraphs Act of 1878, and took steps to have the matter heard by a judge of the City of London Court. The case—a full report of which will be found in another column—was heard on Wednesday, and the result, as might have been expected, was that consent should be regarded as given and the condition set aside. Had the refusal been upheld in this Court, the Postmaster-General would still have had the right of appeal to the Railway Commissioners. In the meantime the Commission of Sewers have sent a copy of this summary of the minutes and correspondence to every municipality in the United Kingdom, and to all the vestries and district boards in the metropolis, and are soliciting their co-operation in this campaign against the telephone company.

It is under a clause of the agreement entered into between the Postmaster-General and the National Company on taking over the trunk lines in 1895 that the rental of underground lines is allowed for. The clause in question runs: "So long as this indenture is in force the Postmaster-General will in any case so far as it is practical so to do (but not otherwise) at the request of the Company, and upon such terms as may from time to time be agreed upon between the Postmaster-General and the Company, connect by means of underground wires any two or more exchanges of the Company situate in one and the same exchange area." Why the Post Office consented to insert this clause in the agreement is not apparent. It is evident that the National Company foresaw a difficulty like the present one; but yet the clause only enables them to get inter-exchange lines laid for them by the Post Office, and does not assist them in the case of underground lines to subscribers.

The present situation of things telephonic is to be regretted for several reasons. It is a matter for regret that the steady improvement which has been developing in the London telephone system during the last few years should be impeded at a critical moment. It is, as we have pointed out before, unseemly that a Government Department should place itself at the disposal of an industrial company. And, finally, it is to be regretted that the whole telephone system of the country is not entirely in the hands of the Government, although perhaps the present arrangement, by which the Post Office receives a share of the gross receipts as royalty, may be the more remunerative.

We have from time to time referred to an ingenious process, the invention of Prof. Serullas, for the extraction of gutta-percha from the leaves of the *isonandra gutta*. The advantage of this method over the usual process lies not

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merely in the salvation of the trees, which, it will be remembered, it has been the practice formerly to ruthlessly bleed first, and in many cases to cut down in order to obtain the gutta-percha—there would appear, from the expert reports, to be the further advantage of an improved quality of material. Prof. RAMSAY, after exhaustive chemical tests, declares that the Serullas gutta-percha "is of exceptional quality"; Lord KELVIN, having made equally exhaustive electrical tests, states that "the results were very remarkably satisfactory in respect to the value of the gutta-percha for submarine cables," and finds that with the Serullas dielectric 10 per cent. increase in speed of signalling is rendered possible. Dr. JOHN HOPKINSON confirms Lord KELVIN's favourable opinion, his tests having shown that the material possesses "exceedingly good insulating property, higher than is usually given for gutta-percha in the text-books," while the specific inductive capacity is lower. None of these tests, of course, guarantee the *commercial* value of the process. But, as will be seen in our City Notes, the Serullas process is about to be further developed on a large scale.

MR. RAWORTH, in a letter we publish this week, expresses disagreement with the opinions put forth in our leading article of November 19th. We stated that, failing storage batteries, an electric traction steam engine requires flywheel capacity; Mr. RAWORTH says that it does not, and that a flywheel is positively harmful. Flywheels undoubtedly burst sometimes, and in America great damage has been done by the pernicious habit they have of flying to pieces; but it is not proven that the tendency is due to their being of unusual weight. An exceptionally heavy wheel is neither more nor less liable to burst than one of moderate mass, if both are equally well made. American flywheels burst because they are run at too high a peripheral speed—a condition which, in combination with a sudden short circuit on the dynamo, will burst any ordinary wheel, light or heavy.

SHORT circuits on electric traction mains are not always due to any defect in the electrical connections. Several cars starting at the same time will impose what is practically a short circuit, and will sometimes throw off the automatic switch. The energy absorbed by a so-called "short" is often therefore of a useful kind, and if the engine is unable to supply the requisite extra power flywheel storage must be resorted to. We do not contend that a short circuit subjects the engine to greater strain than usual, nor will a well-designed engine and dynamo be injuriously strained by the flywheel if the plant is properly proportioned. Although the start of a car is primarily a demand for *force* rather than for horse-power, yet, since the force cannot be increased without an increase in current, and since the voltage must be kept fairly constant, the extra force required really implies extra horse-power. We have never yet come across an automatic expansion governor that could so promptly respond to a 150 to 200 per cent. overload, due to several cars starting at once, as to render the equalising energy of a flywheel superfluous.

As regards the effect of variation of line voltage on the running of the cars, it is surely as unwise as it is novel to preach that steady line-pressure is unnecessary. Yet if it be not required for keeping the cars steady, for what other purpose is it provided? We have travelled over many thousands of miles of electric tramways, and it is impossible to convince us that there is not a very perceptible difference between running on steady voltage and running with the line-pressure subject to large and rapid variation. The difference is noticeable even on the level, but it is more pronounced, of course, when ascending a steep gradient. Even such variations in the effective pressure as will arise from defective bonding or bad grounding of a section of the line are sometimes detectable as a car enters or leaves it. If the gospel of "no flywheel!" is to be gauged by the individual tenet in it that steady line-pressure is not essential to satisfactory running, it is not a gospel that promises to make many converts.

THE opinion has sometimes been expressed that while accumulators may do very well in electric cabs they will probably do badly in omnibuses, and still worse in tramcars. The trolley and the conduit systems are formidable rivals as regards traction on rails, but they do not apply to traction on common roads—unless, indeed, the latest American idea be carried into practice, to provide country lanes and town streets with trolley wires and every cart and carriage with a trolley arm and wheel. But really we do not see wherein the insuperable obstacle to the electric omnibus lies. Have the latest patterns of cells, motors and regulating gear had a fair commercial trial? There was formed not long ago a London Electric Omnibus Company, and Londoners used sometimes to see *an* electric omnibus. It is alleged that the Directors of that concern laid claim to "a bonus on the profits," and this being of problematical value they also allowed themselves £3,000 a year, while they paid their engineer £1,200 a year. We wonder when the commercial feasibility of the electric omnibus will be seriously put to the test.

Erratum.—On page 150 of our last issue, instead of the last two words "true ohms," at the bottom of the first column, read, "cm."

Royal Patronage of the Electric Cab.—It is stated that H.R.H. the Prince of Wales patronised the electric cabs in London recently by riding in one of them accompanied by an equerry. This should ensure the popularity of these useful vehicles.

Telegraphic Communication with the Philippines. — The Eastern Extension Telegraph Company notify that the Company's cable system from Manila has now been extended to the Island of Panay (Iloilo), Negros and Lebu, and that telegrams can now be accepted for direct transmission to these places.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Otranto—Vallona	Oct. 11, 1897	—
Paramaribo—Cayenne	Oct. 25, 1897	Dec. 2, 1897
San Thomé—Loanda	Nov. 8, 1897	Nov. 29, 1897
Pernambuco—Ceara	Nov. 22, 1897	—
Emden—Vigo	Nov. 28, 1897	—

The Jungfrau Railway.—The *Elecktrotechnischer Anzeiger* hears that a portion of the generating plant at Lauterbrunnen,

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representing the first 1,200 H.P., will be running in a few days, in order to supply electrical power for boring the tunnels at the Eiger Glacier. The conductor from the turbine-house to the Scheidegg station and Eiger Glacier, a distance of 6¼ miles, is complete. The permanent way from the Scheidegg to the Eiger Glacier (which includes only 90 yards of tunnel) is also practically finished, and trains will commence running on this line before the end of June.

The Royal Society.—The anniversary meeting and dinner of the Royal Society took place on Tuesday last, the business meeting being held at Burlington House, and the banquet at the Hôtel Métropole. The following is a list of officers and council elected for the ensuing year:—President, Lord Lister; Treasurer, Sir John Evans; Secretaries, Prof. Michael Foster, Prof. Arthur William Rücker. Foreign Secretary, Sir Edward Frankland. Other members of the Council: Prof. William Grylls Adams, Prof. Thomas Clifford Allbutt, Sir Robert Stawell Ball, Rev. Thomas George Bonney, Prof. John Cleland, Prof. Robert Bellamy Clifton, Prof. James Alfred Ewing, Alfred Bray Kempe, John Newport Langley, Joseph Larmor, Prof. Nevil Story Maskelyne, Prof. Raphael Meldola, Prof. Edward Bagnall Poulton, William James Russell, Dr. Dukinfield Henry Scott, and Prof. Walter Frank Raphael Weldon. Among the medals presented were a Royal medal to Prof. A. R. Forsyth, and the Davy medal to Dr. J. H. Gladstone.

Electric Railway up the Gorner Grat.—The first trial trips on the electric railway up the Gorner Grat, near Zermatt, were carried out last week in the presence of the Inspectors of the Swiss Railway Department. The section already completed has a length of 1,600 metres, and a gradient of 12 per cent. The tests gave complete satisfaction, both the ascent and descent of this gradient being effected without the slightest difficulty, the motors holding the locomotive perfectly to its proper speed. Starting on the maximum gradient with a fully-loaded train was also effected with great facility. It will be remembered that this is a rack railway, the total length being 9·8 kilometres, and the maximum gradient 20 per cent. The power is derived from the Findelenbach, which drives four turbines of 250 H.P. each, coupled directly to three-phase alternators of 5,000 volts and 40 ∿. Transformers are placed in the power-house itself for feeding the line as it passes the building, and two other transformer stations are provided. The pressure on the trolley line is 550 volts. Each locomotive is equipped with two three-phase motors of 90 H.P. each, driving the main pinions by spur-gear. Owing to the property of three-phase motors, by which they will act as generators and take up the full power which they are designed to give out as motors, when driven at 2 or 3 per cent. above the speed of synchronism, the locomotives will, in descending, give power back to the line. In case only descending trains should be on the line, the surplus power will be taken up in a water resistance in the power-house. The contractors for the whole of the electrical equipment are Messrs. Brown, Boveri and Co., who, in the well-known Lugano tramway, were the first to apply the three-phase system directly to traction. They have also supplied the electrical parts of the locomotives for the Jungfrau railway, where their system is to be adopted, and are now engaged on the equipment of the line from Stansstaad to Engelberg, which is to be running next spring.

Gutta-Percha.—At the Society of Arts on Monday, Dr. Eugene F. A. Obach delivered the first of a series of three Cantor lectures on "Gutta-percha." The lecture was devoted to consideration of the raw material. After giving the history of its discovery and briefly detailing some of the properties of the gum, Dr. Obach entered very fully into the question of the botanical derivation of the gutta-percha tree, this part of the lecture being illustrated by some very fine specimens borrowed from Kew. The gutta-percha country was next demarcated by a rectangle drawn on a map, and the lecturer explained with what mathematical accuracy the growth confined itself within these bounds. This latter point was so insisted on, in fact, that the younger students among the audience might have been led to believe that the rectangle was more than a mere *memoria technica*; in fact, it may be noted that in order not to exclude the north-eastern corner of Boreo, a narrow strip of Celebes had to be included within the rectangle, although it is well-known that in the latter island no gutta-percha is to be found. Interesting accounts of the various expeditions were given, and particulars of the experimental cultivation carried out up to the present day. The method of collecting the latex was briefly described, and the practice of cutting down a tree for an average yield of 2½lb. of gutta-percha was criticised with just severity. The analysis of various commercial brands was next dealt with by the aid of graphical wall diagrams, and attention was called to the interesting coincidence that the best gutta-percha, *i.e.*, that in which the proportion of pure gutta to resins is greatest, is in many cases to be found in those brands containing the greatest proportion of impurities (dirt and water). The lecture closed with some particulars, also shown diagrammatically, of the exports and imports of the material, and of the fluctuation in prices. There was a large array of bottled specimens to illustrate the lecture, several good photographic lantern slides, and a number of excellently-drawn wall diagrams, besides the valuable specimens from Kew already referred to. The next lecture, on the 6th inst., will deal with cleaning processes and natural substitutes for gutta-percha. The third lecture, on the following Monday, will be on the composition, properties and applications of the clean material, and some remarks will be made on artificial substitutes.

Motor Cycles at the Stanley Show.—The Humber Cycle Company had an interesting show of motor cycles, &c., at the Stanley Show. Among their exhibits were some electrical motor-tandem bicycles designed exclusively for pacing purposes. A 1¼ H.P. series-wound bipolar motor is fixed below the lower longitudinal bar between the wheels. On the armature shaft is a pinion of 8 teeth gearing into a toothed wheel of 69 teeth on the axis of a small sprocket wheel. This latter is geared by a sprocket chain to the rear or driving wheel which is 28in. in diameter. The ratio of the rotational speed of the motor armature to that of the rear road wheel is about 9. The motor is merely supplementary to the manual power, and is supplied with energy from 16 accumulator cells connected in series; these are arranged in four sets. Each cell has five plates, giving a capacity of 50 ampere hours, the maximum discharge rate being 80 amperes. We are told that pasted lead positives are used, protected and sustained by a perforated celluloid envelope, and that zinc is used in the negative plates. The electrical pressure of the 16 cells is 27 volts. The rear rider controls the motor by means of a simple rheostat mounted on his handle-bar, regulating the speed by inserting more or less resistance into the motor circuit. These pacing bicycles, which can attain speeds of between 30 to 40 miles per hour, are manufactured under the Pingault patents. Other features of this exhibit were various oil-driven motor carriages and cycles; the latter, both single and tandem, are so fitted that, by removing the back wheel with the motors, the whole motor gear may be removed and replaced by an ordinary back wheel, the change being effected in about a quarter of an hour. The single machines are fitted with a 1½ H.P. oil motor, while the tandems are supplied with a double cylinder 2½-H.P. motor, which drives on an axle, which passes through the geared hub of the rear wheel, the gear ratio being about 1 to 7, and wheel diameter 28in. The speed of the motor shaft reaches 1,500 to 2,000 revolutions per minute. The charge is fired electrically by means of a dry battery and an induction coil. The circuit of the battery is closed periodically by a contact maker consisting of a cam on the motor shaft making contact with an adjustable contact spring. It is found that, in consequence of the lag between the closing of the circuit and the production of the spark, the adjustable contact has to be advanced or receded in angular position for different speeds; to facilitate this, it is geared to a small button on the handle bar, so as to be conveniently manipulated by the rider. These oil-driven cycles and carriages may be fitted with tube or electrical ignition. The former can attain speeds up to 20 miles per hour, but the latter are built for two speeds, viz., six and twelve miles per hour.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Cadmium Cell.—Weston's cadmium cell, which is really a Clark cell with the zinc replaced by cadmium, has a temperature coefficient 20 times smaller than the Clark. Its advantages over the latter have been repeatedly urged of late, but it has been found that the E.M.F. of the Weston cell is subject to certain irregularities at temperatures below 15deg. These have been investigated by E. Cohen, and found to be due to a change undergone by the cadmium sulphate crystals near that temperature. This change can be placed in evidence in three ways. In the first place, the solubility line of cadmium sulphate shows a break at 13deg., above which it remains horizontal. Secondly, if at any point the cadmium sulphate solution is not saturated, a decided variation of E.M.F. occurs below 13deg. Lastly, if crystals of the sulphate are warmed up from 0deg. in a dilatometer containing the same substance in solution, a strong contraction sets in at 13deg. All these experiments show that the sulphate undergoes some change at that temperature, but the author leaves us in doubt as to what that change consists in, only hinting that it does not consist in a loss or gain of water of crystallisation. To restore the original E.M.F., the cell must be heated above 15deg. for about an hour and a-half.

[Cohen, *Verslag Akad., Amsterdam*, November 10, 1897.]

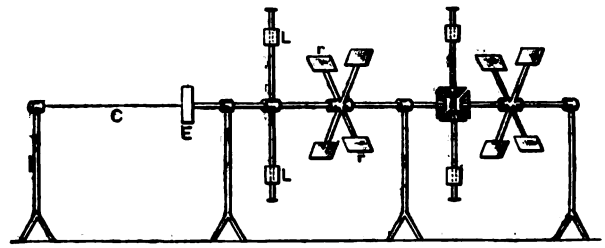
Photographs of the Zeemann Effect.—P. Zeemann has succeeded where Anderson and Adeney failed. The latter worked with a grating of 6·5m. radius and a field of 17,000 units, and exposed the plate to the cadmium electrodes for half-an-hour, without obtaining a measurable negative showing the magnetic broadening of the spectrum lines. Zeemann, by choosing a more favourable arrangement, obtained negatives suitable for measurement with an exposure of 15min. He photographed the cadmium spectrum with and without the field by means of a grating of 1·85m. radius. If the broadening only is to be shown an exposure of 10min. suffices, with a suitable slit and a field of 20,000 units. For measurements, it is better to photograph the doublet or triplet, preferably the outer components of the latter, obtained by the interposition of a nicol in the path of the light travelling at right angles to the lines of force. The current strength was 15 amperes. A stronger current was excluded by the heating of the induction coil. Perhaps the cadmium amalgam arc devised by Gumlich would meet this difficulty. The measurements were confined to the blue cadmium line (4,800). With a field of 30,000 units, the space between the two components of this line was 0·191mm. This means a change of period on both sides of 0·0000918, and gives a value of $2{\cdot}4 \times 10^7$ to the ratio e/m. The value previously found for the sodium line was $1{\cdot}6 \times 10^7$.

[Zeemann, *Verslag Akad., Amsterdam*, November, 10, 1897.]

Motion of the Ether.—It will be remembered that Michelson some time ago (see *The Electrician*, Vol. XXXIX., p. 208) endeavoured to detect a difference in the motion of the ether, at different heights above the earth's surface, by sending a beam round a rectangular path 200ft. long in a horizontal direction, and 50ft. long vertically. No trace of relative motion was detected, and the conclusion was that either the ether is quite unaffected by the earth's motion, or that it is dragged along with it to a distance of many thousand miles above the surface. H. A. Lorentz criticises these conclusions in detail. It is not inconceivable that the glass covers of Michelson's iron tubes do not allow the ether to penetrate, although they probably do so. On the other hand, an extension of the earth's influence to a distance comparable with the earth's diameter is not unthinkable. If the dragging is analogous to that exerted by a gas upon a solid sphere traversing it, the velocity imparted to the ether by the earth could well be $\frac{1}{3}\frac{3}{2}$ of that at the surface at a height equal to the radius, and $\frac{7}{2}\frac{7}{7}$ at a height equal to the diameter of the earth. But in that case some displacement of the fringes should have been observed. For at midday or midnight, when the earth's surface moves in the direction of the earth's path or against it, and the dragging is likely to reach a maximum, a displacement of $\frac{1}{6}$th of the distance between two of Michelson's fringes should have been produced. This would have been well within the limits of observation.

[Lorentz, *Verslag Akad. Amsterdam*, November 10, 1897.]

Model of Electric Circuit.—A. Garbasso has devised a model of an electric circuit which clearly illustrates most of the properties of a circuit with capacity and inductance, or of two circuits with mutual induction. The essentials are shown in the diagram. The "E.M.F." is applied at the pulley E. The resistance is represented by the vanes $r\,r$, and the current strength by the angular velocity. Inductance is represented by a cross-piece to which movable weights, L L, are attached, whose position can be suddenly altered. Capacity is represented by the twisted wire c. A second such system, connected with the first by a set of bevel wheels, represents a secondary circuit. The multitudinous observations which can be made with this model scarcely need pointing out, but a few may be selected. Leaving out the secondary circuit, we see at once that if the wire is twisted and the circuit released, the "discharge" will in general be oscillatory, but the damping will depend upon the length of wire (capacity), the moment of inertia (inductance), and the resistance. As regards the



secondary circuit, there will be an opposing current while the primary current is being established, owing to the fact that the induction levers are at first stationary. Similarly, there will be a current in the other direction when the primary current stops, the bevel gearing being called into play by the levers retaining their angular momentum.

[Garbasso, *Nuovo Cimento*, October, 1897.]

Polarisation Capacities of Membranes.—G. P. Grimaldi and G. Platania have investigated the polarisation of a voltameter containing a thin metallic membrane by means of a pendulum interrupter enabling them to charge it for a very short and precisely-determined interval. They used films and plates of gold, that metal being particularly suitable on account of its malleability and its slight tendency to occlude gases. The films were $94\mu\mu$ thick on the average, and were manufactured by Müller in Dresden. The experiments brought out the important influence of duration of charge upon the polarisation capacity, that being invariably greater in the case of films than in the case of plates when the charging time was very short. As the time increased the difference in the behaviour of plates and films decreased, and eventually reached zero. After that point, however, a difference in the opposite sense set in, the polarisation capacity of the plates becoming greater. The shortest time interval obtained was 0·001sec. The neutral point set in about 0·3sec. The explanation of these facts is to be sought in the penetration of the charges, *i.e.*, the diffusion of ions into the interior of the electrodes. They show that the charge traverses the whole thickness of the gold film in a very short time.

[Grimaldi and Platania, *Nuovo Cimento*, October, 1897.]

The Conservation of Matter.—It is not often that the fundamental axiom of the science of chemistry is critically examined. Landolt, in 1893, thought he had obtained a decrease of weight of two substances sealed up in a glass tube after they had been allowed to act upon each other. One of his reactions, showing the largest diminution (0·14mgr. in 114gr.) was that between silver sulphate and ferrous sulphate, producing silver

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and ferric sulphate. Recently, some further work has been done by F. Sanford and L. E. Ray, and published under the title "On a Possible Change of Weight in Chemical Reaction." Their results were negative, the changes not exceeding the probable error, which was 0·04mgr. The law is therefore not invalidated. But kindred investigations, like those concerning the dependence of mass upon motion or temperature, will retain their fascination for some time to come.

[SANFORD and RAY, *Phys. Review*, October, 1897.]

SECOND ANNUAL MOTOR CAR MEET.

Sun shone brightly and Fortune smiled on the second annual meet of the Motor Car Club, which took place on Monday last; and even the bitterly cold wind did useful service in drying roads that had been drenched on the previous day, and, perhaps, in bracing the spirits of the large company of riders. Some 43 motor-driven vehicles assembled between 11 and 11:30 in the morning outside the Hôtel Métropole, the majority of these being oil-propelled carriages, tricycles, and bicycles. Electricity was represented by the now familiar electric cab, of Mr. Bersey's design, and the 4-passenger "Headland" car, described in our issue last week. We were fortunate in obtaining a seat on the last-named vehicle, which, under the skilful guidance of Mr. Parr, the chief engineer to the Headland's Company, performed a remarkably rapid and successful journey down to Richmond and back. Through some misunderstanding in the arrangements, the electric vehicles were later in getting away than some of the oil-driven cars, but it was with no small satisfaction that the latter were gradually overtaken and, in many cases, out-distanced ere Hyde Park-corner was reached. The hills at Trafalgar-square, St. James-street, and in Piccadilly proved serious obstacles to one or two of the oil-driven cars, but the majority of vehicles of all classes surmounted every gradient with an ease and rapidity that were especially noticeable in the electrical specimens. From the Corner to Sheen House was run in 28min., but the time might well have been shorter had there been no hindrance from other traffic.

Arrived at their destination the members of the club and their guests partook of luncheon, and then proceeded to the ¼-mile cycle track in the grounds of Sheen House, to see the motor-bicycle and motor-tricycle races which had been announced to take place. In these, however, no electrically driven cycle took part.

The start for home was made at about 4 o'clock in the afternoon. We did a remarkably quick run *viâ* Barnes Common to Hammersmith, the Broadway being reached in 12min 54sec.; thence the dense traffic somewhat damped the ardour of our driver, but, for all that, a run to South Kensington Station in 24½min. from the start was no mean performance. On the return journey the various cars took different routes, so it is not possible to draw a direct comparison; but we understand that all the cars reached home safely and in good time.

Referring to the external appearance of cars in the procession, we may say that many of the oil-driven vehicles, and the single steam-driven car, were rendered ugly by the conspicuousness of their machinery. This defect was absent from the electric cars, which exhibited careful and neat design. The oil-car of Mr. Cross's design was, however, an exception that may be recommended to the attention of future designers of motor vehicles. We must not omit to refer also to the notable difference between the electric and other types of cars in regard to smooth and inoffensive running. Prior to the start from Whitehall heavy fumes might have been seen enshrouding the oil-motor vehicles, while the noise of their engines as they ran on the idle gear must have been audible a considerable distance away. Further than this, these vehicles were thrown into such a state of vibration as must have been very uncomfortable for the riders. Indeed, a careful study of the latest types of cars in last Monday's procession does but confirm the opinion we expressed in our leading article last week, that the prospects of the electric car are superior to those of any other type, and are, on the whole, very good. Last year electric cars were nowhere; this year they are decidedly somewhere; next year they will probably be everywhere.

ELECTRIC MOTOR-CAB SERVICE IN NEW YORK CITY.*

The motor-cab service and station has now been in actual service in New York for some five months, and although no attempt is made to compete in rates with other cab service, yet the demand for electric motor cabs has assured the success of the enterprise. This pioneer electric cab station is said to be already on a paying basis. The station is situated several doors west of Broadway, on Thirty-ninth-street. The building utilised for this purpose is a three-story brick structure occupying a ground space of about 40ft. by 100ft. On the ground floor (shown in Fig. 1) are the office, storage battery racks, switchboard and charging apparatus, and the cab equipment. The cabs are all placed side by side, and the batteries on the other side of the room. That section occupied by the cabs has an inclined cement floor with suitable sewer drains, so that the vehicles can be easily washed and cleaned. The second floor is used as the repair department, being equipped with lead-burning furnace, electric tyre pump, and suitable tools for battery, motor and vehicle repair. Ample storage facilities are afforded on the top floor. This station is open at all hours. Its location could not be better for the purpose, as it is almost in the centre of New York's busiest district.

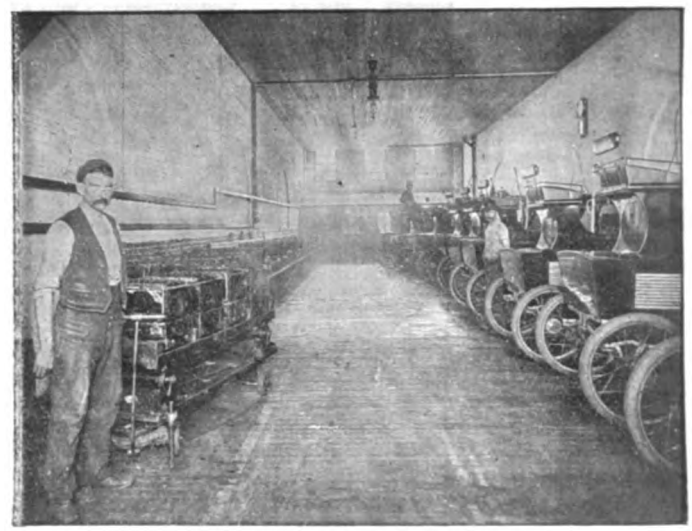

FIG. 1.—Electric Cab Station, New York.

Twelve electric hansom cabs and a "surrey" constitute the rolling-stock equipment. Aside from these, however, the Electric Carriage and Wagon Company has completed and is developing other types, among which are broughams, victorias, coaches, delivery wagons, &c. In the construction of these vehicles two general plans have been adopted: In the construction of the "surreys" and the hansom the design of the body is modified to accommodate the batteries, while in the case of the broughams, delivery wagons, carriages, &c., the entire mechanical and electrical equipment is independent of the body proper, which can be constructed precisely as the present designs.

Certain essential elements and limiting conditions were clearly demonstrated in the earlier experiments. The best results obtained with these vehicles show that about 1·25 H.P. is necessary for the propulsion of 2,000lb. over ordinary approximately level roads at 10 miles per hour. This consumption of energy, which is only two and a third times that necessary for similar work on rails, is astonishingly small, and can only be obtained by the reduction of all mechanical losses to a minimum, the use of an excellent motor and transmission, and a battery of only sufficient size to afford a practical travelling capacity, thereby bringing the weight within a reasonable limit.

Careful deduction and the result of experiments and trials have enabled the designers to approximately state as follows the limiting figures of the four important elements.

* Abstract from the *Electrical World* of New York.

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Maximum total weight of vehicle.	Max. weight of battery.	Max. distance. Miles.	Max. speed.	Average speed.
Surreys, 2,000lb.	800	35	15	8
Hansoms, 3,000lb.	1,200	25	12	6
Broughams, 3,300lb.	1,200	25	12	6
Closed carriages, 3,500lb.	1,200	25	10	6
Victorias, 2,000lb.	800	35	15	8
Landaus, 2,500lb.	1,200	25	12	6
Delivery wagons, 3,000lb.	1,200	25	9	6
'Buses, 5,000lb.	...	...	...	...

To propel a vehicle weighing about 2,000lb. with passengers at a speed of 10 miles per hour it would be necessary to have a battery output of somewhat over 1½ H.P. The essential output would, however, be far exceeded ordinarily, and approach nearer 3 H.P. It has therefore been found that about 900lb. of battery are needed to give a travelling capacity of about 30 miles at this rate, or about 1 350lb. with a vehicle weighing complete about 3,000lb.

All the various vehicles constructed by this concern are built on very nearly the same general lines. A detailed description of the electric hansoms (*see* Fig. 2) will therefore serve to illustrate the general features of all designs. In general appearance the electric hansom carries out the lines of this type of vehicle as far as the fore body is concerned. The similarity ends here, however, as the vehicle essentially has four wheels and a rearwardly extending box body carrying the batteries and on which the driver's seat is mounted. In finish the cab body is elegant. The enamelling, trimmings and upholstering are of the finest. Double doors are fitted to the fore body and are operated by means of a lever in front of the driver's seat. An examination of the illustration will show that the vehicle has a very low centre of gravity, and that the front and rear wheels are independently fixed to the vehicle body, the front being used for driving and the rear wheels for steering purposes. All the wheels are of a tangent-spoked metallic bicycle-type construction, with heavy 3in. Hartford pneumatic tyres. The latter are inflated to about 100lb. pressure, giving a flat bearing on the pavement of from 6in. to 8in. The front driving wheels are

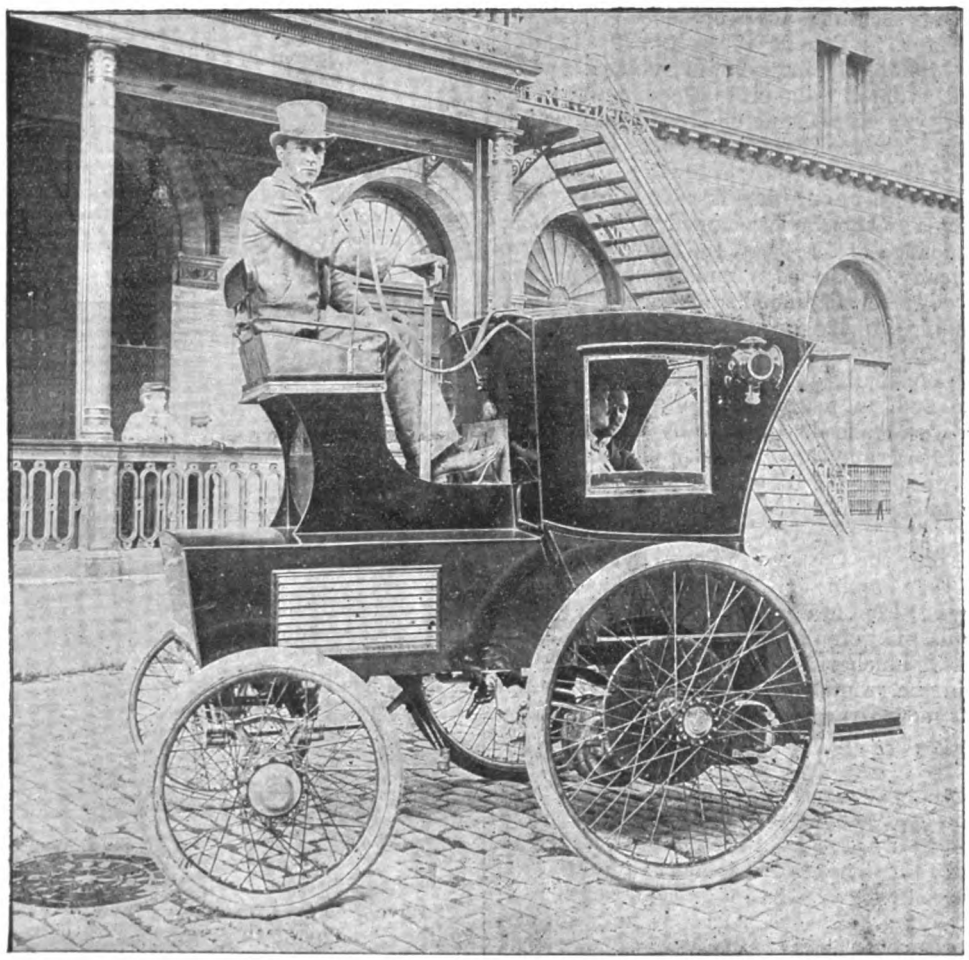

Fig. 2.—A New York Motor-Hansom.

It has been urged that the practical electrical vehicle has a very limited travelling capacity. Close investigation will clearly demonstrate the fact that the average carriage or wagon horse does not travel more than 25 to 30 miles per day. It is not expected that a trip from New York to Philadelphia, for instance, should be made with one horse relay; in fact, it would be more in keeping with usual methods to make such a trip by rail. It does not seem essential, therefore, to provide a motor vehicle with any such excessive travelling capacity; but if there should be occasion to do so, the eventual substitution of the electric motor carriage charging station for the livery stable will make this a possibility.

Greater maximum travelling capacities than above stated are by all means desirable. An electrical vehicle to travel 50 miles could readily be built, but a heavier construction would be necessary throughout in order to accommodate nearly twice the battery capacity. Such a combination would, however, be excessively heavy, at least from a carriage point of view, and limit the safe maximum speed. It would be entirely impracticable to run such a vehicle weighing, say 4,000lb., at a speed of about 15 miles per hour over ordinary streets, aside from the less efficient operation which would result.

44in. and the rear wheels 32in. in diameter. On some of the other vehicles wheels up to 42in. in diameter and tyres 5in. in diameter are used.

It is to be especially noted that not only have front driving wheels been adopted in these vehicles, but each driving wheel is independently connected to a separate electric motor. It is claimed that several advantages result from the use of rear steering wheels. Unless the weight were properly disposed however, this arrangement would by no means be desirable. Two-thirds of the hansom and passenger weight is said to be supported on the front wheels. The adoption of two independent driving motors eliminates the use of balance gears, which would be essential otherwise.

In the selection of a motor for these vehicles many elements needed careful consideration in order to secure a motor which should be highly efficient, almost absolutely weather, dust and waterproof, and capable of developing for short intervals two to three hundred times its rated normal capacity without developing any defects or weaknesses. A special type of bi-polar, single-field coil Lundell motor has been adopted for all these vehicles. These motors have an ironclad, almost spherical, outer casing, are fitted with self-oiling ball bearings, and are practically dust-proof. The

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hansom motors are each of 1½ H.P. capacity, weighing 172·5lb., and running at a maximum speed of 1,350 r. p. m., being series-wound for 80 volts. Tests of these motors show some very excellent results. Two such 1½ H.P. motors have been found amply sufficient for these hansom cabs, which weigh, complete with passengers, 3,000lb. Such motors will, without any signs of undue heating or weakness, drive the vehicle at a maximum speed of 15 miles per hour or develop an average vehicle speed of 8 miles per hour for 25 miles. For larger vehicles, up to 3,500lb., two 2 H.P. motors are used. These motors are wound for 75 volts at about 800 r. p. m.

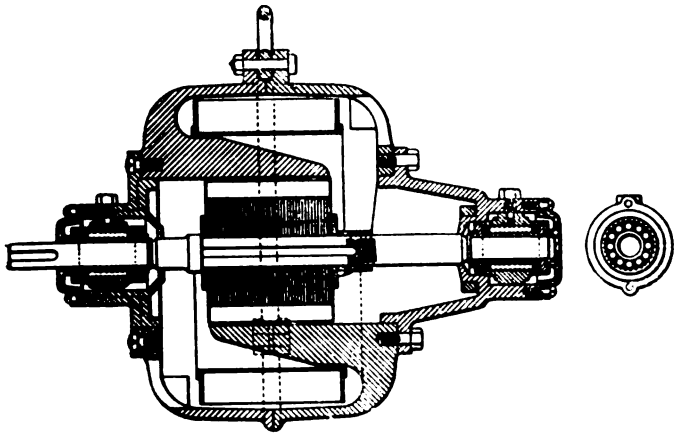

FIG. 3.—Details of Electric Carriage Motor.

The method of gearing the motors to each driving wheel is very simple. The driving wheels rotate on roller bearings at each end of a fixed axle. The gear consists of two internal gears bolted to spun plates of steel, attached to the hubs of the front or driving wheels. The exterior of these internal gears may either form a surface to which the brake is directly applied, or through the medium of a supplemental band furnishing a removable wearing surface, the brake being applied by a foot-lever in the usual manner. The pinions on the motor shafts engage directly with the internal gear, thus making a single reduction of suitable proportion between the motors and driving wheels of the simplest possible form.

Each of the driving motors is pivotally suspended from the fixed axle supporting the driving wheels. The method of suspension is shown in the illustrations (Figs. 3 and 4). Fixed to the upper part of the spherical motor arm are two circular clamps holding the motor to the axle, and permitting it to swing radially on the axle, so that the motor-pinion always remains in mesh with the gear on the wheel. Attached to the lower edge of the motor frame is a rod, the other end of which is fitted with a rubber buffer, which is fixed to the lower carriage body. This arrangement takes up all slight movements of the motor, and minimises shocks to the gearing, due to vibrations when travelling over rough roads. Both the driving and steering wheels are, so to say, independent of each other, each set being fitted to a separate supporting gear, on which each end of the carriage body proper is supported.

The arrangement, which is almost similar in each case, consists of two parallel, slightly bent compound flat springs placed horizontally across the vehicle at a slight distance from each other. These are fastened to suitable bolsters at the bottom of the vehicle body. Connecting the ends of these traverse horizontal springs are short connected springs pivotally attached to each end of the horizontal springs, and centrally fitted to these short connecting springs the fixed axles. Each cab is equipped with a cyclometer, registering the miles travelled.

A particularly interesting feature of these vehicles is the steering gear, which is what may be called the hub-pivoted type. At each

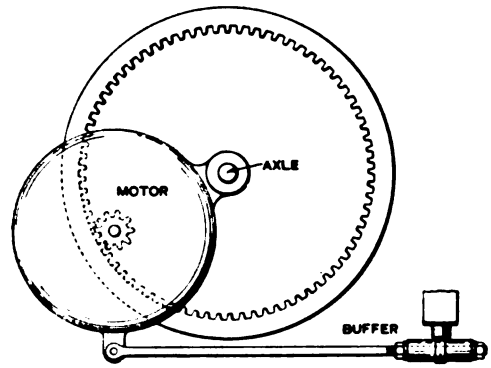

FIG. 4.—Scheme of Driving Gear.

end of the fixed rear axle is a T-shaped double vertical pivot, on which swivels a bearing shell, to one side of which is fitted an inwardly projecting arm. An examination of the illustrations (Figs. 5 and 6) showing this arrangement in detail, will also indicate the method of taking up side thrusts. It will be noticed that the outside of each steering wheel proper is provided with an inwardly projecting flange. The previously mentioned shell has an outwardly projecting screw lug, fitted with suitable discs, between which and the previously mentioned wheel-hub flange are steel balls, arranged so that the thrust pressure in either direction is taken up on them. An important feature in this construction is the accessibility to all parts, and the ease with which the entire steering wheel and gear can be inspected.

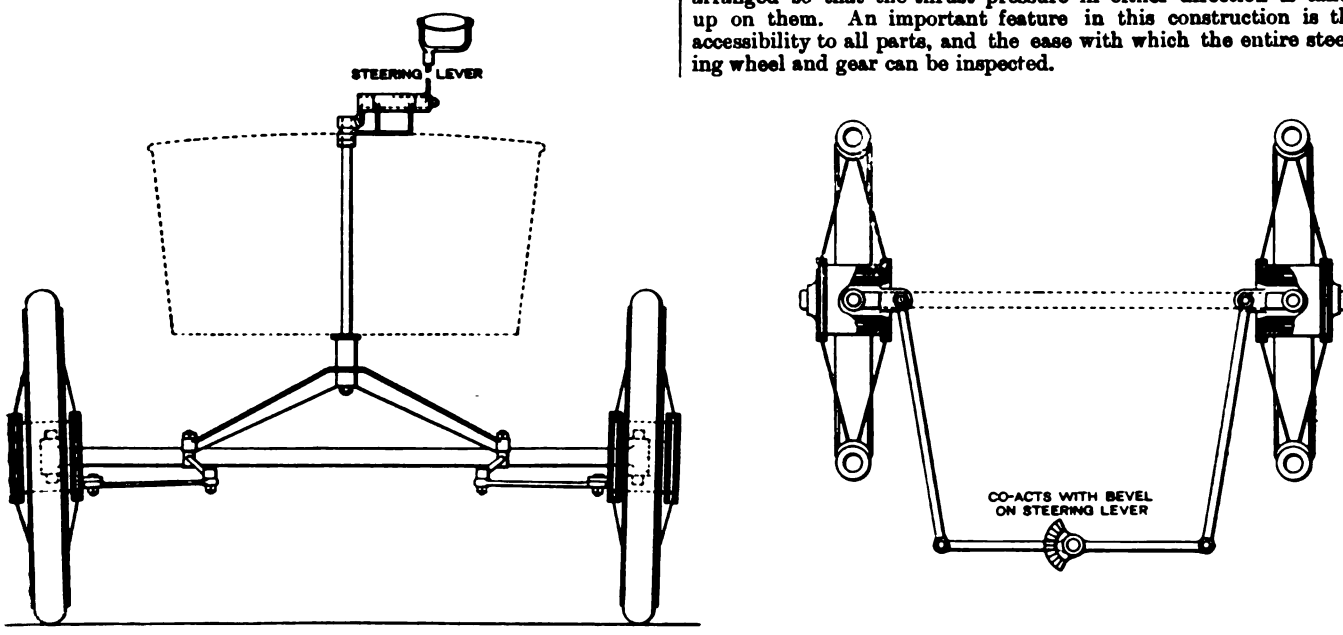

FIG. 5.—Scheme of Steering Gear.

Attached to the previously mentioned inwardly projecting arm from the pivoted-bearing shell is a pivoted rod connecting each of the steering wheels with opposite ends of a central-pivoted bar under the vehicle body, at about the centre. The pivot of this arm passes up in the form of a post until it reaches the top of the battery-carrying box body, where a bevel-gear segment is fitted to it. This bevel-gear segment meshes with another similar gear attached to the short end of the pivoted steering lever, the other end of which projects upward immediately in front of the driver's seat, and terminates in a spade handle. The movement of this steering handle forward or backward from its normal position operates the gear mechanism correspondingly. The wheels are turned parallel with each other. Although at first sight it might be supposed that steering from the rear would be more difficult than steering from

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the front, and notwithstanding the consensus of opinion among carriage men was decidedly opposed to rear steering, yet as a matter of fact this has not been found to be the case, as the carriages can be moved with the slightest effort on the part of the driver and with the greatest certainty in any direction desired, and be turned completely around in a circle of from 20ft. to 30ft. in diameter, depending on the length of the wheel base, gauge, &c.

A peculiar form of brake mechanism has been adopted, in which simplicity and positive action have been particularly aimed at. Instead of using a separate brake mechanism, it was decided that the best place for the brake was directly upon the wheel tyre. Ordinarily this plan would have been extremely unwise owing to the possibility of serious wear upon the rubber wheel tyre. By the use, however, of a peculiar rolling brake shoe the wear has been reduced to a minimum. These brake shoes consist of two concave rubber rollers fitted to opposite ends of a short metallic support bar, which is fitted to one end of a piloted lever, the other end of which is suitably connected with the foot-brake operating lever, immediately on the top of the battery-carrying portion of the body and in front of the driver's seat. One of these brake shoes is arranged to act upon the rear of each driving wheel, as shown in the illustration, and the levers to which each is attached come together about centrally between the wheels, where they are connected to the above-mentioned foot-operating device. An application of this brake shoe with almost any pressure possible through the foot-operating device does not cause a rubbing of the wheel tyre as would be the case with an ordinary fixed brake shoe.

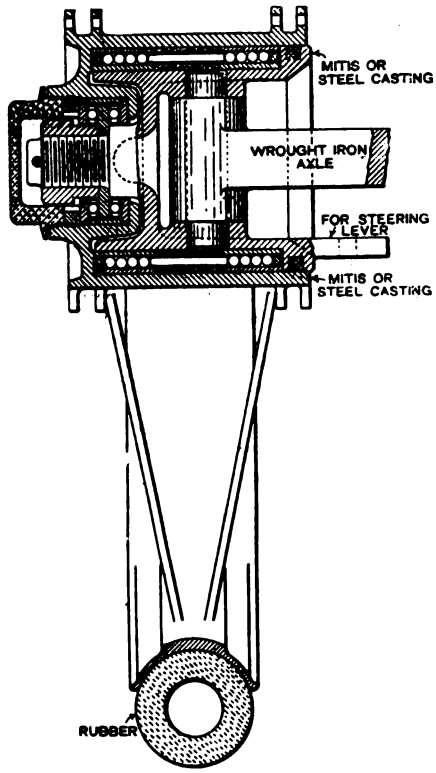

FIG. 6.—Detail of Steering Wheel-Hub Pivot.

For the equipment of the hansom cabs 44 cells of battery are used. These are arranged in four sets, each of 11 cells. Each set is a separate unit retained in a single holding box or tray. These trays have at each end a contact strip connected with the batteries in that particular box, all of which are connected in series with one another. The trays are of sheet-iron, measuring 20in. by 13in. by 6in., lead coated and painted all over with acid-proof paint. Four such trays are placed in the battery box, forming the rear body of the vehicle proper. The rear end of this box body has a hinge door which opens downwards. The batteries are therefore readily accessible, and can be easily taken out and replaced. The bottom of the box is divided longitudinally by a centrally placed double wooden partition, and the battery trays rest on rollers between the central partition and the side of the box body. The steering and brake rods and levers occupy the space between the two sides of this partition. The use of the rollers greatly facilitates the handling of the battery. In placing the battery within the vehicle all connections are automatically made, terminals at the side of the containing trays automatically coming in contact with corresponding plates attached to the side-supporting bars forming the bottom of the body. Each of the elements has but three plates. For the cab service, the 3 F 100 ampere-hour cell is used, although the equipment also includes some 75 and 80 ampere-hour cells. For lighter service the 3 M type, having a capacity of 75 ampere hours is used. These batteries are manufactured by the Electric Storage Battery Company. In some instances the cells consist of Manchester type plates, while in others chloride plates are used throughout. The complete battery equipment for a single hansom cab weighs about 900lb., has a normal discharge rate of about 21 ampores, and maintains 80 volts even at abnormally high rates of discharge. The use of three plates in each cell greatly facilitates and reduces renewals. All the elements of one set of 11 cells are solidly connected. With the above battery equipment the following travelling capacities are possible: with the first speed of from four to five miles an hour the battery discharges at about 12½ amperes, and will last for a run of between 30 to 35 miles; the second speed of between seven and nine miles per hour necessitates a battery discharge of about 25 amperes, and limits the run from 20 to 24 miles; and the third speed of about 15 miles an hour necessitates a discharge rate of about 40 amperes, and limits the travelling capacity to about 15 miles.

In addition to the controlling devices which have already been noted, the steering and brake-operating levers, the actual operation of the motors and batteries, and their suitable action in order to produce the necessary speeds and direction of movement, is accomplished by means of a controlling cylinder placed inside of the raised driver's seat over the battery box. The spindle of this controlling cylinder projects through the side of the seat, and is fitted with an upward-projecting handle at a right angle to the spindle. This controlling cylinder in general construction somewhat resembles a street-car controller. It consists of an insulating cylindrical support having various sets of longitudinally arranged inter-connected contact blocks, each block being separated from the next by an annularfibre insulating flange. Parallel with the axis of the cylinder is a row of contact brushes which form the terminals of the various battery sets and motor armatures and fields. These terminal brushes are all in line, and make contact with the blocks on the controlling cylinder. The controller cylinder and contact brushes are placed horizontally. In addition to the actual controlling devices, an electric bell push is provided adjacent to the driver's seat, and also carriage lamps on each side of the fore body, as well as interior lamps. To produce the speeds already mentioned the batteries and motors are put through various series-parallel combinations. The controller is so arranged that for the forward movement of the vehicle three speeds are possible, while for the reverse only one. The reverse speed is at the rate of 4 to 5 miles per hour.

The batteries are divided into two sets, each of 22 cells. In the central position of the controller handle the motor circuits are broken. In the position for first speed the two sets of batteries are in parallel, and the two motors are in series. In the second position both batteries and motors are in series; and in the position for full speed the batteries are in series and the motors in parallel. There is one reversing position, in which the batteries are in parallel and the motors in series.

In the case of the "surrey," the controller cylinder, although constructed on the same general lines, accomplishes a somewhat different combination of the various elements. Instead of having a single field coil, the field winding of each motor is divided into two halves, which allows of a somewhat further combination, giving four speeds ahead, with one reverse speed. It has been found that three or four speeds ahead, with one reverse speed, are ample.

Along the wall of the ground floor of the station opposite the stored hansom cabs are the battery-charging racks. There are twenty of these, arranged side by side, each supported on iron posts. Each rack includes two transverse compartments which hold exactly the equipment of one hansom cab—44 cells in 4 trays. Each alternating-traverse cross-bar forms a rack partition, and on each side of these bars are slate slabs on which are mounted brass connecting strips. The bottom of each rack is made up of rubber-coated steel rollers arranged longitudinally between these bars, and a centrack rack-dividing bar in each rack. For handling batteries either from the rack to the vehicle, or *vice versâ*, a battery cart or truck is used. This truck is mounted on low wheels, and has a table divided into four compartments, each of which accommodates a single tray of 11 cells. This platform rests upon inclined planes, and is moved up and down thereon on rollers. A hand wheel and screw-spindle arrangement at one end of the battery truck is used for raising or lowering the platform. This accommodates the level of the battery-carrying platform to either the battery rack or the battery box of the vehicle. This adjustable cart is essential, owing to the fact that when the batteries are removed from the vehicles a decreased weight on the pneumatic tyres and springs causes a slight raising of the battery box. The batteries in each single rack are connected exactly as if they were in the vehicle—that is, the four sets in each rack are connected in series. The entire battery equipment consists of 1,144 cells, making 104 trays of 11 each, and 26 vehicle equipments, which is about 50 per cent. above that necessary for the present needs.

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Current supply for battery-charging purposes is taken from the Edison three-wire service, mains from which are run back to the switchboard room, the same current being also used for light and power purposes.

Aside from the mechanical and electrical side of this new enterprise, the business at the New York station is carried on in very much the same fashion as any regular cab service. The working force consists of the superintendent, Mr. C. J. Harrington, a starter, chief battery man, assistant battery man, machinist, washer and twelve drivers. The latter are uniformed in drab livery, and were ordinary cab drivers previously. They seem to take hold of the new vehicles very readily, appreciating their advantages, and at the present time are very expert in handling them. A number of vehicles are usually sent out to cab stations, but ordinarily the station is kept quite busy supplying the calls from hotels, clubs and even private residences for the electric cab service. The charging of each of the vehicles, its washing, cleaning and overhauling has now assumed a machine-like routine, and the men who have charge of each particular part of the work have become so expert that a cab can be got ready for service in a very small fraction of a minute. The arrangement for tyre pumping may be noted. On the upper floor, as has been previously stated, an electric tyre pump is located. From the accumulator of this pump a pipe line extends to the lower floor, where a flexible tube from this pipe extension can be connected to any of the tyre valves. The pumping of the tyre takes an almost inappreciable short time. All ordinary battery, motor, and carriage repairs are made directly on the premises, and, as a whole, the station is entirely self-maintaining. The vehicles are usually recharged with a new set of batteries after they have travelled for 15 miles or more.

The main consideration of an enterprise of this kind, from a commercial standpoint, is whether it pays or not. Indications seem to show that even at the present stage the service is already on a paying basis. During the month of June a total number of about 632 calls were received, with a maximum of 32 and a minimum of 12 per day. 1,580 passengers were carried a distance of 4,603 miles. The rates are exactly similar to the horse-drawn cab rates, $1 being charged for the first two miles or any part thereof, and 50 cents. for each extra mile. When taken by the hour, for shopping and visiting, $1 is charged per hour.

ACCUMULATOR TRACTION ON RAILS AND ORDINARY ROADS.

The discussion in connection with Mr. Epstein's Paper on the above subject was resumed at the meeting of the Institution of Electrical Engineers on November 25th. The following is an abstract. Speakers who have returned their proofs revised are denoted by an asterisk.

* Mr. E. MANBY spoke again as to the merits of the "Marchner" accumulator now being used in Dresden. The cars carry 48 passengers, and are provided with a single motor working at 250 volts. A battery of 144 cells is placed under the seats of the motor carriage, which weighs nearly 5,300lb. The weight of the battery complete was about 77lb. per kilowatt-hour, but he understood that a still lighter form was being made. They were charged at the rate of 60 amperes and their efficiency was said to be very high, exceeding 90 per cent. The sum charged by the Dresden electric works was 9s. for a full charge, which amounted to 0·84d. per mile for the two cars containing about 80 passengers. With reference to what might be expected from an accumulator, Mr. Epstein had stated that an ideal battery should require no handling and should be treated as an indivisible unit. The Dresden battery fulfils these conditions, as it is charged *in situ*. It is only charged once a day and has given a very large mileage under these conditions, so that instead of the 750 days which Mr. Epstein had stated as what might be expected as the life of a battery, the Dresden battery should actually work 1,500 days without renewal. Its efficiency had not been impaired for the six months it had been working up to now, and time would show whether it really would work so long. The hauling car on the Dresden line weighed, with a "Marchner" battery and fully occupied, about 12 tons, and hauled another car weighing with 32 passengers 5½ tons. On one occasion these cars had, on a flat section of the line, travelled for 130 miles with a load of 17½ tons without recharging. It was said to have developed nearly 69 kilowatt-hours, which would only give about 39 watt-hours per ton mile if only one-third full of passengers, whereas Mr. Epstein assumed that 80 watt-hours would be a proper proportion per ton-mile hauled, but this was obviously dependent upon other considerations than the merits of the battery.

* Prof. W. E. AYRTON said that the propulsion of vehicles along ordinary roads with accumulators was an old love of Prof. Perry and himself, and it might be in the memory of some of them that in 1882 a tricycle which they were then running in the streets of London was propelled with some of the first Electric Power Storage Company's batteries that were ever made. Mr. Epstein had rightly said that all the early experiments, indeed all subsequent experiments, until perhaps quite recently, were commercial failures, although from a scientific point of view they had been very interesting. They had been given particulars of the Hanover traction. He did not quite understand what Mr. Epstein meant when he said in respect to the probable possible cost, "the Directors anticipate that this cost will be increased somewhat, but they are confident that it will in no case exceed 60s. per car and month (which amounts to 0·266d. per car mile)," while a little further on he said it would be 0·4d. per car mile. No doubt some difference was intended, but it was not clear what that difference was. If he (Prof. Ayrton) had been asked—indeed when he was asked eight months ago—to advise on the probability of the use of accumulators being commercially successful with ordinary road traction he said they would not, but if Mr. Manville succeeded with the London Electrical Cab Company's vehicles there was no one who would be more delighted than himself; in fact he hoped Mr. Manville *would* prove him in error. When he had made some experiments for Mr. Epstein some years ago he had been asked to submit the cells to the roughest possible treatment, and he might say that nobody would have been more hurt than Mr. Epstein himself if, in drafting up his report, he (Prof. Ayrton) had applied in the most delicate way the varnish brush to his statements. The calculations which Mr. Epstein had made as to the weights of accumulators, &c., in his Paper depended upon two things. They depended upon the storage capacity of the accumulator and on the resistance to traction on an ordinary road—the resistance per ton. As regards the first point, the storage capacity of an accumulator, they knew that a good many experiments had been made in the past in his laboratory on all kinds of accumulators, each experiment lasting for several months day and night, so as to get the real history, and he had got an impression that he had some sort of knowledge of what might be expected as to the storage capacity of an accumulator. A few days ago, however, a pamphlet had been put into his hands published by the Lamina Accumulator Company, and in that pamphlet there were extracts from the reports of certain persons who had presumably made tests; but in these extracts no particulars were given as to how the tests had been made—whether there was a cycle of charge and discharge, or how long the tests had lasted. He had been struck with one statement in one particular report, which stated that these Lamina accumulators working under normal conditions gave 14 watt-hours per pound gross weight as their storage capacity—nearly twice as much as he had ever been able to obtain with any accumulator which he had ever tested. For when an accumulator was discharging at the test-rate the best result he had ever obtained was eight watt-hours per pound gross weight, and nine watt-hours per pound when it was discharged at *half* its test-rate. Then he saw in other reports some tests which had been made on these accumulators, giving complete figures which were not nearly as large. He had then turned to the prospectus of the Company, and found that they themselves did not claim half as much storage capacity for their own accumulators as was vouched to be possessed, so that it was quite possible that, although their own experience of manufacturers was not to decry their own wares, the modesty of the Lamina Company was such that it only claimed for its accumulators half the storage capacity they actually possessed. On the other hand, they had heard that the accumulators used in Dresden gave approximately the same storage capacity—13 watt-hours per pound. He was not quite sure whether, when Mr. Manby gave the weight of the cell as 77lb. per kilowatt-hour, he meant 77lb. of gross weight of plates. (Mr. Manby: Yes, it was gross weight). However, the best results he had ever obtained himself were about half that, and the Lamina Accumulator Company themselves only claim about six watt-hours per pound, but if it is possible to obtain 13 or 14, well, so much the better. The other point was the question of the resistance to traction. Mr. Epstein, Mr. Crompton, himself, and a few others, had had a talk after the last meeting as to what was the resistance, and Mr. Epstein had stated that his 60lb. meant 60lb. per ton, not 60lb. per 30cwt., as was thought by Mr. Crompton. Not being able to make any experiment on electric cabs he had made some on bicycles, and found that to drag a bicycle in good condition over a concrete road required about 30lb. per ton at a speed of 5½ miles an hour. Getting up higher speeds on good macadamised roads, the resistance was 43lb. per ton at a speed of 12 miles an hour. Experiments made on good macadamised roads slightly wet, with a very slight wind, gave the following figures:—At a speed of 10 or 12 miles an hour, going against the wind, a resistance of 62lb., and a resistance of 40lb. per ton going with the wind. Taking, then, into account the fact that the gearing would not be so good on a motor car and the greater friction in the bearings of the wheels, he should think that Mr. Epstein's estimate of 60lb. was not excessive, and perhaps it was rather under than over the truth. In some experiments published in *Engineering* in January, 1896, by Mr. Ravenshaw on various bicycles and tricycles on all manner of roads the figures ranged from 30lb. per ton to 146lb. in a heavy mud. Thus they would see that large figures were to be expected, certainly not under 60lb. Turning again to the case treated by Mr. Epstein, where he proposed to use a dummy, the motor being on the car and the accumulators on a dummy, according to this for a 52-passenger car it would be sufficient to have 2¼ tons of accumulators. As he had said before, the best accumulators he had ever tested had only nine watt-hours' storage capacity for one pound gross weight, and with such accumulators he had found that the weight proposed by Mr. Epstein ought to be doubled for a car taking 52 passengers. In fact, five tons of accumulators were necessary for driving such a car satisfactorily, since it would require 12 H.P. to propel this at 10 miles an hour along a level road. Owing to loss of power on the motor, &c., Mr. Epstein's figure of 60lb. per ton resistance to traction came out also as the effective result for an electric car if all the loss of power on a level road was regarded as arising from mechanical friction. Coming to Mr. Epstein's estimate for a small car, to carry three or four people -viz., two effective H.P.—this did not seem sufficient, for, according to Mr. Manville, an electric cab carrying, at the maximum, only three people, two passengers and the driver, required its batteries to give out 3 E.H.P. when travelling on smooth wood and 5 E.H.P. when going on ordinary macadamised roads. There was one other point touched at the last meeting—viz., the question of altering the speed. They probably knew how the speed was altered in the London cabs. There was a double armature with two commutators, two sets of brushes, and the field-magnet winding

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in two halves could be dealt with separately. They varied the inter-connections of the fields and the armatures, and did not alter the arrangement of the cells. If Mr. Manville had been present he would have asked him whether he had considered the other possibility. Of course, they all knew that it was unwise to treat cells so as to get a greater discharge from one than from another. A way was patented by his colleague and himself in 1882, especially in connection with the Brighton and South Coast carriage lighting by a dynamo driven from the axle of the guard's van, a plan just about to be started at that date. With their device every cell was used in succession, although the total number connected to the lamps might not be the total in the van. But without using one cell differently from another it was clear that with 40 cells—as they had on the London Electric cabs—they had three combinations. They could have them all in series—20 in series and two in parallel, or 10 in series with four in parallel. He asked whether that was not quite as good an arrangement as was obtained at present, without the necessity of constructing double armature motors. There certainly was one objection, and that was the number of wires to the cells they would have, but as soon as they invented a means of preventing the spray corroding the contacts, the alteration of their resistance would be prevented, and one of the reasons for the resistance of one batch of cells being different from that of another would be removed. In connection with the London cabs he would like to know why it was necessary for the engineers to go to America for their motors. He did not mean why did the company do it, but why did not English electro motor manufacturers arrange matters so that they should not have to do it? They had the Lundell motor on the cabs, which was much lighter for its weight than the English motors.

Mr. THOMAS PARKER thought that, as the designer of the Bourne Brook-Birmingham line, a few particulars from him would not be out of place. His first experience with accumulators began about 17 years ago, but in 1891 he had been asked to construct a locomotive with accumulators to compete with the steam trams at Birmingham. He constructed such a locomotive, and for months it held its own with the steam line to the satisfaction of those who were appointed by the Council of Birmingham to watch it. It weighed about 8 tons, and its accumulators were all fixed. The success of this determined the Council to put down a station at Bourne Brook, and they were all sanguine enough to hope that accumulators would do as well on tramcars as they did in stationary work. The contract for the construction was accepted by him, but he did not get a free hand with regard to the "mechanics and electrics" of that installation. There were several conditions imposed, which, in his opinion have been the destruction of that line. First the Council determined that they should use the identical cars used on the cable tramway. As mechanics they all knew that these cars were only double bogey cars, and upon one of these bogeys had to be put a motor for driving this very heavy car, and it was necessary to have double gearing at one end for that purpose. Another condition was imposed by the mechanical engineer, and that was they were to run these cars at 15 miles an hour if wanted. They were then between two fatal positions, in addition to which the cost of the installation was abnormally large. All these features brought about the circumstances which destroyed the success of that line. They had built the whole of the electrical work and put it to work. Since that time every battery-maker had been in the same box, viz., they could not get the batteries on cars to do what they did in stationary work. When these cells were discharged they lost their capacity, not slowly but suddenly, and they could not recover it again. It was horrifying to him to find that one day he could run a car for eight or nine journeys from Bourne Brook to Birmingham, and in two or three days' time he could not get it to do more than three or four journeys at the outside. This had broken down his hope for accumulators for traction work, and since that time he had not meddled with them; but given a free hand on a tramway like this it would have been successful, or given a free hand to-day, he would guarantee to make it a respectable engineering installation, and make it pay. With regard to tractive force, his son was building a car in Wolverhampton which would very likely be seen in London shortly. It weighed about 24cwt., and seated about nine persons. It had been tested about the neighbouring hills of Wolverhampton, and the resistance was about 45lb. per ton by electrical measurement. It was fitted with solid rubber tyres on wheels that carried about 15cwt. each, and many people who had seen the vehicle had spoken well of it. Another feature about this car was that on a gradient of 1 in 14 it did not increase the speed over eight miles an hour, while it mounted a hill at six miles an hour. He thought the time of charge and discharge was a very important question, although he did not care to discuss any particular battery.

* Mr. E. WILSON said he would confine his remarks to the question of relative weight and output of cells. About six months ago he had carried out a series of experiments upon traction type cells in the Siemens' Laboratory, King's College, for the purpose of a small work entitled "Electrical Traction." Those experiments were given in full in the book, and he had extracted the results in the table below, which refer to an electrical power storage company's Faure-King traction type 5-plate cell. The cell was fully charged when delivered. The two positive plates measured each 7¼in. by 8in., and had a thickness of ¼in., not including the perforated envelope in which they are placed. They weighed, with lug, when just taken out of the acid, 7lb. 7oz. The total weight of the cell in ebonite box and acid was 21lb. 2oz. The specific gravity of the acid in the fully-charged cell was 1·275. Tests Nos. 5 and 7 in the table showed for a net drop of about 0·2 volt, with current passing, a work efficiency of about 72 per cent., which agreed with Mr. Epstein's figures. It was to be clearly understood that these tests had been made upon new cells, and that therefore no conclusions could be drawn as to the life of such plates; and further, tests made upon isolated cells like these might not respesent the average results which would be obtained from many. It was interesting to see what weight of these storage cells would fulfil the conditions put down by Mr. Epstein. Taking his lower rate of discharge at 2,208 watts for five hours, the watt-hours would be 11,040. The Faure-King type cell just referred to, when working under the conditions given in the table, gave 156 watt-hours. Therefore, $\frac{156}{21}=7{\cdot}43$ was the work in watt-hours per lb. of total weight of cell. Dividing this into 11,040 should give the total weight of a battery of these cells to fulfil the conditions put down, $\frac{11{,}040}{7{\cdot}43}=1{,}490$lb., as against Mr. Epstein's 1,000. This made no allowance for diminished capacity after continued working, if such existed in this cell. The number of such cells would be $\frac{1{,}490}{21}=71$, and since 2·6 volts were required for the fully charging of the cell at the rate given in the table, the total charging volts would be $2{\cdot}6\times71=185$, if the cells be kept in series. The number (71 cells) just given could be considerably reduced if the capacity be increased and still give currents convenient to deal with in motor and controlling apparatus. This was important, since the weight of an equivalent battery, so far as work is concerned, would come smaller. Taking the 9-plate instead of the 5-plate Faure-King cell, it was capable of discharging 150 ampere-hours at 30 amperes, the time, as before, being five hours. The weight was 35lb., complete with acid, as against 21lb. in the 5-plate cell. From these figures the watt-hours per pound $=\frac{300}{35}=8{\cdot}57$, as against 7·43; also $\frac{11{,}040}{8{\cdot}57}=1{,}290$lb., as against Mr. Epstein's 1,000. The number of such cells would be $\frac{1{,}290}{35}=37$, and allowing 2·6 each the voltage would be 96 if the cells be charged in series. Under these conditions, then, 1,000 as given by Mr. Epstein seemed low, but he might have assumed different conditions of working. Mr. Wilson thought that it would add to the value of the Paper if the author would give exact details as to number of cells and the conditions of working. Experiments made on the Chloride Syndicate's cell representing the Planté type, as against the pasted type above discussed, showed the same character of result, but with somewhat greater weight. Mr. Epstein's higher rate quoted, namely 2,812 watts, would naturally increase the weight of the battery, and make the difference greater than shown above. It was premature to discuss which type of cell will eventually survive for traction purposes. The cell of the future must be capable of being overdischarged without serious injury.

No. of test.	5	6	7
	Discharge.	Charge.	Discharge.
Volts, initial without current...	—	—	2·18
Volts, initial with current	2·04	2·135	2·02
Volts, final with current..... ...	1·85	2·6	1·85
Amperes, constant at	15	17·8	14·9
Total time of discharge	5hr. 20m.	5hr. 30m.	5hr. 15m.
Ampere-hours	80	97·9	78·2
Watt-hours	157	228	155
Quantity efficiency	82	—	89·7
Work efficiency	58·8	—	76·1

*Mr. CUTHBERT HALL thought that with regard to the watt-hours per pound of cell it was an important point what was the size of the cell, because, obviously, if they took a cell with one positive and two negatives and acid in proportion, and gave the watt-hours from a cell of that construction, they got less good results than if they had, *e.g.*, seven positives and eight negatives, because the proportion of useless negative to positive was greater in the first instance than in the second. With regard to charging at constant potential, Mr. Epstein had said that in Paris they charged the cells at constant potential, which was advantageous because it formed practically an automatic method of preventing overcharge. He thought also that charging at constant potential gave a more efficient result than charging at constant current. If they put exactly the same number of watt-hours into cells of similar construction, first at constant potential and then at constant current, they would find the efficiency at constant potential was higher than at constant current. He attributed this to the fact that at the end of a charge at constant current a very large amount of the energy was expended in producing what was known as "gassing," whereas at constant potential there was very little of this "gassing," because the plates were capable of absorbing the comparatively low current at the end of the charge; while at constant current the current density seemed to be too great for the cells to take it up when almost fully charged. Mr. Epstein had also stated that the capacity of the plate was determined by the body of active material, a statement which he thought required considerable qualification. It might lead one to suppose that with two plates of equal dimensions as to length and breadth, but one twice the thickness of the other, the thick one would give double the capacity of the thin one, whereas it did not. In a series of elaborate experiments be made some years ago he found that if they took a plate 10in. in length by 10in. wide and $\frac{1}{16}$in. thick, and a similar plate double the thickness, the output from the thin plate was just as great as from the thick one, and therefore the statement that the capacity of the plate was determined by the body of active material was not upheld, as there was a certain amount of active material which the electrolytic action did not penetrate. This brought him to one of the most important considerations in connection with accumulators. His ideal accumulator was one that had such a thickness of active material that nearly the whole of it underwent chemical change at every charge and discharge. If they estimated the amount of active material on one of the best plates on the market and calculated theoretically what output should be obtained from it, they would find it to be about three times that which was actually obtained

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He very heartily endorsed Mr. Epstein's remarks as to negative plates, because if they took any cells and discharged them and then divided the positive and negative plates, and put with the negatives fully charged positives, and with the positives fully charged negatives, they would find that it was the positive plates which had given out first and not the negative.

* Mr. J. S. RAWORTH said he attended as one who wished to learn, in which capacity he thought he represented the majority of the members. His experience with accumulators ceased some eight or nine years ago, and to that happy fact he attributed the circumstance that he had any hair left. In those days it was rapidly going, and he noticed that most of the members in the accumulator business had none at all. He saw, from the reports in the papers of the previous meeting that the question had been raised as to the effect of vibration on the plates of an accumulator; and Mr. Manville had brought before them some experiments which he had made, and to which it was demurred that they were not conclusive. Now he knew of a case which was on record and had been on record for many years which absolutely settled the point, namely the cells used on the Brighton and South Coast line for lighting the carriages. They got the most violent shaking it was possible for anything to get. It was a very well-known fact that these accumulators did not deteriorate by the shakings to which they were exposed. He was very much interested in electric traction, and had before him cases where accumulators could be worked under the very finest conditions from the accumulator traction point of view.

* Mr. J. W. SWAN shared with Prof. Ayrton the hope that the difficulties in connection with accumulator traction were not insurmountable, and had felt a good deal reassured on reading the Paper, taking into consideration Mr. Epstein's great experience both in the manufacture and use of accumulators. It was satisfactory to find that in such cases as the non-successful lines at Birmingham the difficulties were remediable. He quite agreed with charging the cells at constant potential rather than at constant current, as it was certainly a step towards making the cells more useful in connection with motor traffic since it shortened the time so considerably in charging. With regard to Mr. Manby's remarks, it was astonishing to find that although it was 16 years ago since the first "box containing millions of foot-pounds of energy" was brought over from Paris the question had seemed to be quite given up as to the possibility of the Planté cell competing with the Faure type. Now the Planté type appeared to have commended itself in several points of superiority, more particularly in connection with the positive plate, and notwithstanding the experience of the last 16 years they were still debating which cell was the right thing. He noticed that some of the chief English makers of batteries had apparently, after long experience, come to the conclusion that the Faure type was the better. One of his reasons for mentioning this was that the late Mr. Alfred Tribe should get whatever credit or honour there was due in the origination of a plate of the Faure type. He quite agreed with Mr. Epstein that it was far better in the long run to completely renew plates that had become inefficient than to adopt the doubtful economy of patching up.

* Mr. E. TREMLETT CARTER said that since the last meeting he had inquired into the matter of the advisability of series-paralleling the cells rather than the motor fields and armatures. He had found that that method of re-arranging cells had in several instances been adopted for traction work, and only a few days ago he came across a motor car now running about the streets of London in which 40 cells were arranged in groups of 10, the car being started with the four groups in parallel. The cells were then put 20 in series, in parallel with the other 20, and all cells were then thrown into series. He had been told that the arrangement worked admirably, and it seemed to him a very effective way of starting. No resistances were used, and, besides giving low volts for starting, intermediate volts for intermediate speeds, and high volts for rapid speeds, it had the further advantage that the heavy current that existed when starting a car was not sent through all the cells, but was divided among the groups of cells. On starting they could have about two and a-half times the normal current; but if they had four rows of cells in parallel, instead of all the cells in series, then at the start each cell would not have as much as its normal current, but something under, and starting or slowing down would not impose a greater load on each cell than it would have at the maximum speed. The name of this car was the Headland's motor car.

Mr. M. HOLROYD SMITH thought one pleasing thing about the Paper was the fact that Mr. Epstein had not hesitated to tell them when he had had failures. In connection with the question of accumulators for traction work he was of opinion that Mr. Epstein had come nearer to the mark than anyone else. No battery could show its true merits in a few tests. The great question was duration. A battery had been offered him last summer which was to give 3 H.P. for 2½ hours with a total weight of 300lb. He would not dispute that such a thing was obtainable, but he had positively declined to give a report upon this battery or any other unless he could be shown that there was a chance of the battery lasting for 12 months. Again, most of the batteries which had been brought before him were stated to be capable of doing so many miles of work. This he considered to be an exceedingly rash statement for anyone to make, because naturally the state of the roads to travel and the number of stoppages to be made would be a consideration in determining the number of miles a battery would travel. The statement should be confined to the discharge of a battery at varying rates, and let it devolve upon the user of it to say how many miles he could get out of it. They could take the very best battery, and if they were obliged to run the car with a bad motor or some old-fashioned and useless gearing, so that the tractive force was very high, it would be against the interests of the battery. He perfectly agreed with Prof. Ayrton in his doubts as to the tractive force necessary, and he, in all his calculations on the subject, never took it at less than 100lb., and he believed that in practice this would be very much nearer the mark than the low figures given by some of the speakers. They had not only to consider the force to maintain the movement of the car, but they had to consider the force required to start a car from a state of rest into a speed, and in London, for instance, they had to be always stopping and slowing. A point in which he did not quite agree with Prof. Ayrton was his advocacy of using the accumulators in series and parallel instead of attempting to use the armatures and fields of the motors in controlling the speed. In the early days of tramway work the method of varying the coupling the batteries had been tried over and over again, and, he had been emphatically informed, was never successful, because they were always having varying discharges from the varying batteries. They never maintained the batteries at the same strength. He not only used the dual armature motor for the purpose of being able to vary the power of the motor, but he took advantage of dual armatures to enable him to dispense with the differential gearing in driving a car by having each wheel separately driven by one of the armatures, so that they could get a mechanical advantage as well as an electrical one.

Mr. T. PARKER said the batteries on the Birmingham line had always been used as described by Prof. Ayrton—viz., quarter, half, three-quarter and whole batteries. The chief objection was against using three-quarter, but nothing was found objectionable when using the others.

* Mr. J. BROWN said that the amount of tractive force required varied in proportion to a constant, which constant varied from 2 on very good wooden pavements in London, for instance, to 14 on such roads as they had in Ireland. He quite agreed with Prof. Ayrton that the power at present calculated for electric motor cars was too small, and this had been the case with all kinds of motor cars. As a would-be designer of a carriage for private use, what he wanted was a battery that would give him a very high discharge for a short time. He did not want a battery which would last for five hours, but one which would give 80 or 100 amperes for one hour and a-half.

The PRESIDENT reminded the members that the whole of the discussion had, as yet, gone on the question of batteries. He thought they would like to hear something about the other parts of a motor car. Would Prof. Smith kindly give them some particulars about gearing at the next meeting; and if anyone else would give particulars of the other parts he was sure it would be appreciated.

The discussion was then adjourned.

ELECTRIC LIGHTING AND TRACTION NOTICES.

Subjoined is a complete list of the new electric lighting and traction concerns advertised in the *London Gazette*. Of the electric lighting notices 13 are metropolitan; 75 are applied for under Provisional Orders, and 10 additional applications are to proceed by Bills in Parliament. The total of these is therefore 98. Of the electric traction notices (excluding light railways, which are dealt with under a separate heading) 11 are metropolitan and 84 are provincial. The numbers for the last seven years are as follow:—

—	1891.	1892.	1893.	1894.	1895.	1896.	1897.
Lighting ..	34	20	32	32	41	61	98
Traction...	15	15	17	13	37	61	45

The numbers show that a healthy increase both in electric lighting and traction enterprise has developed during the last year.

Electric Lighting Notices.

THE METROPOLIS.

District.	Name of applicant.
Bermondsey	Vestry.
Bermondsey, Rotherhithe, Greenwich, and Lewisham	County of London and Brush Provincial Company.
Bethnal Green, Poplar and Whitechapel	County of London and Brush Provincial Company.
Holborn, St. Giles-in-Fields, and St. George, Bloomsbury	Charing Cross and Strand Electricity Supply Corporation.
Hornsey	Urban District Council.
Lewisham	Great Western Electric Light and Power Co.
Do.....	District Board of Works.
Marylebone	Vestry.
Do.....	Central Electric Supply Company.
Do.....	Marylebone Electric Supply Company.
Do.....	County of London and Brush Provincial Co.
St. Giles-in-the-Fields, Holborn, Lincoln's Inn, Gray's Inn, and Staple Inn	County of London and Brush Provincial Company.
Willesden	Urban District Council.

THE PROVINCES.

Airdrie	Corporation.
Aldrington (Hove).....	Urban District Council.
Acton (Middlesex).....	Mr. James de Lara Cohen.
Aldershot	Urban District Council.
Aston Manor	Urban District Council.
Barnes (Surrey).....	Urban District Council.

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District.	Name of Applicant.
Batley	Corporation.
Bolton (Rural District)	Bolton Corporation.
Budleigh Salterton (Devon)	Salterton Gas Company.
Burslem	Corporation.
Birkdale	Urban District Council.
Chichester	Corporation.
Chelmsford (Rural Dist.)	Chelmsford Electric Lighting Company.
Chorley	Corporation.
Chislehurst (Kent)	Chislehurst Electric Supply Company.
Colne	Corporation.
Crewe	Corporation.
Dartford	Urban District Council.
Darlington	Corporation. [Extension of area.]
Doncaster	Corporation.
Bridgwater	Corporation.
Buxton	Buxton District Electric Light Company.
East Ham	Urban District Council.
East Stonehouse	Urban District Council.
Gravesend	Corporation.
Greenock, Port Glasgow and Gourock	North British Electricity Supply Co.
Hamilton	Corporation.
Hastings	Corporation.
Hereford	Corporation.
Haworth	Urban District Council.
Kingswinford (Staffs.)	Rural District Council.
Huyton-with-Roby (Lancs.)	British Insulated Wire Company.
Do. do. do.	Urban District Council.
Ilford (Essex)	Urban District Council.
Ilfracombe	Urban District Council.
Leamington	Midland Electric Light and Power Company.
Do.	Corporation.
Leatherhead	Urban District Council.
Leigh	Urban District Council.
Lewes	Corporation.
Lowestoft	Corporation.
King's Norton	Rural District Council.
Margam (Glam.)	Urban District Council.
Maidenhead	Corporation.
Melton Mowbray (Urban	Melton Mowbray Electric Lighting Company.
Middlesbrough	Corporation.
Mitchelstown (Ireland)	Board of Guardians. [area.]
Norwich	Norwich Electricity Company. [Extension of
Nuneaton and Rural Districts)	Nuneaton Electric Company.
Ossett	Corporation.
Oldbury	Urban District Council.
Partick (Glasgow)	Kelvinside Electricity Company.
Perth	Corporation.
Peterborough	Peterborough Electric Light and Power Co.
Penarth (Glamorgan)	Penarth Electric Lighting Company.
Prescot	British Insulated Wire Company.
Ramsgate	Electric Supply Corporation.
Rawmarsh	Urban District Council.
Rochdale	Corporation.
Rotherham	Corporation.
Rothesay	Corporation.
Ryde	Ryde Electric Light and Power Company.
St. Anne's (Lancs.)	Urban District Council.
Stafford & Worcester (portions of the counties of)	Midland Electric Corporation for Power Distribution.
St. Albans	Corporation.
Stourbridge	Corporation.
Smethwick	Urban District Council.
Stoke-on-Trent	Corporation.
Shrewsbury	Corporation.
Westgate-on-Sea	Isle of Thanet Rural District Council.
Weymouth and Melcombe Regis	Corporation. [Syndicate.
Weston-super-Mare	Weston-super-Mare Electric Light and Power
Warrington	Corporation.
West Bromwich	Corporation
Whiston	Rural District Council.

A special feature is the increase in the number of notices to proceed by Bill. In some cases the promoters already possess electric lighting powers, but are desirous of obtaining authority to extend the area of supply or an extension of powers. It will also be noticed that the list includes three gas companies, while the Yeovil Corporation seek powers to purchase the gas works and supply electrical energy.

The *Blackpool* Corporation are promoting a Bill to enable them to supply electrical energy or gas "in bulk" to any Local Authority within or beyond the jurisdiction of the Corporation. The *Bolton* Corporation seek an extension of their present electric lighting area. The Chelsea Electricity Supply Company wish to acquire or lease certain premises in the parish of *Chelsea* for the purpose of erecting an electricity station or stations. The *Enfield* Gas Company are "seeking powers to enable the Company to make applications for power to supply electricity." The General Power Distributing Company are applying for powers to incorporate a company to construct electricity supply works, and to supply electrical energy in the county of *Derby* and parts of the counties of *Nottingham*, *Lincoln* and the *West Riding* of *Yorkshire*. Some further particulars of this scheme were given in our last issue. The Isle of Thanet Gas Light and Coke Company desire to obtain powers to arrange a transfer of the Provisional Electric Lighting Order (1896) of the *Margate* Corporation. In the Southend Gas Company's Bill powers are sought to enable the Company to manufacture, purchase and deal in electrical or gas apparatus, to authorise the erection of electricity supply works, and to take a transfer from the *Southend-on-Sea* Corporation of their Electric Lighting Provisional Order (1891). The Tottenham and Edmonton Gas Light and Coke Company are promoting a Bill authorising them to engage in the generation and supply of electric current in the districts of *Tottenham* and *Edmonton*. The *Yeovil* Corporation (who seek powers to acquire the undertaking of the Yeovil Gas and Coke Company) also ask powers for the generation and supply of electric current. The Metropolitan Electric Supply Company are promoting a Bill authorising the use of lands at Willesden and Acton for the purpose of erecting electricity generating stations and for supplying electric current in the districts of *Willesden* and *Acton*, and, further, to enable the Company to provide for the supply of current from the Company's station at Amberley-road, Paddington, mains being laid along Acton-lane, Minet-avenue, Harley-road, Bramshill-road, Station-road, Tubbs-road, High-street, Harlesden, Harrow-road and Amberley-road. The Company also propose to lay a cable along the towing path of the Grand Junction Canal from the Company's works in Willesden and Acton through Willesden, Acton, Hammersmith, St. Mary Abbott's (Kensington) and Chelsea, terminating at Amberley-road station.

Electric Traction Notices.

THE METROPOLIS.

Name of Applicant.	Powers Sought.
Hornsey and Finchley Tramways Co.	To construct tramways and to effect junctions with the North Metropolitan system.
Charing Cross, Euston, and Hampstead Railway Company	To construct additional railway from Charing Cross-road to Craven-street, Strand, and to enter into working and other agreements with the South-Eastern and North-Western Railway Companies.
City and South London Railway Company	To revive and extend powers sanctioned by 1893 and 1895 Acts.
Southwark and Brixton Hill Railway Company	To incorporate company, to construct railway from the City and South London line in St. Saviour's, Southwark, to Brixton-hill.
Great Northern and City Railway Company	To make extensions of the line authorised by their 1892 Act, for the purchase of additional lands for electricity generating station, &c., and for an extension of time.
Metropolitan Railway Co.	To use electric traction on the joint lines of the Company and the Metropolitan District Railway Company, and on any railways of the District Company over which the Metropolitan Company hold running powers; also to purchase lands for an electricity generating station.
Paddington and Charing Cross Railway Co.	To incorporate a company, to construct an underground railway between Paddington and Charing Cross, to alter and lower the level of the Baker-street and Waterloo Railway, between Vigo-street and Cockspur-street, and to employ electric traction.
Commissioners of Sewers (London)	To construct railways in the parishes of St. Nicholas and St. Paul, Deptford.
New Cross and Waterloo Railway Company	To incorporate a company, and to construct underground railway between New Cross and Waterloo-road.
London and United Tramways Companies	To construct additional tramways in Hammersmith, Acton, Chiswick, Richmond, Kew, New and Old Brentford, Heston, Isleworth, Hanwell and Ealing.
Woolwich and South-East London Tramways Co.	To construct tramways in Woolwich and Plumstead.

THE PROVINCES.

Blackpool Corporation	To construct and equip tramways.
Blackpool and Fleetwood Tramroad Company	To construct additional tramlines.
Blackpool, St. Anne's and Lytham Tramways Co.	To extend tramway system.
Blackburn Corporation	To purchase undertaking of the Blackburn Corporation Tramways Company and to construct additional tramways.
Brighton Underground Railway Company	To incorporate company, and to construct an underground railway in Brighton.
Bury Corporation	To work local tramway and to construct additional lines.
Burnley	To work and improve the Burnley tramway system.
Bristol Tramways and Carriage Company	To construct additional tramways and to equip existing lines electrically.

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Name of Applicant.	Powers Sought.
Caledonian Railway Co...	To work Glasgow Central Railway electrically.
Cardiff Corporation	To construct additional tramlines and to equip same electrically.
Carlisle	To incorporate company, and to construct tramways.
Clontarf and Hill of Howth Tramways Co.	To incorporate company for the construction of a tramway between Clontarf and the Hill of Howth (Dublin).
Dundee Corporation	To acquire and work coasting tramways, and work same electrically.
Eccleshall District Council	To construct tramways.
Folkestone, Sandgate and Hythe Tramways Co.	To incorporate company, and to construct tramways in Folkestone, Sandgate and Hythe.
Great Crosby District Council	To construct tramways, and to enter into agreements for sale or lease of lines.
Hastings and St. Leonard's-on-Sea Tramways Company	To incorporate company, and to construct a system of tramways in Hastings and St. Leonard's.
Keighley Corporation ...	To confirm and legalise the construction, and to provide for the maintenance of existing tramways.
Leyton District Council	To construct tramways.
Linthwaite District Council	To construct tram lines.
Llandudno and Orme's Head Tramway Co,	To incorporate company, and to construct tramways in Llandudno, and from Llandudno to Orme's Head.
Llandudno District Council	To construct tramways in Llandudno and Eglwysrhos (Carnarvon).
Liverpool Corporation ...	To construct 63 additional lengths of tramline in Liverpool and suburbs.
Manchester Carriage and Tramways Company	To electrically equip their tramways and to construct additional lines.
Plymouth, Devonport and Stoke Tramways Company	To incorporate company, to construct tramways, and to enter into agreements with the Plymouth and Devonport Corporation for supplying electrical energy.
Norwich Electric Tramway Company	To extend their tramway system.
Oldham Corporation.....	To work the local tramways.
Portsmouth Corporation.	To acquire and work tramways authorised by the Landport and Southsea Act (1863) from the Portsmouth Street-Tramways Company.
Plymouth Corporation ...	To construct additional tramways.
North Staffordshire Tramways Company	To construct tramways in Stoke-on-Trent, Newcastle-under-Lyme, Hanley, Fenton, and adjoining districts.
St. Helens Corporation...	To construct additional tramways, and to work existing lines.
Waterloo-with-Seaforth Urban District Council	To construct tramways and to enter into agreements as to sale or lease of lines.
West Ham Corporation...	To work the local tramways and to construct other lines.
Wigan.....	To construct additional tramlines.

PROJECTED LIGHT RAILWAYS.

During the past month 30 applications were lodged with the Light Railway Commissioners for powers to construct light railways; 16 of these are for electric traction lines, as against 10 in May last. The following is a list giving particulars of the 16 electrical schemes, which represent a total length of 125¾ miles:—

Proposed Light Railway.	Country.	Promoters.	Agents.	Length in miles.	Motive power.	Gauge.	Engineer.
						Ft. in.	
ENGLAND—							
Bournemouth, Poole, and District	Dover and Hants.	Bournemouth, Poole and District Railways Company	W. M. Webb and Co.	15	Electric	3 6	Kincaid, Waller and Manville.
Bradford and Leeds.....	Yorks.	T. Beanland and Others	Baker, Lees, and Co.	5½	Do.	4 8½	G. Hopkins & Son.
Brighton	Sussex.	British Electric Traction Company	S. Morse	4¾	Do.	3 6	S. Sellon.
Christchurch and Poole.	Hants and Dorset.	British Electric Traction Company	S. Morse	15¾	Do.	3 6	S. Sellon.
Finchley and Hendon ...	Middlesex.	Finchley, &c., Light Railways Co.	W. M. Webb and Co.....	9	Do.	3 6	Sir D. Francis, D. Fox
Folkestone and District.	Kent.	Folkestone, &c., Light Railways Co.	Ashurst, Morris, and Co.	15½	Do.	4 8½	S. G. Fraser.
Hastings and Bexhill ...	Sussex.	Hastings, &c., Light Railways Co.	W. M. Webb and Co.....	12½	Do.	3 6	Kincaid, Waller and Manville.
Hastings & St. Leonard's	Sussex.	British Electric Traction Company	S. Morse	4	Do.	3 6	S. Sellon.
Kinver	Staffs.	E. Garcke and Another	S. Morse	4	Do.	3 6	S. Sellon.
Middleton	Lancs.	British Electric Traction Company	S. Morse	8¼	Do.	4 8½	S. Sellon.
N. Shields, Tynemouth, &c.	Nrthmbld.	British Electric Traction Company	S. Morse	2	Do.	3 0	S. Sellon.
Potteries Extension.....	Staffs.	British Electric Traction Company	S. Morse	4	Do.	4 0	S. Sellon.
Rochester, Chatham, &c.	Kent.	Rochester, &c., Elec. Railways Co..	Ashurst, Morris and Co.	14½	Do.	4 8½	S. G. Fraser.
WALES—							
Llanfair and Beaumaris	Anglesea.	J. F. Firbank and Others.....	J. C. Ball	6½	Do.	2 6	W. Myers Beswick.
Penarth and Cardiff.....	Glam.	Cardiff Light Railways Company...	W. and W. M. Bell	4	Do.	4 8½	V. B. D. Cooper.
SCOTLAND—							
Coatbridge and Airdrie..	Lanark.	British Electric Traction Company	S. Morse	3	Do.	3 6	S. Sellon.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, December 3rd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Permanent Way: its Construction and Relaying," by Grote Sterling.

MONDAY, December 6th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:40 p.m. Second General Meeting of the Fourteenth Session in the Lecture Hall of the Sunderland Literary Society, Fawcett-street, Sunderland. Business: (1) Minutes of the last General Meeting will be submitted for confirmation; (2) the ballot for new members will be taken; (3) presentation of gold medals for thirteenth session; (4) the Discussion on Mr. Archibald Hogg's paper on "The Comparison and Construction of Ships' Lines" will be resumed; (5) Paper on "The Theory of the Centrifugal Pump and Fan" will be read by C. H. Innes; (6) Discussion.

SOCIETY OF CHEMICAL INDUSTRY.

8 p.m. Meeting of the London Section in the Chemical Society's Rooms, Burlington House. Paper to be read: "The Sulman-Teed Process of Gold Extraction," by H. L. Sulman and Dr. F. L. Teed.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II.: "Gutta-Percha," by Eugene F. A. Obach.

TUESDAY, December 7th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "On the Law of Condensation of Steam," by Messrs. Hugh L. Callendar, F.R.S., and John T. Nicolson.

RÖNTGEN SOCIETY.

8:30 p.m. Ordinary General Meeting in the Medical Society's Rooms, 11, Chandos-street, W. Paper to be read: "Adjustable X-Ray Tubes," by A. A. Campbell-Swinton.

WEDNESDAY, December 8th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Asbestos and the Use of Asbestos in Electrical Engineering," by B. H. Adler.

THURSDAY, December 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Annual General Meeting.

FRIDAY, December 10th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) An exhibition of an apparatus for self-acting temperature compensation of a Standard cell, by Albert Campbell; (2) "On Lord Kelvin's Absolute Method of Graduating Thermometers," by Mr. Rose Innes.

SATURDAY, December 11th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7 p.m. Graduate Section. The Third Meeting of the Ninth Session in the Institution Lecture Hall, 4, St. Nicholas-buildings West, Newcastle-upon-Tyne. Business: (1) Mr. C. W. Cairns will reply to the discussion on his Opening Address; (2) Paper on "Some Methods of Filtering and Heating Feed-Water," by A. H. Burbidge, will be read and discussed.

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ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.—By J. ELTON YOUNG. This work will be issued early in 1898. Some extracts from the book have already appeared in *The Electrician*, from which it will be seen that the latest practice in Electrical Testing for Telegraph work has been treated by the Author.

THE ELECTRIC ARC.—By Mrs. AYRTON. This work will shortly be published, and will contain an historical sketch of the early experiments on the electric arc, as well as the important results of recent research.

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ELECTRICAL POWER DISTRIBUTION.

"It is impossible to force one unvarying system on varying conditions," so Mr. C. H. WORDINGHAM truly declares in his Paper on "The Distribution of Electrical Energy," which we commence this week to reprint. With this reservation he proceeds to recommend an almost unvarying system of electrical distribution, to be adapted to all requirements in every varying condition of supply. Apparently there is a contradiction here between the precept and the recommendation, but when the matter is looked into more closely the disparity may be less glaring. The central doctrine, if such it may be called, in Mr. WORDINGHAM'S Paper is that, for purposes of distribution and consumption, continuous current should invariably be used, and that this consideration should in no way be influenced by the particular requirements in regard to power transmission. A distribution network, in other words, is to be regarded as a thing to be considered by itself and solely on its own merits, the manner in which the network is to be fed being a totally independent matter. Sometimes the network will be fed by a number of low-pressure stations, sometimes by sub-stations equipped with transformers and connected to a high-pressure continuous, single-phase or polyphase central station. This indeed would appear to be a close approach to an unvarying system, so far as the distribution network is concerned; and it will be a matter for surprise if a doctrine so trenchantly radical in its scope does not excite hostile criticism in many quarters. Noting in passing the variations permitted, it may be remarked that Mr. WORDINGHAM allows considerable latitude in the electrical pressure on the mains, and in the selection from two-wire, three-wire, five-wire, and similar systems. We reiterate his hope that the Board of Trade will never be induced to raise the limit of low pressure to 800 or 900 volts—at any rate for continuous currents, or for alternating currents of a harmfully-low frequency. Some day, indeed, we may see the limit of

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officially-recognised low and safe pressure for high-frequency raised to several thousand volts, but with continuous current the safe limit has already been closely approached.

Mr. WORDINGHAM'S defence of continuous-current distribution is mainly based upon the contention that it gives us what we want. He is less careful to inquire if it does not sometimes give us what we do *not* want, or if other systems cannot be made to render in an equal degree the things that are desirable. For lighting purposes we do not deny "continuous current is as good as alternating," and for some purposes it is better; but against the sins of alternate currents in regard to induction may be set the evil tendency of a continuous current to set up electrolytic destruction of gas and water mains, and to increase fire risk through the same electrochemical process. And as to the ability of rival systems to give consumers what they want, surely the polyphase system is not behind the continuous current in that respect! Without wishing to suggest that we consider polyphase distribution in all respects and in every circumstance superior to continuous-current distribution, we should have no difficulty in mentioning several instances where the former would be superior. Take one example: for a network supplying electrical power to some extent for lighting, but chiefly for motive-power purposes, as in a milling district or among collieries, especially where the use of brushes and commutator is attended with danger, one or the other modification of the polyphase system, suitable for combined lighting and power purposes, is undoubtedly preferable to the simple continuous current. Upon a nation of mere shopkeepers the beauties and advantages of polyphase distribution would be utterly wasted, for the plain, unvarying, direct current is all that is required to keep their lamps glowing. But a people needing electrical energy for other purposes than lighting, and especially a nation that long has prided itself in—and should still continue to be worthy of—being placed in the front rank as an engineering and industrial people, may not improbably soon discover that the polyphase system possesses merits unknown to its rivals. It may seem monotonous to be repeatedly pointing to foreign practice; but in this instance we are compelled to do so again, for both in America and on the Continent polyphase distribution of power for factories, milling districts and general purposes has become a proved success.

REVIEWS.

Instruments et Methodes de Mesures Electriques Industriels. By H. ARMAGNAT. (Paris: George Carré et C. Naud.)

"Practical Electrical Measurements" might be taken as the equivalent of the rather unwieldy title of M. Armagnat's work, but the book is a general one; and the special modifications to meet the needs of the manufactory, the electric lighting station, or, for the matter of that, the telegraphic testing-room, are not dealt with. The author's connection with the Carpentier firm should place him in a position of advantage for the composition of a book of this kind, and there is little left for the reviewer to do beyond indicating what is to be found in it, and what not. On the title page the publishers have taken time by the forelock, and placed the date 1898, but of the instruments and methods described it may be said at once that the older ones are treated most fully, the newer ones by comparison scantily, and some of the newest not at all. Part I. begins with suspensions and the theory of "damping." Galvanometers and electrometers are dealt with at considerable length. Resistances and standards follow. In the matter of standards it may be noted that the author does not consider sufficient trial has been made with the cadmium cell to enable him to pronounce upon its qualities. Before one gets to voltmeters, ammeters, and so on, half the book is done, and what follows is less satisfactory. It is not only that one may differ from the author as to the particular patterns of instrument to be selected for description, but the treatment is unequal. For instance, take the instrument that determines the gross receipts of all electricity supply companies. That is decidedly a practical matter. But if anybody consults M. Armagnat on "electricity meters," he finds first of all a page and a-half wasted in explaining (in the language of the integral calculus forsooth) that if the voltage is constant a current meter will do, and that if the consumer always has the same number of lamps on circuit a closed-circuit-hour meter suffices. Two of these latter are described. Chemical meters are rightly dismissed in a few lines, but the Thomson instrument is made to stand as the representative of the whole class of motor meters and gets less than a page and a half. Four pages follow on the Aron meter (hardly in its latest form); and with half a page more on the Frager meter, which is a discontinuous integrator, the inquirer would go away, if not empty, at least dissatisfied. In another chapter, however, there is a brief description of the Shallenberger instrument, with the warning that it must not be used on a circuit containing arcs or motors. Part II., which deals with measurements requiring the combination of more than one instrument, opens with a chapter on the cumulation of errors which is calculated to damp the enthusiasm of those who would carry things unto the third and fourth place of decimals. Bridge methods naturally have a large amount of space devoted to them, but as in Part I. the further one goes on the briefer becomes the treatment, so that magnetic measurements and the problems of the alternating current are rather poorly served, and at the very end the questions of phase difference are settled in a single page. There is no index, but a table of contents at the end gives one some sort of an idea whereabouts to look for anything among the 570 or so large pages which make up the book.

The Dynamo. By S. R. BOTTONE. Tenth edition. (London: Swan Sonnenschein and Co., 1897.)

This little book is intended as a guide to the amateur dynamo builder, and the fact that it is now represented by its tenth edition is evidence that Mr. Bottone's exposition of the art of dynamo building is appreciated by the amateur electrician, who eagerly grasps at any and every attempt to furnish him with non-mathematical instructions of a nature by which he will be enabled—with the limited means usually at his disposal—to produce results. But while the practical and detailed instructions for making a small dynamo to which Mr. Bottone limited his earlier editions might be looked upon as useful in stimulating in the youthful experimenter further interest in electrical phenomena, we cannot so regard the present extension of the book wherein, in a relatively voluminous appendix, is given instructions for the building of a six-unit dynamo of very indifferent design. While Mr. Bottone's extensive experience of small and toy dynamos and motors is useful to such applications, the rules of design in which the experience in such matters seems to have resulted should not be mistaken for the principles which govern the design of dynamos of a more serious order.

"Steam Boilers Constructed by Yates and Thom." Written and compiled by W. H. FOWLER, M.I.M.E., Assoc.M.Inst.C.E., &c. (Manchester: The Scientific Publishing Company, 1897.)

We hesitated to treat this work as one falling into the category of those legitimately taking a place in our review columns. It is avowedly a catalogue, and as such it might seem to find a more appropriate reference in the Trade Notes. But it is in reality something more than a catalogue, and sufficiently different from that necessary but generally uninteresting species of literature—*pace* those who say that literature is all fiction!—to justify a notice of it in this place. If we were asked to define succinctly the work before us we should say that it is a practical treatise on steam generating plant written round the manufactures of a leading firm of boiler makers. If it should be thought that the blend is not likely to suit either student or prospective customer, we can only recommend a careful perusal of Mr. Fowler's book as an antidote to the opinion.

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The early portions of the book deal with such matters as the choice of a steam boiler, the rating of boilers, boiler efficiency, the testing of boiler materials, and with other boiler tests. Two sections on fuel, and a succeeding one on smoke prevention, give useful information, after reading which we come to some practical directions for boiler setting and chimney construction. A well-illustrated section discusses "Steam-pipe Arrangements," and is followed by sections on feed-water heaters and economisers. The middle portions of the book are devoted to illustrated descriptions of various types of boilers, most of the drawings being made to scale. Boiler feed-pumps and injectors are described in later sections, together with sundry other matters relating to auxiliary apparatus. The work concludes with a number of useful tables of data. Altogether this is a practical and useful compilation, that should be in the hands of steam users and students of steam engineering. It is none the less useful because it is an *ex parte* publication.

STORAGE BATTERIES.*

BY E. J. WADE.

(*Continued from page 126.*)

Built-up Supports.

Besides those supports, cast or otherwise, manufactured all in one piece, a variety of forms have from time to time been designed which are composed of a number of parts separately prepared, and afterwards joined together by bolting, rivetting, burning or casting, according to the nature of their construction.

Sellon described a support in 1881 consisting of a number of strips of perforated lead, set edgeways, with small spaces between them, and then cast in a frame. Epstein proposed a somewhat similar form in 1887, but in this instance the strips were provided with projecting pins or ridges to keep them from close contact with each other.

Double Grids.

By far the most numerous of this class, however, are the double grids, consisting of two grids joined back to back, generally in order to overcome some difficulty involved in constructing them all in one piece, such, for instance, as in the production of grids with undercut cell walls. Grids of this type have been designed by Maxwell-Lyte, Correns, Andreoli, Gadot, Humphreys, Doubleday, Gibson, Riker, Roberts and Wheeler amongst others, while in one or two instances triple grids have been proposed. The first three of the above have already been described. Doubleday's grid had several smaller cells on one side opening into one larger one on the other, and when the two grids were put back to back the large holes were innermost.

Gibson's support is constructed by punching and pressing out rectangular tongues alternatingly on either side of flat lead plates, so as to stand at an angle of about 45deg. Two such plates are then joined back to back, either with the tongues interlocking, as shown in Fig. 20, or with their tips bearing against each other as in Fig. 21.

Humphreys' support, patented in 1882, consisted of a number of bars of oval, diamond or other section, set diagonally, after the manner of the laths in a Venetian blind, and cast in a frame (*see* Fig. 22). These could be used either singly or two of them together as double grids, and with the bars either parallel or at right angles to each other (*see* Fig. 23). In the illustration of the bars at right angles it will be noticed that the two sets do not touch each other, but have a space left between them to allow for a larger proportion of active material.

Tube and Trough Supports.

Another type of built-up supports are those in which the active material is contained in perforated tubes or open troughs. Sellon, in 1881, proposed to construct electrodes by placing a number of perforated lead tubes filled with active material close alongside each other and then casting a frame round them (*see* Fig. 24.)

Fig. 20.

Fig. 21.

In 1890 Foote patented an electrode prepared from a single length of perforated tube bent backwards and forwards on itself to form a rectangular plate of the desired dimensions.

Fig. 22.

Adjacent bends of the pipe were burned together in order to strengthen the electrode and reduce its resistance.

In the same year Pitkin and Holden patented their ladder electrode. This consists of a number of open troughs of

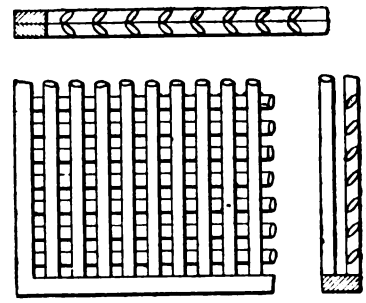

Fig. 23.

channel section lead placed vertically above each other with small spacing pieces in between them, and then united by casting on two vertical side bars, after which the spacing pieces

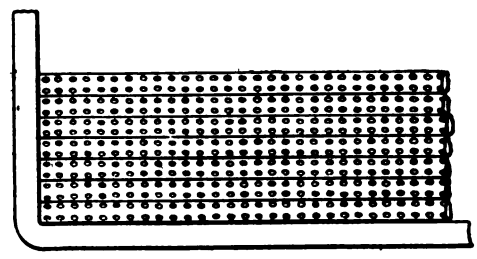

Fig. 24.

are withdrawn. Fig. 25 shows a portion of an electrode of this kind in vertical and longitudinal section. The active material is placed in the troughs before they are connected together.

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Pins project into it at intervals from the bottom of the troughs for the purpose of ensuring a better contact with the support. In a modification of this support, patented in 1893, Pitkin greatly simplified its construction. The troughs were made in the first place with solid ends and projecting feet of the same depth as the spacing required between the troughs. To build up the electrode these troughs simply have to be piled on each other and burned together down the two ends without casting on any extra metal, the feet forming the spacing pieces and the solid ends the main connecting bars (*see* Fig. 26).

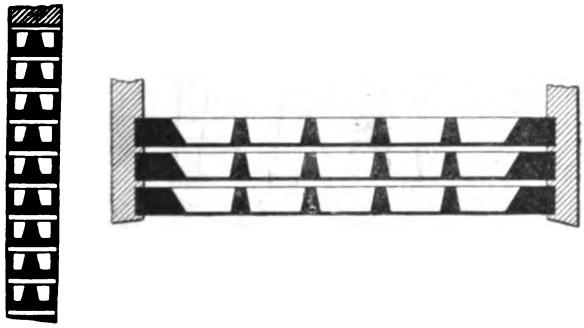

Fig. 25.

A patent for a somewhat similar plate, also having a vertical series of troughs set in a frame, was obtained by Winkler in the United States in 1892. The troughs in this instance were of a V-section, and could either be of metal or of some insulating material with conducting rods lying along their bottom. Electrodes differing in details of design from those already described have been patented by Schneider in 1896, but their main features are the same, *i.e.*, perforated tubes or open troughs set in a frame.

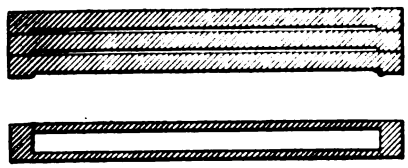

Fig. 26.

Headland's support, patented in 1892, might also be described as built up of a number of lengths of perforated tube, only the perforations are so numerous and of such a size that the tubes resolve themselves into long narrow rectangular frames or grids, consisting of four uprights joined together on all sides by numerous cross-bars. Fig. 27 shows a length of one of these hollow bars partly in plan and partly in longitudinal section; also a cross-section. To constitute an electrode a number of these bars are set parallel to each other in a frame, a small space being left between each to allow for the electrolyte to circulate round them on all sides.

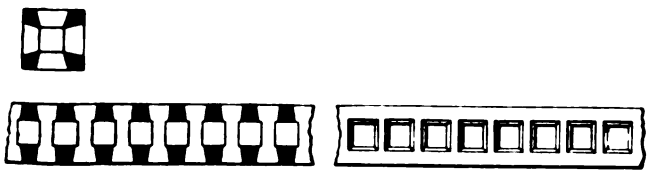

Fig. 27.

According to a later design of grid bar, the four uprights are replaced by eight—four outer and four inner bars—of much slighter construction, and joined together at intervals by three horizontal ledges or shelves, so that altogether considerably more space is provided for active material than in the earlier type.

Moulded Pellet Electrodes.

The class of electrodes in which the active material is prepared and shaped in separate pieces before attachment to the support, generally by casting the latter round them, do not present any very novel features so far as the design of the grids is concerned. In pasted electrodes the grid determines the shape, size and disposition of the pellets of active material but here, of course, the reverse is the case, and the pellets and their spacing determine the grid. A description of the grid resolves itself therefore into one of the arrangement of the active material. In this method of manufacture it is just as easy to construct the supports with undercut or concave cell walls as of any other design, merely by using pellets with a corresponding convexity on their edges, and most of these grids will be found to possess this feature.

Maxwell-Lyte appears to have been the first to propose the construction of plates in this way in connection with the use of lead chloride as active material. He patented the process

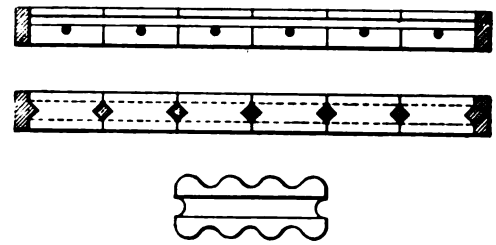

Fig. 28.

in 1888, and specified that the pellets or studs should be provided with collars or projections on their edges of such a form as to be retained in place by the support. Besides casting a grid round the studs, he also proposed to use two half-grids with taper cells, and to burn them together after the pellets had been inserted, while, according to a later patent of the same year, in order to secure better conductivity, he placed a solid metal plate between the two half-grids against which the broad bases of the pellets rested.

Epstein described some electrodes of the same class in 1884, but in this instance rectangular pellets of active material were packed close together, and the support cast either through

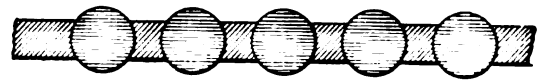

Fig. 29.

holes in their interior or in recessed grooves in their edges, so that none of it appeared at the surface of the plate. Fig. 28 shows a section of a plate of the former description with round holes passing through the centre of the pellets at right angles to each other, and one of the latter kind with triangular grooves round their edges. The single pellet illustrated has a semi-circular groove round it, but the channels running across its surface are also intended to be filled with metal, which will constitute an additional conductor and support.

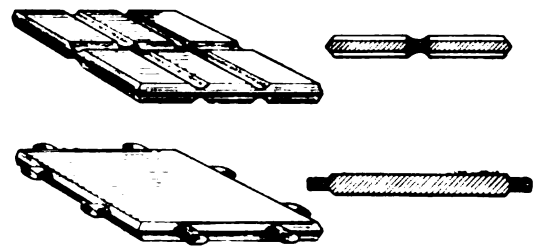

Fig. 30.

In 1886 Reckenzaun described electrodes having frames cast round pellets of active material, the form of plate he preferred containing cylindrical rods about 1in. long and ¼in. in diameter. Their curved surfaces projected on both sides of the plate, which was about ⅛in. thick. Fig. 29 shows such a plate in cross-section. In the same year Frankland patented an electrode very similar to that of Reckenzaun, but the cylinders of active material were flattened down to form flat convex-edged tablets of the same thickness as the frame to be cast round them. Also in 1886, Beaumont proposed to apply the same method of construction, more especially in

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connection with active materials of the "lithanode" type, which had just recently been introduced by FitzGerald, Fig. 30 shows two of the various forms of pellets described. the one simply having convex or bevelled edges, and the other projecting pins in addition, to key it still more securely into the frame. Either small pellets with flat faces could be used, or larger ones with a network of channels crossing their surfaces, and holes passing from side to side at their points of intersection, as illustrated. The object of this latter arrangement is to keep down the weight of the frame as much as possible, while at the same time providing efficient support and conduction to all parts of the active material.

In 1887 Laurent-Cély applied for a patent for an electrode similarly constructed to those already described, and using lead chloride for the raw active material; but this was successfully opposed and consequently not granted. In 1890,

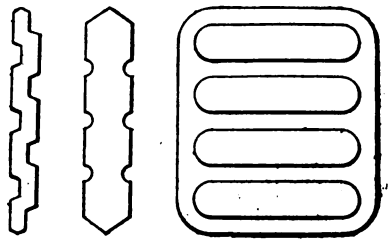

Fig. 31.

however, in conjunction with Timmis, he obtained a patent for the same kind of plate, in which very full details are given regarding the processes of manufacture. Fig. 31 gives a plan of one of the forms of pellet illustrated, and two typical cross-sections, from which it will be seen that they embody very similar features to those of Epstein and Beaumont, already described—that is, bevelled or convex edges to afford a firm grip to the frame, and cross channelling of their faces to further subdivide the exposed surface. In later forms of the plate, however, these surface bars have been largely abandoned.

Grooved Supports.

Generally speaking, the main difference of construction between grid supports and grooved supports is that in the

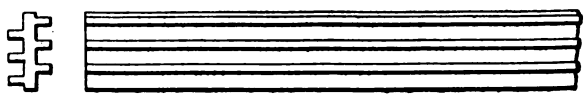

Fig. 32.

former the holes are open right through from side to side, while in the latter they are closed and separated into two by a solid core plate or backing passing down the centre. Fig. 32 is a cross-section of Swan's grooved support already referred to.

Brush's first United States patent for pasted electrodes, applied for in 1881, also shows a variety of designs for grooved plates, some of which are illustrated in Fig. 33. The con-

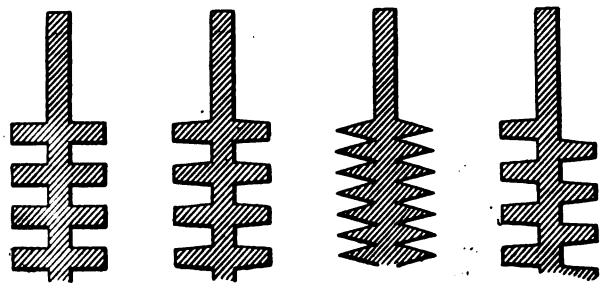

Fig. 33

struction of Ludor's early type of grooved support is given in Fig. 34, on an enlarged scale. In all these forms the ribs are at right angles to the plane of the plate, but it was early perceived that if the ribs sloped upwards, the receptacles for the active material afforded a much better support. In one of Brush's United States patents of 1882 a support is mentioned whose ribs in cross-section resemble the teeth of a saw (*see* Fig. 35), and Hochausen also illustrated a similar construction in 1883. Since that time many grooved supports have been proposed, and they are largely used at the present day, but this type does not appear to afford the same scope for novelty of design as he grids, and hardly any require special description. Van

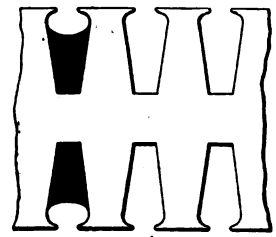

Fig. 34.

Gestel in 1888 described a support in which ribs projected at right angles from a solid core plate, but after pasting it was passed through rollers, and the ends of the ribs turned up parallel to the plate, so as to convert them into shallow troughs.

In practice most grooved supports are strengthened by ribs running across the grooves at intervals, and dividing them up into a series of oblong cells or pockets. In 1892, Heyl pro-

Fig. 35.

posed to slot these bars from end to end and so allow for expansion of the active material in the grooves, this being substantially the same as his method, already described and illustrated, of providing for a similar growth of grid supports.

Studded Supports.

Another class of supports also possessing a central core plate are those which have numerous pins or projections on either side instead of ribs. Sellon illustrated one of this kind in 1881, and proposed to burr over the ends of the pins in order to give a better hold upon the active material in between them. Brush included studded plates amongst the various designs claimed in his patents of the same year. Pitkin described a very similar construction in 1886, and Pollak in 1889 patented a rolled support of the same type, which is now manufactured on a commercial scale in Germany.

A rather curious studded plate was patented in the United States by Starr in 1883. In this instance the pins were perforated and the circular walls remaining then turned over and spread out by pressure or other means.

(To be continued.)

MANCHESTER ELECTRIC SUPPLY SYSTEM.

In conjunction with the useful Paper on "The Distribution of Electrical Energy," commenced in our issue this week, by Mr. C. H. Wordingham, the electrical engineer to the Manchester Corporation, a few notes and illustrations relating to the present stage of development of the system of electric supply in that city may prove of interest to our readers.

Shortly after the opening of the central station in Dickinson-street we gave a detailed description thereof, which will be found in Vol. XXXI., p. 613. At that time the spacious boiler and machinery rooms were but scantily stocked with plant, ample space having been purposely held in reserve for extensions. The boiler house is 132ft. long and 70ft. wide, and is now equipped with 12 Lancashire boilers (Fig. 1). Each boiler measures 30ft. by 8ft., and has a heating surface of 1,120 sq. ft., and a grate area of 35 sq. ft. A mechanical stoker of the coking type is fitted to each furnace. The feed-water arrangements include four donkey pumps, each having

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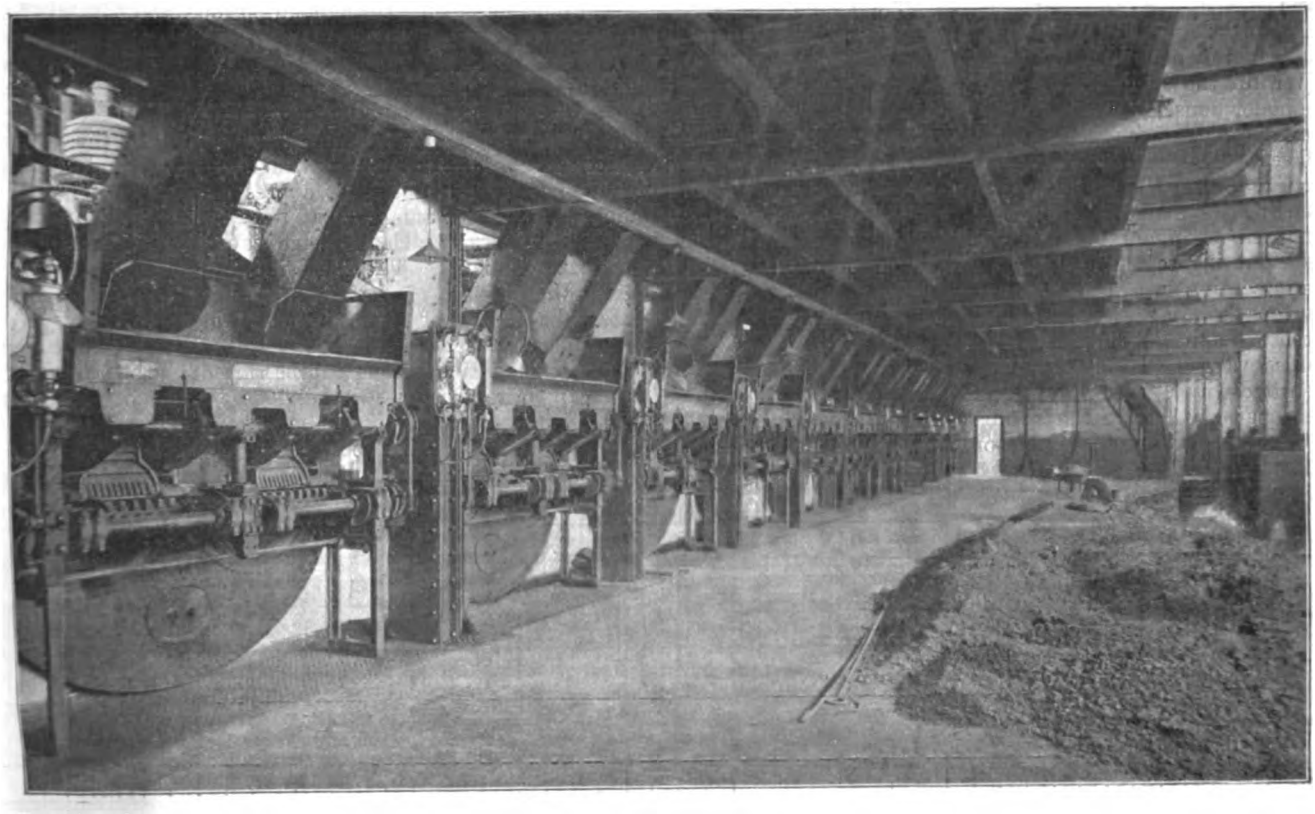

FIG. 1.—Manchester Municipal Electric Supply Station. Boiler House.

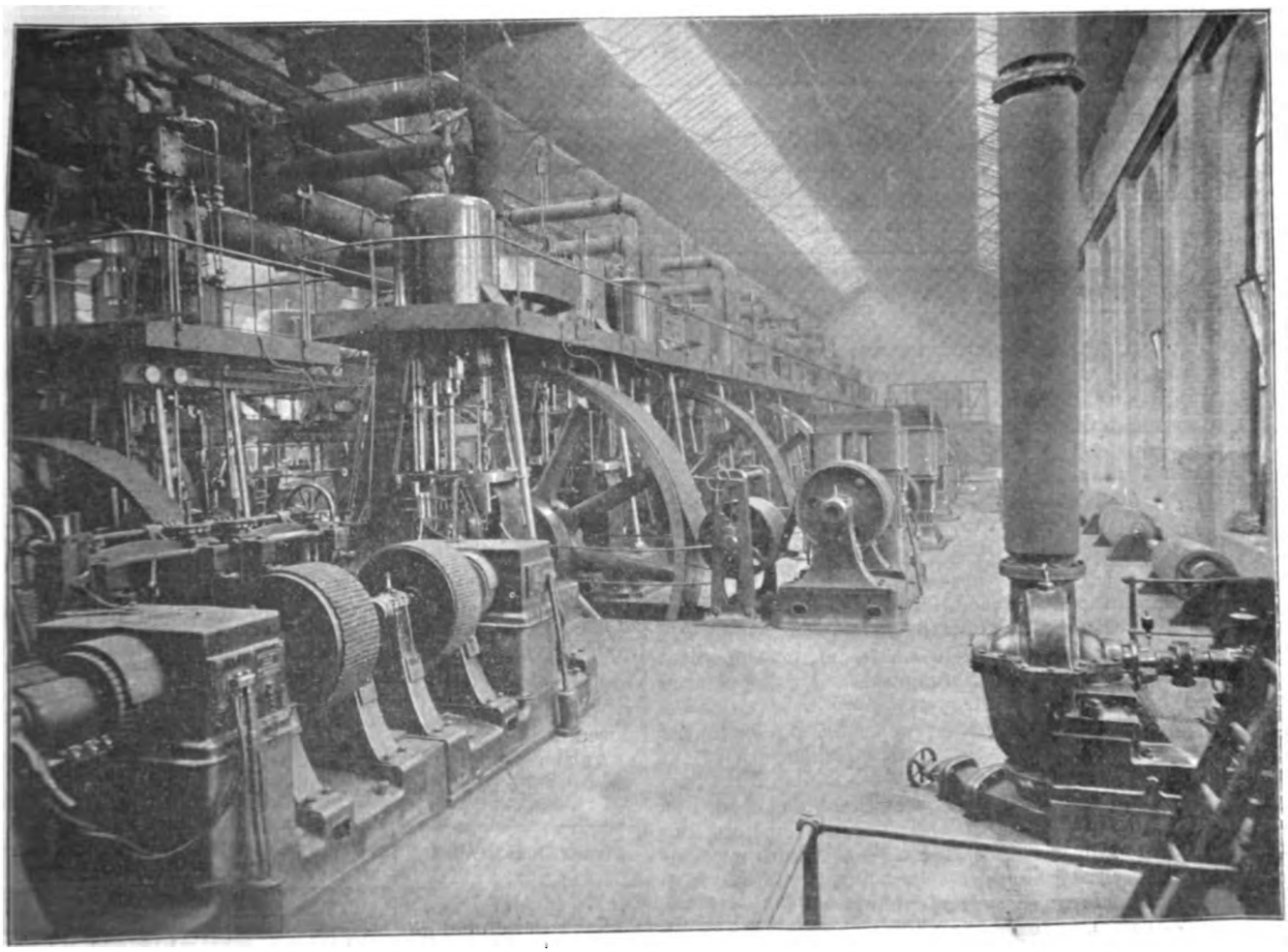

FIG. 2.—Manchester Municipal Electric Supply Station. Machinery Room.

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a capacity of 34 gallons per minute, three injectors of the same capacity, and a storage tank of 40,000 gallons capacity. It is worthy of notice that the steam and feed-water mains are duplicated throughout.

Within the spacious machinery hall (Fig. 2) that adjoins the boiler house, and stands on somewhat higher ground, all available space for generating plant has practically been utilised. The earlier sets comprised steam engines of the vertical marine type belted to the continuous-current generators; later additions, however, are of a different pattern, comprising horizontal slow speed engine sets. There are now 14 generating sets, 12 of which are of the vertical type and the remaining two of the alternative type. The former each develops 400 H.P., and runs at 78 revolutions, half of this batch of engines being fitted with slide-valves and half with Corliss valves. The latter are also each of 400 H.P.; they are fitted with Corliss valves and run at 85 revolutions, and are rope-geared to the dynamos. The plant in this room also includes two motor-generators of 15-kilowatt capacity at 100 volts.

without undue heating. This is by far the largest continuous current generator hitherto built in Europe, and it marks a new departure in English practice.

One of the most important features of the Manchester system is the large battery sub-station, situated in five arches beneath Hunt's Bank.

The battery comprises 224 cells, supplied by the Chloride Electrical Power Storage Syndicate (Limited), and is capable of supplying 600 amperes at a pressure of 400 volts for 2½ hours. It is so arranged that it can be split up into four separate batteries, each of which can be connected between any pair of mains. The batteries are normally charged in series, the pressure of the mains being raised to the requisite extent by means of a motor generator; if necessary, each can be charged separately. The number of cells connected in each circuit of each battery can be varied to the extent of 12 by means of regulating switches. The whole of the connections have been worked out in solid bare copper rods, and the station is absolutely fireproof.

As is well known, the mains are arranged on the five-wire

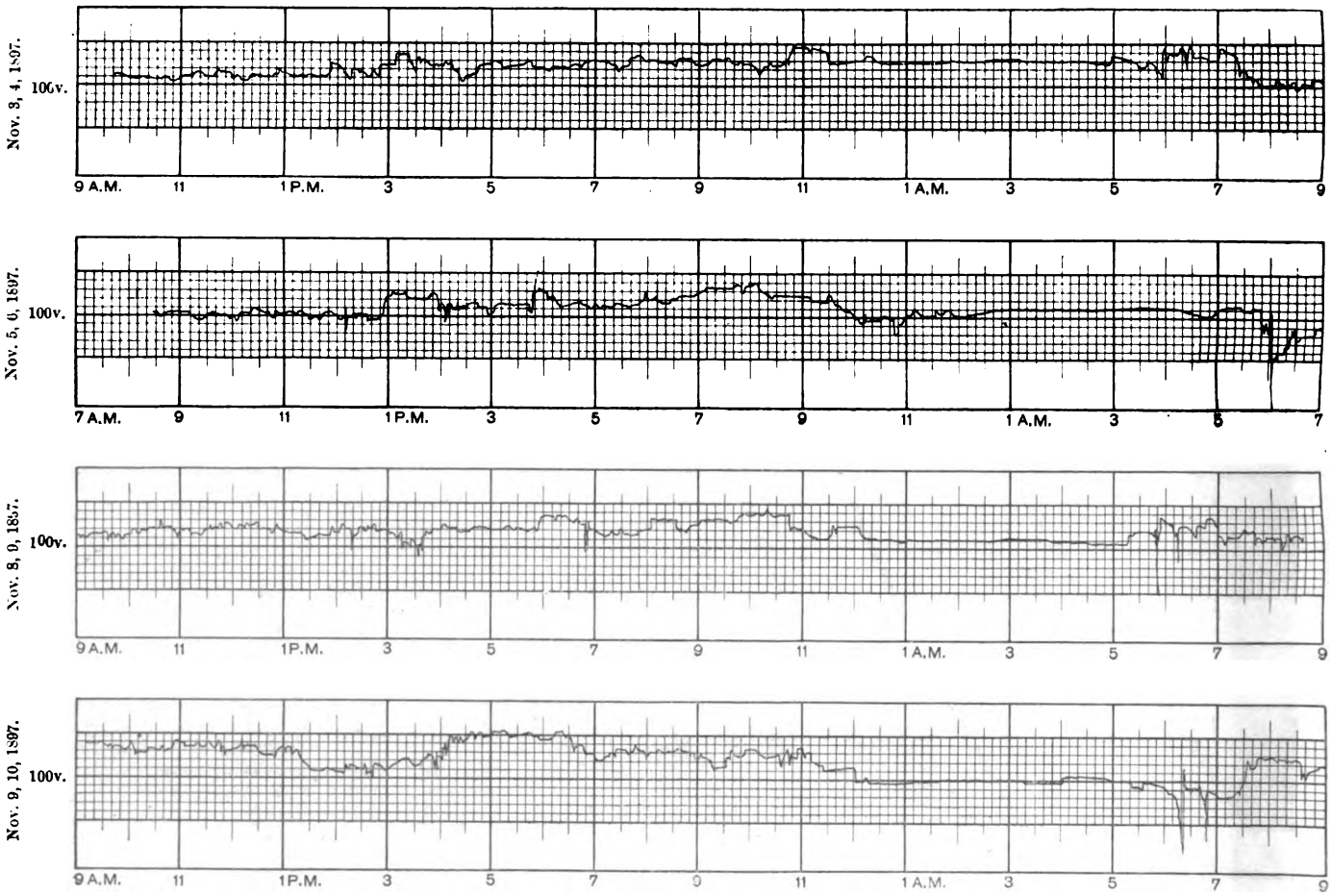

FIG. 3.—Curves showing Variation of Pressure on the 5-wire electric supply mains at Manchester. The curves were taken on a consumer's premises.

Extensive alterations and additions to the system are now going forward. Six small vertical balancing sets, comprising 100 H.P. vertical engines belted to small dynamos of about 60 kilowatt capacity, have been removed, and their place is being filled by two large horizontal sets now in course of erection. Each of these consists of a 2,500 H.P. Corliss engine direct-coupled to the generators, which are of the multipolar type. The dynamo of each set is placed between the two halves of the engine, the armature being carried on the same shaft as the flywheel. Only two bearings are thus required, and these are swivel bearings. The armature weighs 30 tons and the flywheel 80 tons. Oil will be supplied at high pressure to all bearings. The dynamo will give 3,500 amperes at 410 volts, or the same output at any pressure up to 500 volts with correspondingly diminished current. In case of emergency it will give 4,750 amperes at 430 volts

system. Particulars of this system are given in Mr. Wordingham's Paper, so a detailed account here is unnecessary. We may, however, refer to the degree of steadiness maintained in the regulation of the pressure on these mains, and nothing we could say could better indicate this than the curves reproduced in Fig. 3.

At the present time there are the equivalent of 165,880 lamps of 8 c.p. connected. The quantity of current sold each year has been as follows:—

Year ending March 31.	Quantity sold.	Total maximum supply demanded.
	B. T. units.	
1894 (8 months)	439,370	651,500 watts.
1895	1,168,382	1,187,000 watts.
1896	1,748,244	2,082,600 watts.
1897	2,508,588	2,737,400 watts.

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Two rates of charge are in operation: (1) 5d. per unit, with a minimum of 8s. 4d. per quarter, (2) £7 per kilowatt of maximum demand plus 1½d. per unit consumed. For motive power guaranteed not less than 4 H.P. for 48 hours per week, the simple charge of 1½d. per unit is made,

Not less interesting than the engineering features are the financial results. Supply was begun on July 31, 1893, and in March, 1894, it was found that, although the revenue had only been earned for eight months of the year, it was sufficient to defray all charges of the undertaking, including interest on loans, provision for sinking fund, &c., to within £210. The profits during subsequent years were are follows:—

—	Gross profits.		Interest on loans, &c.	Amount transferred to sinking fund.	Surplus, being net profit.
	Amount.	Percentage to capital.			
	£ s. d.		£ s. d.	£ s. d.	£ s. d.
1894-5	13,648 6 1	9·03	4,391 10 4	3,547 8 3	5,709 7 6
1895-6	20,549 12 8	9·63	5,149 4 6	4,261 18 2	11,138 10 0
1896-7	31,116 8 8	11·10	7,171 9 7	7,132 11 0	16,812 8 1

Borrowing powers were in the first instance obtained for £80,000, then for £70,000 more, and since then borrowing powers have been increased twice by £100,000. The total capital expenditure to March, 1897, amounted to £309,291. A further sum of £130,000 has recently been applied for. The cost of production, exclusive of capital charges, has been as shown below:—

Costs per unit sold.

Year.	Coal.	Oil.	Wages.	Repairs and maintenance. — Plant, buildings, mains, &c.	Works costs. — Total.	Rents, rates, and taxes.	Management expenses. — Salaries, office & legal expenses.	Total costs.
1893-4 (8 mos)	1·33	0·31	0·64	0·13	2·41d.	0·15	0·44	3·00d.
1894-5	0·50	0·23	0·55	0·21	1·49d.	0·19	0·49	2·17d.
1895-6	0·42	0·15	0·38	0·27	1·22d.	0·22	0·36	1·80d.
1896-7	0·40	0·11	0·26	0·17	0·94d.	0·20	0·32	1·46d.

In conclusion, we have pleasure in expressing our indebtedness and thanks to Mr. C. H. Wordingham for his kindness in supplying us with many of the particulars embodied in this article, and for the photographs and curves from which the illustrations were prepared.

THE DISTRIBUTION OF ELECTRICAL ENERGY.*

BY C. H. WORDINGHAM, A.M.I.C.E., M.I.M.E., M.I.E.E.

The nature of the problem of distributing electrical energy has, during the last few years, undergone a complete change. When the first attempts at supply were made, there was usually one of two distinct classes of demand to be met. There was either a cluster of consumers taking a fairly large amount of energy, gathered together in a small compact area, or a number of isolated consumers scattered over an extended area, with long distances intervening between them. Low-pressure supply was obviously the best in the one case, high-pressure the only possible in the other. This sharp contrast between the two classes of demand led to the independent development of the two systems of supply. Each manufacturer devoted himself chiefly to one or other, and thus, unconsciously perhaps, acquired a strong bias in favour of the system he affected, since it was necessarily to his interest that it should be used. The strange spectacle was then presented of two actually hostile camps of engineers, each proclaiming that his own system, or perhaps party would not be an inappropriate word, was the best under all circumstances, and his adversaries were devoid of all understanding. The high-pressure party flattered themselves that they were the most far-seeing, while the low-pressure boasted that they alone conducted their work on commercial lines, the other party being merely enthusiastic visionaries. It is impossible to force one unvarying system on varying conditions, and hard fact overcame, as it always must overcome, prejudice, and as time went on, the high-pressure party had to admit that in small compact districts their rivals were far more successful than themselves both financially and from an engineering point of view; while they had the satisfaction of seeing the low-pressure party compelled to adopt high-pressure as the area of their operations extended. It is to be feared even now this controversy is not quite defunct, but it is far less bitter, and cannot fail shortly to disappear.

Improvements in consuming devices and the cheapening of supply have caused the intensity of the demand, that is to say, the quantity of energy demanded per mile of main to become already very great, and in the near future there can be little doubt that it will be enormously increased, while at the same time the area to be supplied is increasing by leaps and bounds, hence it is clear that the problem now is not comprised in either of the two classes above referred to. Of course, there will always be a certain number of towns in which, owing to local circumstances, there can never be a large demand for electric or any other form of energy, and in which distribution, in the sense in which the word is used of a large city, will never be required, but in towns of any pretence to large size it seems abundantly clear that there will have to be given a supply of electrical energy in large quantities over extended areas for every variety of purpose, whether it be lighting, heating, power, or electrochemical or other industries. This Paper is not concerned with exceptional cases, it being directed to the requirements of cities and towns of considerable magnitude. Now in such towns it appears to the author indisputable that there should be a low-pressure network to which consumers can be connected directly without the necessity for any intervening apparatus on their own premises, and to which such connection can be made at all times without interfering with the supply to other consumers in any way. In his opinion it is equally essential, though he is well aware that it will by no means be universally admitted, that the current supplied to consumers should be continuous and not alternating. This opinion is based upon the fact that for all purposes of consumption continuous current is as good as alternating, with perhaps the solitary exception of some processes of electric welding, while it is undoubtedly superior to it for arc lamps, and for motors in which a variable speed is required, while for certain purposes, such as electro-plating, charging secondary batteries, and certain electrochemical industries, it is indispensable. The superiority of continuous current for arc lamps may be challenged, but what better evidences can be adduced than the fact that most stations giving an alternating supply either employ rectifiers for their street lamps or run continuous-current generators for that purpose.

So far the consumers' aspect of the question only has been put forward; but considered from the point of view of economy and convenience of supply, there are equally cogent reasons in favour of continuous current. In the first place, it admits of the use of batteries, and so enables the load on the generators to be equalised over the 24 hours, and also relieves them from momentary shocks when many motors are at work, securing also better regulation of pressure. It may be argued that with alternating systems batteries can be used through the intervention of a motor generator; but for maximum economy it is essential that they should be kept as close to the consumer as possible in the chain of transmission. And, moreover, the capital cost of batteries is already high enough without adding the cost of an equivalent capacity of motor generators. It may, indeed, be argued that batteries are at present too costly to admit of their use on a sufficiently large scale, but the obvious reply is that even if this be so at present the system should be so laid down as to admit of their use later on if, as can hardly be doubted, the cost should be reduced by improvements or discoveries. In the author's opinion, the ideal to be aimed at in central-station work is the cultivation of a long-hour load from consumers, and the provision of a battery large enough to keep a good proportion of the generating plant economically employed during the night, and to take the whole of the peak or temporary excess over the all-day load during the afternoon and evening. Facilities for the use of batteries are not the only advantage of continuous current. By its use the choice of mains is left quite unrestricted, since the only loss in the conductors is that due to resistance, and there is no danger of causing disturbance to telephone lines. The importance of this is great, for when alternating currents are used it is usually, though not universally, considered that concentric cables are essential. Now without disputing for a moment that connection can be, and is, made to such mains with the current on, it can hardly be denied that separate cables are much more easily and safely dealt with, besides which, it surely is undesirable to cut one or two of the main conductors every time a T-joint is made. That these objections are real is shown by the recent adoption by a few engineers of a cable composed of three separate ordinary cables laid up together within a lead case, though the author is not aware whether such a cable has been found to be equivalent in all respects to a concentric cable. Whether this be so or not, it is clear that with alternating current there cannot be used a system of mains which has proved to be one of the most satisfactory and durable in existence, viz., bare copper. The vibration inseparable from alternating currents gives rise to troubles from which continuous-current apparatus is free. Thus

* Paper read before the Northern Society of Electrical Engineers.

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fuse connections are apt to become loose, causing the fuse to go unnecessarily, and clamped connections of all kinds cannot be relied upon so confidently as in the case of continuous current. There is yet a further respect in which alternating-current distribution is at a disadvantage, and this is in the question of meters. Owing to the impossibility of employing permanent magnets, it is necessary to resort to an electromagnet in order to ensure the instruments starting with small currents, and this leads to waste of energy. When inductive circuits have to be supplied, additional difficulties are met with in ensuring accurate measurements.

It must be clearly understood that the author is only advocating the use of low-pressure continuous-current on the distributing network. How that network is to be fed is dependent absolutely upon local conditions. It may be best if land can be obtained at a reasonable price, and if there are facilities for cheap coal and condensing water, to have several low-pressure stations, or it may be preferable to establish one low-pressure station for the densest portion of the area, and one high-pressure station for the remainder. Or again, the character of the demand may be such as to give rise to material benefit by throwing the whole load on one or two high-pressure stations. There are many considerations which enter into the question, and it would be idle to say that any particular system is best under all circumstances. The cheapest and best system to be adopted cannot be settled *à priori*; the point which it is desired to emphasise is that this is simply and solely a question of feeding the network, and that the network *qua* network can be considered by itself and on its own merits. The feeders may be low-pressure ones emanating from many low-pressure generating stations, or they may be supplied from a number of sub-stations in which continuous-current generators are driven by motors fed at high-pressure with either continuous or alternating current. The author is strongly of opinion that single-phase alternating current is less suitable for this purpose than either continuous or multiphase, and he believes that it will ultimately pass out of use entirely, but as to the relative merits of multiphase and continuous currents he does not wish to offer an opinion at the present time. Assuming that it is admitted that the distributing network can be discussed on its merits, the first point to consider is: What should be the pressure of supply to consumers? and intimately connected with this the further question: Should the system of mains be 2-wire, 3-wire, or 5-wire? Now, here again local considerations must to some extent enter into the question. Undoubtedly the pressure on the network should be as high as is consistent with safety, with the fulfilment of the Board of Trade regulations, and with economy to the consumers as regards lamps and apparatus. This society has already had very ably put before it the case for 200-volt supply, and every day strengthens this case by the invention of improved apparatus for use in connection with it. It may be taken that a 200-volt supply is most suited to the requirements of the majority of districts, but in streets where there are a number of small shops where two small arc lamps would be readily taken up, while four would be prohibitive in price, and where the first cost of the lamps is a material consideration, the author ventures to think that it is still advisable to supply at a pressure of 100 volts. This pressure also is undoubtedly advantageous where very small motors are required, while it possesses the further advantage that at the present time, when a large number of private plants are still in use, it greatly facilitates the changing over of the installation to the town mains.

Two-wire has apparently nothing but simplicity to recommend it in preference to multiple wire distribution, and in point of fact it is now but little used. Into the advantages of multiple-wire it is not necessary here to enter. All persons appear agreed that 3-wire is best suited for the work. The author may perhaps, however, be allowed to refer to the 5-wire system. This, as all are doubtless aware, is in use in Manchester alone in the United Kingdom, hence, few English engineers have had experience of it. There can be no doubt that its use requires a considerable amount of care in the balancing of consumers, but, provided that this point is attended to, it may be said, after just four years' experience, to be entirely successful, and the author is strongly of opinion that had it not been for the introduction of the 200-volt lamp, this system would have been adopted in all those towns in which a 3-wire supply is given, and which have recently changed over to a declared pressure of 200 volts. It may be observed in passing that had this been done there would have been far less difficulty in making the change. The advantages of doubling the pressure of supply are so obvious, and the readiness of all engineers to profit by the experience of others is so universal, that there can be little doubt on this point. Even now the 5-wire system cannot be said to be defunct, for, as pointed out above, it is still desirable to supply in certain cases at a pressure of 100 volts, but that it will ever be adopted on a large scale, now that 200-volt lamps have been introduced, is extremely improbable, unless indeed the Board of Trade should be persuaded to raise the limit of low-pressure to 800 or 900 volts, which it is to be devoutly hoped it will never be induced to do.

In deciding the question of the pressure to be declared, it is important to bear in mind the interests of consumers and of manufacturers. Two arc lamps can be made to burn well in series on a 100-volt circuit, and it appears extremely unfair to consumers to declare a pressure of, say, 115 volts, and condemn them to waste in useless resistance 12 or 14 per cent. of the current taken by the arc lamps. Again, manufacturers incur considerable hardship, which they naturally pass on to their customers in the form of enhanced prices, by being compelled to hold a large stock of lamps of different voltages. It should be decided once and for all what is the best pressure for general supply, and this pressure should be adopted by all towns in the kingdom. Lamps could then be standardised, and not more than three or four pressures would be required. The author would venture to suggest that the best pressures are 100 and 200 volts for lamps and small motors, and 400 volts for large motors. This question of uniformity is one of vital importance at the present time, when production is so much hampered by labour disputes, and the author hopes to refer to it elsewhere more fully than could properly be done in connection with the present subject, and before a purely engineering society.

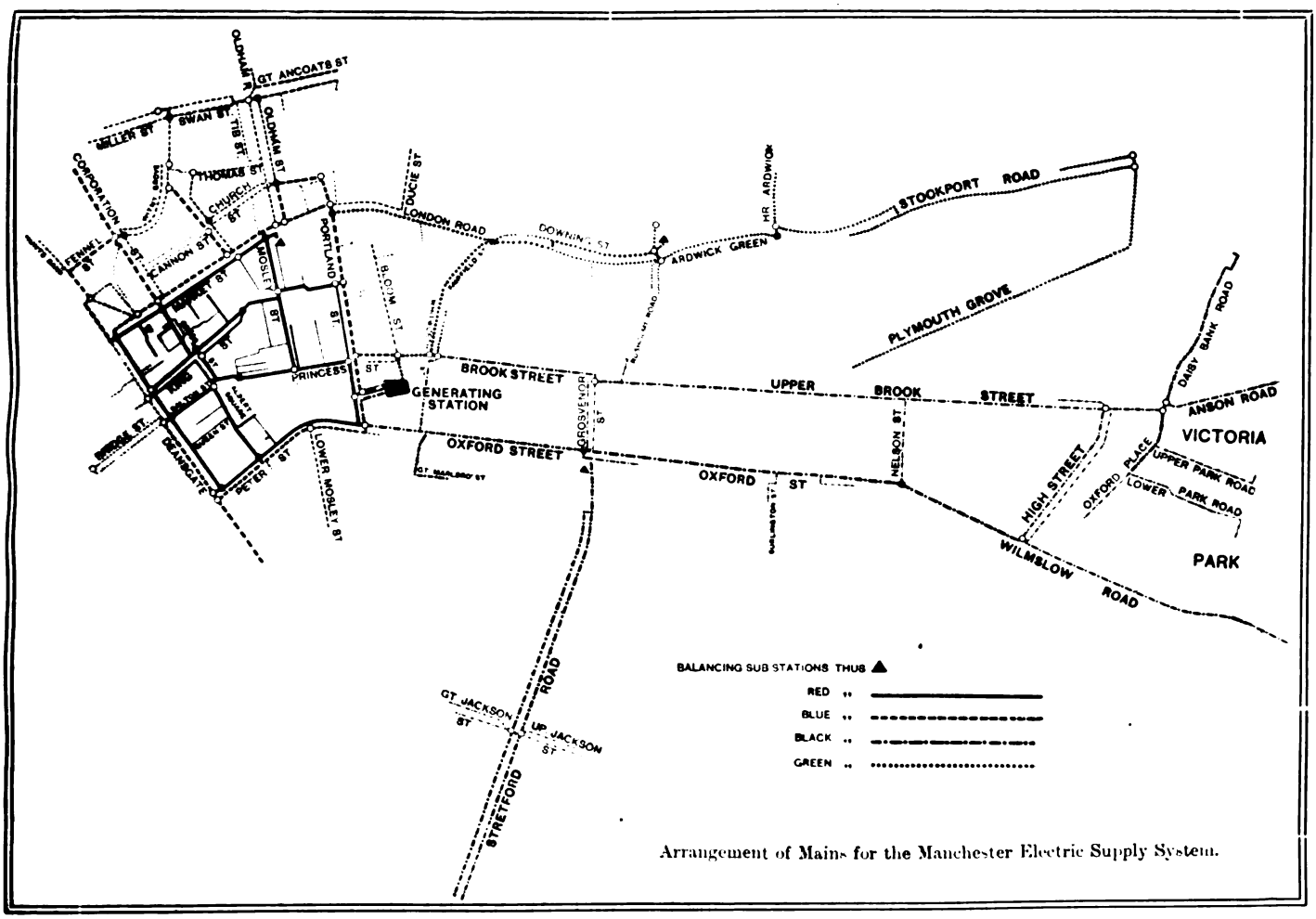
In multiple-wire distribution, the point to which most careful attention must be given to ensure successful supply is the balancing of the various consuming devices. This matter does not appear to be generally well understood. Many persons appear to think that if the current issuing from the station through the middle wire is small, the balancing is good. There could not be a greater mistake. Undoubtedly, if this current is large, the balancing is bad, but even if it be nil, the local balancing may be extremely uneven, and in consequence the pressure also. It is essential that so far as possible each street should be balanced in itself, and further than this, every consumer having a fairly large installation should have that installation split up and balanced in itself; in this way, and in this way only, can a satisfactory supply be given on the 3 or 5-wire system. In spite of all precautions, however, there must always be some want of balance, the amount and direction of which will vary from hour to hour. This may be dealt with either by having multiple wire feeders, or by the employment of balancing motor generators; the former method appears to be the more popular abroad, and the latter in England. In the author's opinion the latter is by far the most satisfactory, as being the simple, less costly, and as securing better compensation for want of balance. The next point to be settled is: Should there be one network for the whole city, or should there be a number of isolated networks? The argument in favour of one network is very strong. By interconnecting all points as far as possible, and by joining up every street at both ends, there is established as it were a conducting sheet on each pole from which current can be drawn, and if the demand is excessive at any one point the supply can flow to that point from all directions. The importance of this is great, for it is within the experience of every supply engineer that it is impossible in laying distributing mains to avoid occasionally underestimating the demand in a given street. If these distributors are connected at several points to the rest of the network this is of little moment. Moreover, the area of maximum demand is constantly shifting from hour to hour, and with such a network as that advocated less copper is required to deal with this than with a number of isolated networks, each of which must be large enough for its own maximum. Again, if the position of the demand has not been accurately foreseen, and the feeding point has not been placed in exactly the right spot, the error is practically eliminated by the network. With such a system also there is much less chance of being unable to reach a consumer in case of a fault. Against these advantages there would be nothing to urge if one could be certain that the insulation of the mains would always continue intact, but the best of mains will fail sometimes, and it may then be urged that the consequences are much more far-reaching than if there are a number of small independent networks. In point of fact, it is a question of the best means of maintaining continuity of supply. If it were feasible to arrange an automatic cut-off, whether in the form of a fuse or a mechanical circuit-breaker, so as to isolate any section of mains which become faulty, there would be no question that one network is preferable, but unfortunately such a system of cut-outs is practically impossible at the present time. For imagine a complicated network arranged with a cut-out on every section of main, and suppose a short circuit on a given section, this short circuit would allow a large quantity of current to flow for a short time. If all was in order, the circuit-breakers on that section of main would be thrown, but in order to throw these circuit breakers large currents must have flowed through other portions of the network in order to reach this section, with the inevitable result that if the circuit-breakers are set to cut off with extra current, they also are thrown, and the unfortunate engineer finds himself in the position of having perhaps a dozen cut-outs gone out of several hundred, with but a slight clue as to where these cut-outs are, as the course taken by the current will vary according to the conditions of the load at the time

If the question once be faced that a short circuit cannot be efficiently provided against by means of cut-outs, but has to be burned out, then the advantages of a large network become manifest, for the relative importance of a short circuit diminishes as the extent of the scale of operation increases. Consider the case of a station supplying half-a-million lamps, and distributing at 400 volts. When all lamps are alight their combined resistance between the outer conductors is only about one four-hundredth part of an ohm, and it must be an extremely bad short circuit which has, and can maintain, as low a resistance as this. There is a good chance of burning out a fault quickly if the network will admit of heavy currents being delivered at any point. In connection with the burning out of faults, it may be interesting to note that a cable is seldom burned out by fusion through excess of current. What really happens in the case of a short circuit is that an arc is established between conductors of opposite polarity, and this arc melts the conductors. If these are so enclosed that a supply of air cannot be kept up, the arc is soon choked out; the current required to burn out the fault is thus very much less than would be necessary if the cable were heated by the simple passage of current through it.

diately isolate it, leaving it, however, connected to the generating station, so that it is left to the discretion of the engineer in charge as to whether the supply shall be cut off from this section or not.

It may be of interest to the society to know what is the nature of the network in Manchester: this is shown in the diagram. It will be seen that there are four networks, coloured respectively black, red, green and blue; three of these networks are already connected direct to the generating station, while the fourth will shortly be so connected. The various networks are all united together at a fair number of points. These points will ultimately be somewhat reduced in number, and if satisfactory switches can be devised, they will be fixed at these points for use in the manner described above. Each network can be split up, and every length of main isolated by means of pillars, shown by circles on the diagram. The present feeding points are shown by larger circles with crosses. In connection with the question of balancing, there are at present four sub-stations with balancing motor generators.

The determination of the size of conductors to be put down is one of the most difficult problems which has to be faced. It must be recognised at once that, contrary to the case of feeders,



Arrangement of Mains for the Manchester Electric Supply System.

With a network so connected up, it is essential that means should be provided for conveniently, quickly and safely disconnecting any section while alive, either for testing purposes or for isolating a faulty main. The author has devised a piece of apparatus for this purpose called a pillar distributor, which appears to fulfil the necessary conditions. There are at the present time about 60 in use on the Manchester network, and the results have been extremely satisfactory. Their position is indicated on the diagram of the mains, which show clearly the circumstances under which they are used. Connections and disconnections are frequently made with these pillars while the current is on, but there has never been a short circuit or mishap with them, although in one case 1,700 amperes at 200 volts was broken, and in another the current flowing at a pressure of 150 volts through a dead short circuit was also successfully broken. The author's opinion is that in the case of a large city there should be only one network, but that this should be sub-divided into a number of smaller networks connected together at certain definite points. At these points should be fixed either automatic switches, or, perhaps preferably, switches operated electrically from the generating station, which, in the event of a fault on any one section, would immediately isolate it, leaving it, however, connected to the generating station, so that it is left to the discretion of the engineer in charge as to whether the supply shall be cut off from this section or not.

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The determination of the size of conductors to be put down is one of the most difficult problems which has to be faced. It must be recognised at once that, contrary to the case of feeders, mathematical calculation is of no avail, and the engineer has to fall back on his experience and judgment entirely; in fact, the probable demand for electrical energy in a given street, like many another engineering problem, is a matter of pure guesswork. The best practical rule in the author's experience is to settle upon certain standard sizes of main; in his own case these are $\frac{1}{10}$th square in., $\frac{1}{20}$th square in., $\frac{1}{4}$ square in., and $\frac{1}{2}$ square in., and after a careful inspection of the street in which mains are to be laid, to decide upon one or other of these, bearing in mind that it is safer to rather over-estimate than under-estimate, the demand for new developments of the uses of electrical energy are likely to lead to increased consumption, and, in a flourishing city, property tends to improve. Moreover, distributors once laid should never require to be increased in section. In multiple wire networks, the usual practice is to make the outer conductors larger than the intermediate, but the author prefers to keep all the same size. If this be done, and the above principle be followed, and if the network be well cross connected as suggested earlier in this Paper, it should be possible to deal with all future demands by adding to the number and section of the feeders. Of course it will be necessary to settle upon a current

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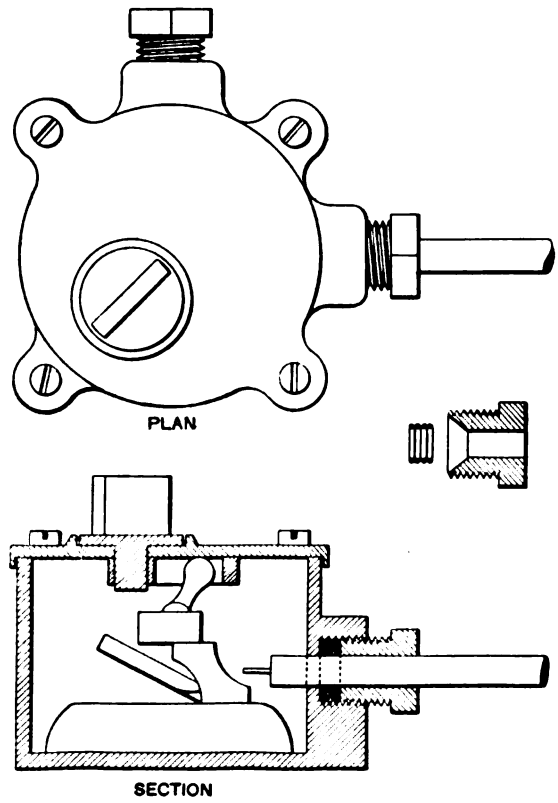
density at which to aim, and the author consider 600 amperes per square inch to be suitable for the average conditions of supply. Summarising what has gone before, we may take it that we have determined to establish a distributing network on the 3-wire system, with five wires in certain streets, and to give a supply of continuous current at a pressure of 200 and 400 volts, and also in special streets when there are five conductors at 100 and 300 volts. The next point to determine is the system of mains to be employed.

Several able Papers on the relative merits of different systems of mains have already been brought before this Society, and the author therefore begs the indulgence of members if, in stating his own experience and opinions, he traverses ground already familiar to them. What are the conditions which are to be fulfilled? In the first place, it is important that the mains should be so arranged that they can be tapped at any point along their length. They should not require that connecting boxes be laid down at predetermined points, for many of these will certainly be wasted, and many will be found to be in inconvenient positions necessitating either the entrance of the service line at an unsuitable point in the building, or the running of unnecessarily long connections. Jointing on of service lines should be easy, quickly effected, and should not require highly trained men or special contrivances. While low first cost is highly desirable, it is of greater importance that the mains should be of durable materials, and should be unlikely to fail, for the failure of a distributing main is of much greater importance than the failure of a feeder, since it is easy and comparatively not costly to provide reserve feeders, while it is out of the question to duplicate distributing mains. Further than this, the feeders can be readily withdrawn, while a distributor cannot be renewed without serious interruption of the supply, and excessive labour for rejointing. The insulation of conductors should be permanent and steady; it need not be extremely high. The system of distributors should be as flexible as possible, since it is always preferable to lay them under the footways and near the buildings, and many obstacles to a straight course are in consequence met with. The mains should afford security against fire, explosion, or other damage to person or property, and they should interfere as little as possible with the surface of the street or pathway. They should be unaffected by the soil, as well as by rats or other vermin.

(To be continued.)

WATERTIGHT FITTINGS FOR ELECTRIC LIGHT.

The accompanying drawings show a plan and section to a scale of about half full-size of a form of electric light switch for use out-



doors, in cellars, workshops and collieries, where protection from damp, dust, and mechanical injury is necessary. The switch is designed to have a snap on-and-off action. The stuffing boxes for twin or two-wire cables are packed with indiarubber, and a rubber ring is placed under the screwed-on lid, whilst a small quantity of tallow is placed in the recess in which the handle works.

For concentric cables having a bare return, one cable stuffing box only, is of course used, of which the gland is countersunk on its inside end, and tightens down on a spiral of lead wire or strip, instead of indiarubber. A detail of this lead spiral and stuffing gland is separately shown above the section drawing; these make a watertight joint and also an electrical connection without soldering; the gland can, however, be packed in the usual way, and the return conductor soldered to the gland.

These switches are being made by Messrs. John Davis and Son, of Derby, who also make wall-plugs and fuse-boxes on the same principle for either system of wiring. We may also mention that these switches, fuses and plugs, are also made up in combination watertight boxes of two to ten switches, or switch and fuse combinations under one cover.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Nov. 19, 1897.*

An Important Engineering Enterprise commenced in this City.—From a railroad standpoint New York city is unique, in that it contains within its limits only one railroad station, and it can be reached by railroad from only one direction—namely, from the north. This peculiar state of affairs is due to the geographical position of the city, which, in the main, is on a long tongue of land, forming an island about 13 miles in length and 2½ miles at its widest part. Railroads from the west and south and on Long Island are compelled to transfer their passengers across the river to New York city on ferry-boats, and some of the most important railroads of the country reach the city with their enormous traffic in this primitive fashion. Naturally, it has long been the desire of these corporations to land their passengers in New York city, and many projects have been floated in the past having for their object this much-desired result. So far, however, none of them has offered any probability of successfully accomplishing this purpose, save, perhaps, the projected bridge across the North River. To the east of the city lies Long Island, with a very large suburban population, and to bring these people into the city in the morning and take them out home at night is a very large problem in itself. The railroad trip, like that on the west, requires a ferry trip. The service is controlled entirely by the Long Island Railroad Company, and it is this Company which has taken the first steps in what seems to be a practicable plan of reaching New York city and landing its passengers right in the business districts. The Brooklyn, New York and Jersey City Terminal Railway Company is the name of a new concern which is to build a tunnel from Flatbush-avenue in Brooklyn, N.Y., where one of the Terminal stations of the Long Island Railroad is located, to a terminal in New York city. The width will be 9ft. 4in., and the height from the floor to the centre of the ceiling will be 8ft. 5in. It is proposed to operate trains by electric power. Four cars will constitute a train. It is hoped that trains can be run on one minute headway at a speed of perhaps 30 miles an hour, some automatic duplicate absolute blocking apparatus being provided to prevent rear-end collisions. The electric service will extend from the end of the tunnel in New York city to a distributing head house at Jamaica, 16 miles out on Long Island. In this station passengers for all points beyond Jamaica will change to the regular locomotive-hauled trains. The New York termini will be at the Pennsylvania Railroad ferry house at the foot of Cortlandt-street on the North River. This station will be reached by a shaft with a depth of 100ft., and by means of a set of elevators the cars will be reached by passengers with the utmost facility.

Consolidation of Wire Interests.—A few days ago it was currently reported that the various manufacturers of rubber-covered wire in this country proposed to consolidate their interests and carry on the entire business under one management, the object being to prevent the cutting of prices which has been going on for a long time as a result of the fierce competition for business. All of the prominent manufacturers

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were reported to have been favourable to carrying out the scheme, but later inquiries showed that the idea will not likely be carried out, owing to the difficulty of arranging terms and details to the satisfaction of all concerned.

Measuring the Frequency of Oscillations.—At the recent meeting of the American Association for the Advancement of Science a Paper was read by Margaret Maltby, in which she described a method for measuring the period of electrical oscillations based on the new application of the Wheatstone bridge principle. The two halves of the measuring instrument, which is an electrometer, form two arms of the bridge, and the other two contain a condenser joined to the electrometer needle and to the two pairs of quadrants, respectively. The relation that exists between the two when there is no deflection is a function of the rate of alternations of the current that passes through the system.

Electric Power in Flour Mills.—An interesting application of electric power in this country has just been brought to the attention of the public, in two of the most important flour mills on the Pacific Coast, at Fresno, Cal In one mill the power is supplied by a General Electric synchronous motor of 150-kilowatt capacity, running at 600 revolutions per minute. The motor is brought up to speed by a small bipolar motor. In the second mill the electrical equipment consists of three General Electric three-phase alternating-current induction motors operating at a pressure of 500 volts. The first of the three motors has a capacity of 75 H.P. It is belted to the main shaft of the mill, and drives all the flour-making machinery. It runs continuously for 24 hours, and for three months without a stop. The second largest motor in this plant is one of 30 H.P., and is used to drive all of the cleaning machinery. It runs continuously for 18 hours every day. The third motor, of 20 H.P., drives the rolls for grinding the corn and barley. Its work, however, is intermittent. It is estimated that the economy in actual power consumed in the mill last referred to by the present method of driving is not less than 15 per cent., and the total saving will pay for the electric motors, their installation and adoption in less than one year.

New Type of Electric Meter.—A meter of novel design, adapted to two and three-wire circuits at 110 and 220 volts, as ordinarily supplied for incandescent lighting and motor purposes, has just been brought out by a Philadelphia concern. These meters, which were designed by Prof. William D. Marks, consist of an ampere-meter, the indication of which determines the movement of an escapement operated by a pendulum, which is isochronously driven by the main current. The instrument consists of a heavy pendulum, which is kept in oscillation at the rate of about 40 beats per minute by means of a coil shunted across the mains, taking about 0·4 of a watt for its operation. The ampere-meter part of the instrument consists of a flat rectangular coil in two parts, surrounding a permanent magnet of the type employed in the Carpentier instruments. The movement of this is communicated to a metal sector, the lower end of which is cut to the shape of a curve generally similar to a logarithmic spiral. Against this curve the escapement movement actuated by the pendulum, bears in such a way that when no current is furnished there is no movement communicated to the train of indicating wheels by the escapement, but as current flows and the sector above referred to moves, the escapement is permitted to work through larger and larger arcs and moves the train of wheels in a corresponding manner. A very ingenious wiping contact for the coil actuating the pendulum is arranged so that it keeps itself clean and free from oxidation indefinitely. This instrument has been subjected to tests of long duration which have shown that the error averages about 0·7 per cent.

The United States at the Paris Exposition.—Major Moses P. Handy, special commissioner from the United States to the Paris Exposition of 1900, has returned to this country from Paris. He succeeded in obtaining a concession of 200,000 sq. ft. of space at the exhibition for the use of the United States' exhibits.

CORRESPONDENCE.

FLYWHEELS FOR ELECTRIC TRACTION ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am much indebted to you for having devoted considerable space in your issue of 19th inst. to an investigation of "The Problem of the Flywheel" in connection with electric traction.

If my "new gospel" be wrong it will be to the advantage of everybody that it be squashed forthwith; but if, on the contrary, it should be demonstrated to be correct, it will at least save this country from flywheel accidents which have become quite common in America. So much so, that the current issue of the *Electrical Review* of New York devotes about a page and a-half to this subject, and quotes two cases in which the aggregate destruction of property amounted to $85,000, accompanied in the one case by "a terrible loss of life," and in the other by "personal injuries."

I should like to point out that although I have been the first to state that a flywheel of abnormal size and power is neither necessary nor desirable in a traction power station, yet in this particular, practice has gone ahead of theory. There are now several sets of traction plant working successfully in this country; some of them have been put down by English engineers and some by Americans, but I do not know of a single instance in which abnormal flywheel power has been provided; but, on the contrary, the majority have quite small flywheels, and two have none.

I regret that in my contribution to the discussion on Mr. Dawson's Paper I appear to have cultivated "brevity" at the expense of "lucidity," otherwise you could not have so far misunderstood me as to have written "In his anxiety to make things right for the steam engine, Mr. Raworth appears to have forgotten that the public requires a smooth and regular service of cars," and again, "The practice may suit the engine well enough, especially if it be a frail one." Now the whole object of my contribution was to show that the variations in load do not and cannot produce any strains in the engine in excess of those caused by the admission of boiler pressure to the back of the piston, and therefore all the talk about "shocks and strains" is inaccurate and misleading. Further, I endeavoured to show that, as the maximum load does not exceed twice the normal load (usually much less), there is nothing in mere load arising out of tramway service that a good cut-off governor cannot take care of, the flywheel being of ordinary dimensions as used for electric lighting. I then discussed the question of short-circuits, and pointed out that the energy absorbed by a "short" cannot exceed the energy put into it; therefore, the piling up of flywheel power simply tended to intensify the strains in the dynamo (*not in the engine*).

On the question of compounding the dynamo, I showed that American practice, as described by Mr. Dawson, defeated its own avowed object. To provide a heavy flywheel, and then to limit its variation in speed, may be right for a cotton mill where even turning is the object aimed at, but in a traction system the object aimed is not uniform speed, but uniform volts. Why, then, should we not take advantage of the power which the dynamo places in our hands of obtaining uniform voltage even with considerable variations in speed? Of course "change in the field excitation cannot increase the *horse-power* developed by the dynamo," but it can enable the flywheel to give out some portion of its store of energy without permitting the voltage to fall. Take two examples:—

The first, arranged on the American system, of 1¼ per cent. variation and no speed compensation in the dynamo.

The second, exactly the same, but with one-half the weight of flywheel and 2½ per cent. variation compensated by 2½ per cent. over-compounding.

In the first instance, we get a possible fall of volts of *at least* 1¼ per cent.; in the second, we get uniform volts, a saving of one-half of the flywheel, a more powerful governor, and a diminution of danger from short circuits. Your readers will, I believe, realise without demonstration that a 10-ton fly-

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wheel with 2½ per cent. drop is just as effective as a 20-ton flywheel with 1¼ per cent. drop.

I hope you will forgive this short reference to the first principles of mechanics. In these days one notices a tendency to believe that American practice is independent of principles; it would be more correct to say that it is devoid of them. The fact that a certain machine or system works, and works well, is no proof that it is perfect or economical. Many of our early bridges are as safe as houses, but we build better ones now for half the money. No steam engines have ever worked more satisfactorily than those made by Boulton and Watt, but we cannot afford them nowadays. The system of construction by trial and error is all right in America, but in England an engineer is paid to use his brains, and not to get his experience at the expense of his clients.

"But what about the tramcars?" Mr. Gadsby informs me, that in his experience in running the Madras tramways under conditions which were the exact reverse of those recommended by Mr. Dawson, the results were entirely satisfactory. The cars had single motors, consequently no series-parallel controller, engines with small flywheels, and rope-driven, shunt-wound dynamos. It is obvious that under these circumstances the voltage must have varied considerably, but Mr. Gadsby, who did *not* design the plant, says the running of the tramcars was steady and entirely satisfactory, and the units consumed were very considerably less than one per mile. I quote Mr. Gadsby's experience, not to prove that fluctuating voltage is desirable, but rather to show that there are more ways of killing a dog than hanging it, and that the cars do not "respond to every fluctuation of load on the line."

I hope, sir, you will excuse the prolixity of this epistle, but I feel that some statement of this kind is due to my opponents, so that they may know exactly the shape of the target they have to fire at, for it is too much to expect that they would carry away with them a perfectly clear recollection of what I said to the "Mechanical Engineers"—apparently with their very hearty approval.—Yours, &c., JOHN S. RAWORTH.

46, Christchurch-road, S.W., Nov. 24, 1897.

TUNNEL ARMATURES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the main part I may be satisfied, I think, with the result of my letter published in your issue of Nov. 12, as Prof. Baily has now replaced his original Fig. 1 by an entirely different one. I must, however, beg you to be so kind as to allow me a few words more in your esteemed paper, because Prof. Baily puts it now as if I had objected to points which were not discussed by him.

In his article (p. 810, Vol. XXXIX.) he said: "A force is exerted on the lower piece of iron (armature), and an equal and opposite one on the upper (field magnet). The seat of this force has been, I believe, the stumbling-block in most explanations . . . but if the lines of force are drawn the cause of the mechanical force may be readily seen (Fig. 1)."

Thus it is clear, I think, that his Fig. 1 was intended to give the explanation of the mechanical force acting on the armature and on the field magnet. I was therefore quite right when I objected to his figure, for the reason that it does not show the cause of the torque; or that if it were true, the torque would be due to an action at a distance of the lines of force within the armature on the field magnet, because the lines did not show any direct tangential pull on the field magnet.

My diagram was given to show the real cause of the torque, being the inclination of the lines of force with the normal in the air-space—that is, the angle ϕ as now introduced by Prof. Baily. For sake of clearness, I had, of course, to exaggerate that inclination, as is generally done in such diagrams. It is indeed somewhat curious that Prof. Baily asserts that his Fig. 1 is "much more nearly accurate" than mine because my lines are too much inclined, though he himself shows in his new figure an angle ϕ very much larger than "1deg. or 2deg." as calculated by him!

Moreover, my figure was only given to show the inclination of the lines with the normal in the air-space, and I have expressly stated that where I had drawn straight lines it was only for sake of simplicity, and as being immaterial to the question under consideration. Prof. Baily's objection to my lines being not accurate has therefore no meaning. My diagram not being a figure in a didactic paper, but a rough sketch by writing-pen in my letter, was only given to show that "the torque is due to the inclination or distortion of the lines of force where they pass from the iron of the armature or the pole face in the air-space, the force at the circumference of the armature being the sum of the tangential components of the mechanical forces in the direction of the magnetic lines of force." My explanation is, therefore, exactly the same as Prof. Baily gives now in a mathematical form, by introducing ϕ so that "tan ϕ is the ratio of the tangential pull on the armature to the direct magnetic pull between pole-piece and armature."

Prof. du Bois' Paper has nothing to do with this controversy; I objected only in so far as he accepted Prof. Baily's Fig. 1 as an illustration of his explanation. But I am perfectly convinced that Prof. du Bois had overlooked the inaccuracy and impossibility of that figure, and that he will now reject it.—Yours, &c., C. L. R. E. MENGES.

The Hague, Nov. 21, 1897.

TELEGRAPH WIRES IN THE CITY.

In the City of London Court, on Wednesday, before Mr. Commissioner Kerr, the case of the Postmaster-General *v.* the Commissioners of Sewers was heard, raising a question of much importance as to the construction of telephone and telegraph wires. The action was brought for the determination of a difference which had arisen between the Postmaster-General and the Commissioners of Sewers of the City of London under the joint operation of the Telegraph Act, 1863, and Sec. 4 of the Telegraph Act, 1878, and which difference fell under the last-named Act, to be determined, where there was no police or stipendiary magistrate having jurisdiction within the district in which the difference had arisen, by the Judge of the County Court having jurisdiction within the district.

The matter had come before the Court, said Sir ROBERT HUNTER, Solicitor to the Post Office, in opening the case, in consequence of a notice which was served by the secretary of the Post Office upon the Commissioners of Sewers on July 28 last calling upon the Commissioners to give their consent "to the placing and maintaining of a line or lines of underground telegraphs in or under the streets or public roads known as Newgate-street, St. Martin's-le-Grand, Cheapside, St. Paul's-churchyard, Cannon-street, Old Change, Knightrider-street, Lambeth-hill, and Queen Victoria-street." The Postmaster-General could not place wires under the streets without the consent of the body having the control of the streets. The Commissioners had stated in a letter in reply to the notice that they did not object to the opening of the streets by the Post Office authorities for laying underground telegraph wires for their own purposes; but the Commissioners objected to giving any consent to wires being laid for the use of the National Telephone Company, unless the Telephone Company were prepared to provide an improved service at a reduced cost. As the Commissioners had made their consent subject to the condition named, the Postmaster-General was now appealing against it.

Mr. Commissioner KERR said he would like to know why the Commissioners had objected. What was their authority for laying down that condition?

Mr. C. LYTTLETON CHUBB, who appeared for the Commissioners, said they had no objection to the Postmaster-General laying wires for the public use and benefit. But they objected to the Post Office authorities laying wires which were going to be used by the National Telephone Company. If the Postmaster-General would give an undertaking not to allow the National Telephone Company to use the wires, then no further objection would be raised. The condition which had been imposed by the Commissioners had been made in the interests of the public. Originally the telegraphy of the country was in the hands of private companies. Then Parliament gave the monopoly to the Postmaster-General. The roads could not be opened without the consent of the public authority, and the Commissioners of Sewers were taking up their present position in order to force the hands of the National Telephone Company to give the public a better and cheaper telephonic service. If the Postmaster-General was going to allow the National Telephone Company to have the use, or perhaps the whole control, of the wires now in dispute, then the public should be paid something for that privilege.

Mr. Commissioner KERR said of course the Postmaster-General was not bound to use the telegraphs at all, if he liked. He might send messages round on foot, or provide everybody in his service with bicycles. Why was it not for the public benefit for the wires to be laid?

Mr. CHUBB replied that the Postmaster-General wanted to benefit a trading company at the expense of the ratepayers, who were entitled to be paid for the privilege to be accorded. Certain it was that the National Telephone Company would pay the Postmaster-General for the permission which he was going to give. Both the Postmaster-General and the Commissioners of Sewers were public bodies, and that was why they had come to the Court to settle the difference.

Mr. Commissioner KERR: There is a further appeal, I am happy to say; so that if I am wrong I can be put right.

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Mr. CHUBB: Many further appeals, possibly.

Mr. Commissioner KERR could not understand by what authority the Commissioners were objecting to the National Telephone Company. Why had they not objected to, say, the Emperor of Russia, or the Emperor of Japan, or even himself having the use of the wires when laid down? Where was the boundary to come in?

Mr. CHUBB contended that it was for the public body having the control of the road to say where that boundary was to come in. It was an iniquitous thing that small provincial towns should have a much better and cheaper telephonic service than the great City of London.

Mr. Commissioner KERR: That applies to everything in the City of London, and England generally. We are far behind the Americans in telephones, and railway service and various services. We cannot help it, I suppose. We must submit to it. Here we are, you know (laughter).

Mr. CHUBB remarked that in Switzerland, Sweden, Norway and other Continental cities it was the same.

Mr. Commissioner KERR observed that the condition of things in the City was one of the results of local self government.

Mr. CHUBB pointed that in Manchester the people paid only half as much. Was that a reasonable state of things?

Sir ROBERT HUNTER said that all that been gone into by the Parliamentary Committee, which had sat recently and inquired into the question at great length.

Mr. CHUBB: Yes, and Parliament has not reported upon it at present, unfortunately.

Mr. Commissioner KERR asked if it was a reasonable thing for the Commissioners of Sewers to say who was to use the wires and who was not?

Mr. CHUBB said that was not their point. They objected to the National Telephone Company using the wires for the purposes of their business. They objected to the Company making money out of it without paying something for it.

Mr. Commissioner KERR supposed the Company paid rates and taxes.

Mr. CHUBB admitted that they did. But that was not enough for the Commissioners.

Sir ROBERT HUNTER desired to add that, as a matter of fact, the wires when laid would be used to connect the Central Telegraph Office with the sub-exchanges of the National Company, and so put them into direct communication with the Post Office.

Mr. Commissioner KERR: That is for the public benefit.

Mr. CHUBB said the National Telephone Company could not afford not to do their business in a reasonable manner. If pressure were brought to bear upon them, and it could only be done by the local authorities, they would be compelled to supply the public with the article which they needed at a reasonable rate and of the proper quality. What the National Telephone Company wanted was to have the enjoyment of an easement without paying for it.

Sir ROBERT HUNTER said that one end of the proposed wires would be in the premises of the Post Office at the Central Telegraph Office, and the other end in the offices of the National Telephone Company. The Postmaster-General could not put the wires down at all if he was to be subject to the condition which the Commissioners of Sewers wanted to impose.

Mr. Commissioner KERR said there was no power in the Postmaster-General to hand over the wires to the National Telephone Company. He could not do that if he had wanted to; but he did not.

Mr. CHUBB said that was just what the Postmaster-General had contracted to do.

Sir ROBERT HUNTER said he had not agreed to do anything of the sort. The wires would be rented by the National Telephone Company.

Mr. Commissioner KERR said the Postmaster-General could stop the whole thing any morning, if he thought fit.

Sir ROBERT HUNTER agreed.

Mr. CHUBB pointed out that the Commissioners of Sewers did not choose to part with their discretion in the matter to the Postmaster-General. Parliament gave them authority to impose the conditions which had been stipulated, and it was not unreasonable.

Mr. Commissioner KERR: Great public bodies sometimes go wrong. Even the House of Commons sometimes goes wrong. The House threw out the Bill for the making of gas because it would ruin the whale fishery at the North Pole. They found out their error afterwards. I could give you fifty instances where public bodies, great and small, sometimes go wrong. It would not do to stop a thing because a public body did not agree to it.

Mr. CHUBB: It is possible that the Postmaster-General may be wrong.

Mr. Commissioner KERR: Possibly. He is not infallible (laughter).

Mr. CHUBB said the Duke of Norfolk was exceeding his powers. The public would benefit by the Commissioners' condition being upheld.

Mr. Commissioner KERR thought it was for the public benefit for the Postmaster-General to get a good round sum in rent for public purposes.

Mr. CHUBB: Not for the ratepayers of the City of London.

Mr. Commissioner KERR: I am afraid the ratepayers of the City of London are like everybody else, they are a part of human nature.

Mr. CHUBB said the reason why the Commissioners were now before the Court was because on a previous occasion the Postmaster-General obtained permission to lay wires which the Commissioners afterwards found were being used by the National Telephone Company. That struck the Commissioners, who were the judges in the matter, as being an improper exercise of their powers by the Post Office authorities. The Commissioners said that as the Postmaster-General had done it once he could not be surprised at the condition being imposed. The Commissioners wanted to know what the public were going to get out of the matter.

Mr. Commissioner KERR thought that the Postmaster-General was the best judge of that. It was his business to get as much money as he could, and at the same time to serve the public interest. He did not agree with the view taken by the Commissioners of Sewers. He thought the Postmaster-General had the power to say he would take the consent without the condition. That was the conclusion at which he must arrive. Therefore the consent would be regarded as given, but the condition would be set aside.

LEGAL INTELLIGENCE.

Taylor v. Sax.

This case came before the Court of Appeal. Mr. Justice Channell a few weeks since found for the defendant, and Mr. A. S. McIntyre (for the plaintiff) now asked their lordships for a new trial, which was resisted by defendant. The previous proceedings have been fully reported in *The Electrician* for Nov. 12 and 19. The ground for the present application was that the defendant did not, in his disclosure of documents, reveal an agreement which it was alleged would contradict the part of his defence which denied that he had received anything in respect to the matter covered by the commission note, he having for a consideration, by way of loan, assigned it to his father-in-law, one Vandenberg, who had received £1,700 out of the total of £6,000 for the purpose of settling claims against the defendant in respect to the promotion and formation of the Company, and which evidence, if disclosed on the trial, the plaintiff contended, must have led to a verdict for him, and have shown that the defendant was not to be believed in stating that he had received nothing out of the promotion.

Mr. TINDAL ATKINSON, for the defendant, opposed the application on the grounds that the plaintiff knew within three days of the trial of the existence of the documents referred to, and that the present application was too late.

Leave to appeal was granted.

Syndicate of Electrical Engineers (Limited) v. Lawrence and Butcher.

The plaintiffs claimed, in the Westminster (London) County Court, for the hire of a testing machine, and said that on June 14 the machine was borrowed by defendants, who sent a man with an order in the ordinary course, and he took the machine away. Defendants denied he had authority. The man was employed at the wharf of Messrs. Crosse and Blackwell, and there was no need for him to have the machine, as the Company supplying the electricity did all the testing in the ordinary course. The machine was left under a bench at the wharf, where it was found. Judgment for plaintiffs for £3 and costs.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 9s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

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"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced, and all the usual important articles, &c., which have made the book indispensable to the industry, will be brought up-to-date and amplified where necessary.

Tenders Invited.—The Corporation of Barrow-in-Furness invite tenders for the supply and erection of (*a*) boilers, pumps, steam and water pipes, tank, crane, economiser, and ironwork; (*b*) engines, generators, switchboards, instruments, accumulators, motor transformers, and sub-station equipments; (*c*) high- and low-tension feeder and distributor cables and house-connection boxes; (*d*) conduits and drawing-in boxes. Our advertisement columns contain some further particulars, and specifications, &c., can be obtained at the Town Hall, Barrow-in-Furness, or at the offices of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. Tenders must be sent in to the town clerk (Mr. C. F. Preston), Town Hall, Barrow-in-Furness, by noon on Wednesday, Dec. 15.

——— The Londonderry Corporation invite tenders for the supply of electric-light carbons for one year from Jan. 1, 1898. Tenders to Mr. John Christie, Guildhall, Londonderry, by Thursday, Dec. 9.

——— The Electric Lighting Committee of the Canterbury (Kent) Corporation invite tenders for the supply of: (*a*) boiler-house plant, (*b*) engine house plant, (*c*) overhead travelling crane, (*d*) switchboard and instruments, (*e*) accumulators, (*f*) mains, (*g*) public lamps, and (*h*) meters. Tenders to Mr. Henry Fielding, Town Clerk's office, Canterbury, by Dec. 20.

Tenders Invited.—The Sanitary Committee of the Leicester Corporation invite designs and tenders for motor vehicles for house refuse collection. Proposals to the Borough Engineer and Surveyor (Mr. E. George Mawbey, C.E.), Town Hall, Leicester, by Jan. 31.

——— The Vestry of St. Pancras (London) invite tenders for the supply and erection of electric lamps, posts, and circuit complete; also fitting and distributing mains. Copies of the specification can be obtained on application to the Chief Clerk, Electricity Department, 57, Pratt-street, N.W., and tenders must be sent in to Mr. C. H. F. Barrett, vestry clerk, the Vestry Hall, Pancras-road, N.W., by noon of Tuesday, the 28th inst.

——— The Hackney (London) Vestry are inviting schemes for the electric lighting of the district. Particulars from the Vestry Clerk, Town Hall, Mare-street, E. Tenders must be in by the 14th inst.

——— Tenders are invited by the Municipal Authorities of Villarmiel for the concession for the electric lighting of the town for 20 years. Tenders to El Secretario del Ayuntamiento de Villarmiel (Palencia), Spain, by 16th inst. Further particulars appear in our advertisement columns.

——— The Barrow-in-Furness Town Council invite tenders for the erection of electricity station buildings. Plans, &c., from the Borough Engineer, to whom tenders, by noon of 15th inst.

——— The Corporation of Newport require tenders for a temporary electric lighting plant (to supply current to about 350 16-c.p. lamps) at Wentwood Waterworks. Tenders to the Town Clerk, Town Hall, Newport, Mon., by the 15th inst.

——— The French Minister of Posts and Telegraphs invites tenders for the establishment of a double pneumatic pipe-line between the post offices in the Rue Saints-Pères and the Rue Morgue. Tenders to the Sous-Secretariat d'Etat des Postes et des Télégraphes, 103, Rue de Grenelle, Paris, by 14th inst.

——— Tenders are invited until Dec. 21 by the Municipal Authorities of Reus (Tarragona), Spain, for the concession for the electric lighting of the town. Tenders to El Secretario del Ayuntamiento.

Tenders Accepted.—The following tenders have been accepted by the Barking District Council for the supply of electrical plant, mains, &c. The engineer's estimate for the generating plant was £5,200, for the mains, &c., £4,500, and for arc lamps £360:—

Sunderland Forge Company (Plant)	£2,250
Chloride Electrical Storage Syndicate (Battery)	600
Laing, Wharton and Down (Switchboard)	478
Callender's Company (Mains)*	1,730
Ditto (ditto)†	2,819
Lucy and Co. (Arc Lamps)	299

* Mains in the compulsory area. † Mains outside the compulsory area.

The following firms also tendered: Crompton and Co., Electrical Construction Company, C. A. Parsons and Co., Brush Company, Siemens Bros. and Co., P. R. Jackson and Co., W. H. Allen, Son and Co., New Fowler-Lancaster, Epstein Accumulator Company, Tudor Accumulator Company, Pritchetts and Gold, Electrical Power Storage Company, Nalder and Hilton, W. J. Fryer and Co., B. Thomas, Williamson and Joseph, Evered and Co., Edison and Swan Company, W. T. Glover and Co., Drake and Gorham, Fowler-Waring Cables Company, British Insulated Wire Company, Reason Manufacturing Company, Brockie-Pell Arc Lamp (Limited), Stewart Electrical Syndicate, Warburg, Dymond and Co., and Beanland, Perkin and Co.

——— The Aberdeen Corporation have accepted the tender of Messrs. Shirras, Laing, and Co. for wiring the new municipal workshops in King-street for the electric light, at £232. 9s. 6d. Messrs. P. C. Middleton and Co., and Mr. A. G. Elmslie also submitted tenders at £240 each.

——— The Southampton Town Council on Monday accepted tender of Messrs. Crompton and Co. for the supply of engines and alternators, motor alternator, rectifiers, high-tension switchboards, and also engines and continuous-current generators, balancing and volt-raising transformers, and low-tension switchboards, at £12,486. Willans engines are specified in the tender. The tender for the supply of the battery of accumulators and accessories has been given to the Chloride Electrical Storage Syndicate at £1,314, with £73 per annum for maintenance, for a period of seven years. Tenders for the whole of the Council's requirements were submitted by Messrs. Siemens Bros. and Co. (£14,285), and by the Brush Company (£15,762); for the engines, alternators, &c., the British Thomson-Houston Company, John Fowler and Co., Chamberlain and Hookham, the Thames Iron Works and Shipbuilding Company, S. Z. De Ferranti (Limited), and the Electric Construction Company sent in tenders, while the E.P.S. Company, Mr. A. B. Pescatore and Messrs. Pritchetts and Gold submitted offers for the accumulators.

——— For the electric wiring of the extension of the Guildhall School of Music 10 tenders, varying from £750 to £342. 15s., were received, and the lowest (that of Messrs. Bergtheil and Young) has been accepted.

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Tenders Received.—The Edinburgh Corporation have received the following tenders :—

Siemens Bros. and Co. (two low-tension engines and dynamos)	£8,480
Electric Construction Company (alternators)	6,550
George Sinclair (four boilers)	4,904

An offer by Messrs. Siemens Bros. and Co. for the supply of a small motor-generator at £125 and for the extension of the low-tension mains down Broughton-street, at a probable cost of £400, has also been received.

Appointments Vacant.—The Lighting Committee of the Wolverhampton Corporation invite applications for a junior assistant in the office of the borough electrical engineer, Mr. F. Harman Lewis. Salary £80 per annum. Applications on forms to be obtained from Mr. Harman Lewis, Town Hall, Wolverhampton, must be sent in by Dec. 8. See advertisement.

——— The Vestry of St. John, Hampstead, require an assistant electrical engineer. For further particulars see advertisement elsewhere. Applications must be sent in to the Vestry Clerk (Mr. Arthur P. Johnson), Vestry Hall, Hampstead, London, N., by 10 a.m. of the 13th inst.

——— The Tramways Committee of the Sheffield Corporation invite applications for the position of resident electrical engineer in connection with the equipment of certain of the existing tramways on the overhead trolley system, and the construction and equipment of extensions. Some additional particulars are given in our advertisement columns. Applications must be sent in to the town clerk (Mr. H. Sayer), Town Hall, Sheffield, by Monday, the 13th inst.

Vacancies.—The Vestry of St. Mary, Islington, require an engine driver at their electricity supply works. Applications to the electrical engineer (Mr. Albert Gay), 50, Eden-grove, Holloway, N., by noon of 7th inst. See advertisement.

——— The Southampton Harbour Board require a competent electrician and fitter. Applications to the traffic manager (Mr. Walter Bowyer), Harbour Board, Southampton. See advertisement.

Business Notices.—Mr. C. Conradty, of Nurnberg, Germany, has purchased the carbon business of Ch. Schmelzer, of that town.

——— The well-known business of Messrs. W. H. Willcox and Co., manufacturers and dealers in engineers' stores, oil refiners, &c., has, for family reasons, been converted into a limited liability company, with a capital of £60,000, in £1 shares. The management remains exactly as hitherto. The public will not be asked to subscribe, but the employés of the firm have been afforded an opportunity of taking a financial interest in the business by subscribing to the shares. The increase of business has necessitated the taking of new offices at 23, Southwark-street, where in future all communications should be sent.

Liquidations.—A meeting of the members of the Electrical Manufacturers (Limited) will be held at 13, Basinghall-street, London, E.C., on 31st inst., to receive an account of the winding-up. Mr. G. A. G. Robertson is liquidator.

——— A meeting of the proprietors of the Akester Electric Syndicate (Limited) will be held at 71 and 72, King William-street, London, E.C., on 31st inst., to receive an account of the winding-up.

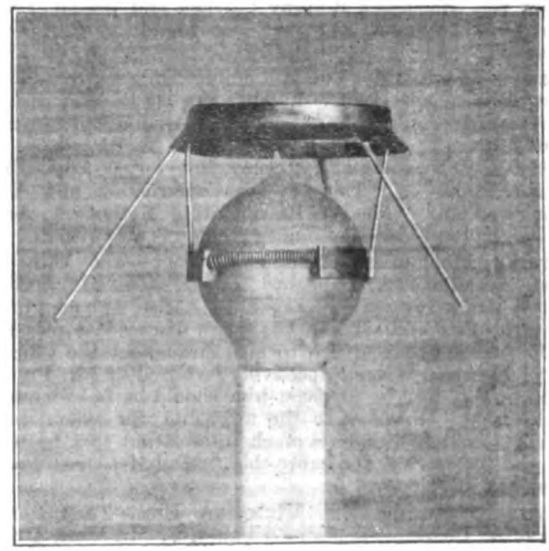
——— Official notice has been given of the appointment of Mr. W. W. North, Ashley Cottage, Ewell, as liquidator of the Epstein Electric Accumulator Company (Limited).

——— Claims against Morris Bros. (Limited) (in voluntary liquidation) must be sent to the liquidator, Mr. E. J. Abbott, 9, Bennett's Hill, Birmingham, by the 18th inst.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 24 to Nov. 30, with the ports of destination :—

Argentina—Buenos Ayres, £50 ; *Australasia*—Adelaide, £12 ; Albany, £70 ; Melbourne, £129 ; Sydney, £3,407 (including £2,117 telegraph material). *Belgium*—Antwerp, £47 (fuses) ; Ostend, £40. *Canada*—Montreal, £36. *Ceylon*—Colombo, £40. *China*—Canton, £30 ; Shanghai, 44 tons old telegraph wire. *Denmark*—Copenhagen, £60. *Egypt*—Port Said, £65. *Germany*—Hamburg, £296. *Gibraltar*, £155. *Greece*—Syra, £170 (telegraph material). *Holland*—Amsterdam, £12. *Hong Kong*—£150. *India*—Calcutta, £387 ; Madras, £37. *Japan*—Yokohama, £1,109 (telegraph cable). *Malta*—£161 (including £85 telegraph material). *North Borneo*—Sarawak, £188 (telephone apparatus). *Portugal*—Lisbon, £681 (including £85 telegraph material). *Russia*—Libau, £8 ; Odessa, £23 (telegraph material). *Siam*—Bangkok, £480. *South Africa*—Cape Town, £391 ; Durban, 40 tons and £116. *Spain*—Passages £26. *Straits Settlements*—Singapore, £74. *Turkey*—Constantinople, £16. *West Indies*—Trinidad, £95. Total, £8,573, against £7,744 in the corresponding week last year (Nov. 25 to Dec. 1).

Shade Carrier for Electric Candles.—The illustration below shows the D.G. "Invisible" shade carrier for supporting electric candle shades, which is being put upon the market by Messrs. Drake and Gorham, of 66, Victoria-street, London, S.W. The carrier has been designed to remedy two defects in the ordinary "Butterfly" carrier—the scratching of the imitation candle by the spring clip, and the liability of the shades to remain in crooked attitudes. The carrier consists of a spun brass ring at the top, on which the shade rests, and to this ring is fixed by means of two wires a thin brass band made of very springy metal, which clips on to the bulb of the incandescent lamp. The band does not entirely surround the lamp, the circle being completed by a spiral spring, which, as well as fastening the carrier securely, allows for variation in the diameter of the bulb. The second object of the carrier is attained by fixing three brass wires to the top supporting



ring, which wires can be bent to any angle corresponding with that of the candle shade, so that the shades are kept straight, which is seldom or never the case with the existing devices. The carrier is placed on the market at a very low price.

The Rosa Curve Tracer.—Messrs. Elliott Bros., of 101 and 102, St. Martin's-lane, London, W.C., inform us that they have made arrangements with Prof. Rosa, and have been appointed sole makers of the Rosa apparatus in this country.

Electric Lamp Guards.—Mr. James Dickson, of 48, Gray's Inn-road, London, W.C., sends particulars of his "Ideal" electric lamp guards, which are claimed to be the only guards that can be fitted

without a shade carrier. The illustration shows the guard attached to a cluster of lamps, but a single lamp can be equally well protected. The carriers can be readily fixed and the cost is very small. Mr. Dickson is an expert in wire work of all kinds.

Bitumen Sheeting.—A dainty *brochure*, describing the merits of Callender's pure bitumen sheeting for a variety of uses, is issued by Messrs. Callender and Montgomery, of 43, Essex-street, Strand, London, W.C. The use of this material is advised for a number of purposes, including transformer chambers, receptacles for liquids, acid vats, &c. 10,000 yards of this sheeting were used in the construction of the Tower Bridge, and the terminus station of the Waterloo and City Electric Railway Company is lined with over 13,000 yards. The pamphlet under review contains some admirable illustrations, and the text is interesting.

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Oil Engines.—A catalogue giving particulars of "Trusty" oil engines, &c., is to hand from the Trusty Engine Works, Cheltenham. Included in the list is a copy of the report of trials of the "Trusty" oil engine made in Jan., 1896, by Mr. Hamilton Kilgour, electrical engineer to the Cheltenham Corporation, and by Mr. W. Worby Beaumont in May, 1893.

Diaries.—We have received a copy of the useful Diary and Reference Book issued by the *Indian and Eastern Engineer* The book contains a quantity of reference matter relating to India and numerous engineering tables and data.

——— The Gloucester Diary and Directors' Calendar for 1898, issued by the Gloucester Railway Carriage and Waggon Company (Limited), is to hand, and will be found as useful as its predecessors.

Cassier's Magazine.—The December issue of this Magazine contains articles on "Electric Light from City Refuse," by Nelson W. Perry; "Hydraulic Cranes," by R. G. Blaine; "The American System of Rope Transmission," by R. D. O. Smith; "The Manufacture of Coal Briquettes"; "Some Interesting Applications of Hydraulic Power"; "The Proper Construction and Uses of Economisers," and "Modern Refrigerating Methods." An illustrated biographical sketch of James Holden is also given.

Calvert's Mechanics' Almanack, 1898.—The 25th annual issue of this almanack, published by Mr. John Heywood, is to hand. When a reviewer is asked to notice a book in which between the first and sixtieth pages are discussed topics ranging from the time aptitude of fish to bite throughout the year to the length of Hertzian waves respectively favoured by Mr. Preece and Marconi, it may well be forgiven him should he fail adequately to fulfil the task. However, to the mechanic, for whom this little almanack is intended, there is much information that he will find useful and interesting and more than usually free from gross misstatement or inaccuracy.

Telegraphy during the Victorian Era.—The *Gentleman's Magazine* for December contains a Paper, by Mr. Chas. Bright, on the "Evolution of Telegraphy during the Victorian Era," which is interesting reading.

Messrs. W. H. Allen, Son and Co.'s Jubilee Dinner.—On Friday evening last Messrs. W. H. Allen, Son and Co. entertained about 600 of their staff and workmen and a number of guests at dinner at the Corn Exchange, Bedford. The chair was taken by Mr. W. H. Allen, and a most enjoyable evening's entertainment was provided. During the banquet the Bedford string band played a number of selections. Several toasts followed, the principal one of "The Firm," being proposed by Mr. C. C. Hawkins, M.A. Among the guests were the Mayor of Bedford, Lord Alwyne Compton, M.P., Mr. Guy Pym, M.P., the Chaplain of the Savoy, Fleet Engineer Joseph Smith, R.N., and Capt. S. A. James.

Concert.—The Telephone Athletic Association gave a Bohemian concert at the Holborn Restaurant, London, on Monday, at which Mr. W. E. L. Gaine, general-manager of the Company, presided. A lengthy programme was enjoyed by a large audience.

A Useful Thief-Catcher.—A boy named Browning has been cleverly detected pilfering from his employer's till by means of an electric bell connection. Mr. A. Soar, an engineer, of Phipp-street, Shoreditch, prosecuted the boy at Worship-street (London), and said that in consequence of the loss of small sums from the till he had the clerks' drawers fitted with electric alarms. In the absence of one of the clerks the prisoner tampered with the till, when the electric alarm rang, and he was caught. These till robberies are very common, and shopkeepers have here a simple means of detection at their command, which should be much more generally adopted than is now the case.

Barrow-in-Furness.—Mr. R. Bicknell held a Local Government inquiry last week at Barrow into the application of the Town Council to borrow £30,000 for electric lighting purposes. The application was supported by the town clerk (Mr. C. F. Preston), the borough engineer (Mr. W. H. Fox) and the consulting engineer (Mr. E. Manville). Mr. Preston said the resolution to apply for the loan was passed on April 5th last. There would be no opposition, as the scheme was viewed with general favour by the citizens, and he asked that the loan should be for 30 years. The Corporation were the owners of the gasworks, and they had practically expended the whole of their borrowing powers, and hoped the electric light would, to some extent, make it unnecessary to proceed with any further expenditure for gas purposes. Mr. Manville submitted plans and particulars and gave detailed estimates showing the cost of carrying out the proposed works. The capital expenditure was estimated as follows:—Site, £1,000; buildings, £3,150; boilers, economiser, steam exhaust and feed pipes, drain pipes, water storage tank, pumps, engine foundations and boiler settings, £5,533; engines and dynamos, main switchboard, and auxiliary apparatus, £4,075; battery of accumulators and connections, charging transformers, &c., £1,150; four motor transformers, with switch gear, &c., £2,400; distributing mains and feeders, telephone and pilot wires, including excavation and making good of streets, £4,500; 100 house-connection boxes, service wire, £500; 100 meters and house fuse boards, £800; extension to Furness Abbey, £2,500; engineer's fees and salary, clerk of works, £1,910; contingencies, 10 per cent., £2,757; total, £30,115.

Blackpool.—Major P. Cardew, R.E., held a Board of Trade inquiry here on Tuesday into the Council's scheme for the introduction of the overhead trolley system on the tramways. The borough electrical engineer (Mr. R. C. Quin) said that the scheme would mean a saving of £1,500 per annum to the Corporation. He did not consider the overhead system unsightly. Last year the trams were stopped for 32 days by drifting sand getting into the culverts. The capital of the Tramway Company stood in their books at £58,000. The tramway manager (Mr. J. Lancaster) detailed the obstructions the present system met with. When sand was blowing the cars could not run, and it took three days and nights to clear the culverts from the blown sand. When the system was stopped it meant a loss on revenue of £7 per hour per car in the season, and £1 in the winter. A mass of evidence both for and against the scheme was given, the inquiry being a lengthy one.

Bradford.—Though this Corporation was one of the first to undertake the supply of electric current, fresh customers still continue to pour in, no less than 50 applications being dealt with at the last meeting of the Gas and Electricity Committee.

Bradford and Leeds Light Railway.—The Leeds City Council have decided to oppose the scheme for the construction of a light railway between Bradford and Leeds. The principal cause of objection seems to be that running powers are sought over both the Leeds and Bradford systems.

Burnley.—The Town Council have accepted a tender for the extension of the electric light cables to the Manchester-road district at £1,685. The Electric Lighting Committee are also considering the question of the extension of the electricity supply works.

Canadian Postal Rates.—From Jan. 1 next the postal rate from Canada to all parts of the British empire will be three cents per ounce, in place of the present rate of five cents per half-ounce.

Canal Lighting.—The Baltic and Black Sea Canal, which will be nearly 1,000 miles in length, connecting the Baltic with the Black Sea, is to be commenced next spring. The contract for the work, which is estimated to cost between £20,000,000 to £24,000,000, includes the lighting of the canal by electricity, so that night stoppages may be avoided.

Croydon.—A Local Government Board inquiry was held last week by Lieut.-Col. A. C. Smith, R.E., into the application of the Council to borrow, amongst other sums, £5,500 for the extension of the electric lighting undertaking. There was no opposition.

Derby.—The borough electrical engineer (Mr. J. E. Stewart) has received a well-deserved increase of £50 per annum in his salary —from £312 to £362. The advance was given on the recommendation of the Electric Lighting Committee.

Dublin.—A committee of the whole Corporation was held on Monday to consider the present aspect of the electric lighting difficulty. Prof. Kennedy was in attendance, and discussed with the Council the questions of a site for a new station and the renewal of the cables. A detailed report will be presented to the Corporation at its next meeting. In the meantime, however, the Dublin United Tramways Company have submitted an offer for the supply of current for lighting purposes. The proposals of the Company are: The Corporation to transfer their Provisional Order to the Company, with electricity station, buildings, plant, stores, &c.; the Company to take over the obligation for the balance of the debt incurred by the Corporation for the electric lighting installation, to undertake to pay the annual instalments of interest and sinking fund, or to pay off the debt at the Company's option, and also to undertake the provision of the necessary cables and plant with all possible speed to supply the existing demands for private or public lighting. The price of current to be reduced from 7d. per unit to 6d. and 4d. respectively for private and public lighting six months after the transfer of the Order; and when the Company's new power station is in working order to further reduce the price to 5d. and 3d. respectively. The Company also offer to largely extend the present lighting area.

Mr. C. P. Cotton, an inspector of the Local Government Board, will hold an inquiry on Wednesday next into the application of the Council for sanction to borrow £100,000 for the erection and equipment of a new electricity generating station.

Edinburgh.—At Tuesday's meeting the City Council decided to acquire land at M'Donald-road from George Heriot's Trust as a site for an additional electricity generating station. The question of tenders for the supply of machinery at about £20,000 has been reserved. The Electric Lighting Committee reported that a chief assistant at the electric lighting station has

been appointed at a salary of £250 per annum, and a clerical assistant to the resident electrical engineer at a salary of £130. The Convener of the Committee (Bailie Mackenzie) said that in asking the Council to sanction such a large capital expenditure he desired to state the facts of the case clearly. About 2½ years ago they started with machinery equal to 1,900 H.P., which was thought to be quite enough for two, if not three years; but it was found barely sufficient to carry them over the first winter, and they had to borrow an engine in case of breakdown. Seven additional machines, equal to 2,460 H.P., were put down in the second year, and five additional boilers. For the present year, three additional machines of 1,020 H.P. and two boilers were ordered a year ago. The boilers and one machine were working, and another machine was being erected, but he was sorry to say an alternating machine, which they were sorely in need of, was not yet forthcoming. When the extensions now proposed were completed the station would be exhausted. There would be altogether 7,780 H.P. available, sufficient to supply 250,000 8-c.p. lamps wired. From May 15 to Nov. 27, 1895, the applications in 8-c.p. lamps were 27,492 and 12 motors; for the same period in 1896 they were equal to 28,439 and 28 motors; for the corresponding period of the current year the applications amounted to 34,476 and 41 motors—giving a total of 148,082 8-c.p. lamps and 90 motors. The continued increase was simply amazing, and so far as he knew, exceeded anything taking place elsewhere. The units sold for private lighting for the same period in 1895 were 196,160; for the corresponding period in 1896 353,375, an increase of 90 per cent.; and for this year 687,340 units, an increase over 1896 of 95 per cent. The present proposed extensions would carry them over the winter of 1898-99, but they did not think they would nearly cover the following winter. As they could do no more at Dewar-place, the committee and the engineers had looked for a suitable site for a new station, and as it was essential to have it near a railway and in the east end of the city, they were confined to five or six possible situations. After full consideration they agreed that the best available place was on the east side of M'Donald-road.

Current for an equivalent of 4,136 8-c.p. lamps was applied for during the month ended 22nd ult. New offices are to be erected at Dewar-place, and the low-tension mains are to be laid down Broughton-street to the Catholic Apostolic Church.

Electrical Omnibuses.—It will be seen from our report of the meeting of dissatisfied shareholders in the London Electrical Omnibus Company, that the London General Omnibus Company have entered, or are about to enter, into a contract to put 400 electric omnibuses on the streets of London within the next few months.

Electric Power Distribution in the Midlands.—In reference to the scheme of the Midland Electric Corporation for Power Distribution for the supply of electric current for power purposes, a circular has been addressed to the various Local Authorities in the area proposed to be served by the Company, giving particulars of their scheme and pointing out the advantages of cheap power in manufacturing businesses. The Corporation propose to supply current under conditions similar to those which obtain in many places in the United States and on the Continent, whereby, in addition to supplying the necessary current, the company will be prepared to let motors on hire and maintain them, so that consumers can avail themselves of the advantages of power supply practically without capital expenditure on their own account. The Company will also undertake electric lighting. By grouping together the various popular centres in the South Staffordshire district, and by serving them from one central station, under one management, current, it is urged, can be produced more economically than if each individual local authority undertook its own supply. The Directors confidently appeal for the support of the local authorities whose districts are embraced in the scheme.

Electric Lighting Notices.—The following additional notices of intention to apply for electric lighting powers have appeared during the week: For the London district the Charing-cross and Strand Electric Supply Corportion are applying for powers for the parishes of St. Andrew-above-Bar and St. George-the-Martyr, *Holborn*, also for St. Giles's and St. George, *Bloomsbury*; the County of London and Brush Provincial Company for *Bermondsey*, *Rotherthithe*, *Greenwich*, and *Lewisham*; St. Giles's, *Bloomsbury*, and *Holborn*, and the extra parochial districts of *Lincoln's Inn*, *Gray's Inn*, *Staple Inn*, and *Furnival's Inn*; the Marylebone Electric Supply Company for the parish of *St. Marylebone* and the *Lewisham* District Board of Works. The following notices by provincial local authorities and companies have also been given: The *Bridgwater*, *Burslem*, *Bolton* (for extension of the area of supply), *Darlington* (for extension of the area of supply authorised by 1890 Order), *Leamington*, *Shrewsbury*, *Stoke-on-Trent*, *Warrington*, and *West Bromwich* Corporations, the Urban District Councils of *Huyton-with-Roby* (Lancs.), Ilfracombe, *Leigh-on-Sea*, Margam (Glam.), *Oldbury*, *Smethwick* and *St. Anne's-on-Sea*, and the Rural District Councils of the Isle of Thanet (for *Westgate-on-Sea*), *Kingswinford* (*Staffs.*), *King's Norton* and *Whiston*. The Electric Supply Corporation are also applying for an Order for *Ramsgate*, the Melton Mowbray Electric Light Company for the urban and rural districts of *Melton Mowbray*, the National Electric Supply Company for the extension of the present area of supply at *Preston*, and the Ryde Electric Light and Power Company for *Ryde* (*Isle of Wight*). In the Omnibus Bill to be introduced by the Bolton Town Council, power is being sought for the extension of the present electric lighting area.

Embezzlement.—At the Edinburgh Sheriff Court, last week, a man named Sinclair was charged with embezzling £12. 8s. from his employers, Messrs. Cox-Walkers. Prisoner admitted his guilt, and the agent who appeared on his behalf asked that the case might be dealt with under the First Offenders' Act. The Sheriff sentenced him to 30 days' imprisonment, and to find £5 security for his good behaviour, or suffer another 30 days in prison.

Glasgow.—When the report of the Tramways Committee, recommending that the Springburn-Mitchell street tramway route be lighted electrically, came up for discussion at the meeting of the City Council last week, Mr. Paton moved that it be referred back. It was stated that when the Tramways Committee brought up the question of the equipment of the Springburn line it was thought that they would simultaneously light it electrically at a phenomenally low cost. When the matter was considered it was found that the cost would be £1,836. If the poles which the Electric Committee would put up were utilised there would be a further capital expenditure of £1,632.

Gloucester.—The City Council, on Monday, decided to apply to the Local Government Board for sanction to borrow £50,000, instead of £40,000 as originally proposed, for the erection of joint electricity and refuse-destructor works.

Greenock.—A deputation from the North British Electricity Company recently submitted a proposal to the Finance Committee of the Council relative to the erection of an electricity supply station. The Company are applying for a Provisional Order for the district.

Halifax.—At the meeting of the Town Council, on Wednesday, the Tramways Committee reported receipt of a communication from the Stainland-with-Old-Lindley District Council, suggesting that the electric tramways should be extended to Holywell Green and Stainland. The Halifax Corporation was urged to keep possession of the streets in the district, as the Huddersfield Corporation were extending their lines to Outlane. The Halifax Rural Council offer, as far as they legally can, to give the privilege of constructing tramways in the Skircoat district.

Hammersmith (London).—The Electric Lighting Committee have fixed the charge for electric current for motive power purposes at 2½d. per unit, provided that current is supplied for a minimum of 48 hours per week.

Hull.—We are pleased to record that the Electric Lighting Committee have unanimously decided to recommend the Town Council to increase the salary of the borough electrical engineer (Mr. A. S. Barnard) from £250 to £350 per annum. The salary of the assistant engineer (Mr. Bastow) has also been increased from £104 to £150.

Lancaster.—Ripley Hospital is to be lighted electrically. Current will be taken from the Corporation mains.

Liverpool.—At their last meeting the Lighting Committee sanctioned the extension of the electric light mains in Whitechapel, Scotland, Everton and Aighburth-roads, and Brownlow-hill. The periodical report of the engineer stated that there was an equivalent of 55,895 16-c.p. lamps connected for private lighting, and 6,139 Corporation lights, an increase of 1,584 for the month.

Llandudno.—Mr. Frederick H. Tulloch, M.I.C.E., held a Local Government Board inquiry at Llandudno on Tuesday into the application of the District Council to borrow £25,000 for the erection of joint electricity supply and refuse-destructor works. The consulting engineer (Mr. A. H. Preece) stated that the three-wire system of distribution would be adopted. The Council's engineer (Mr. Stephenson) submitted particulars of the refuse-destructor portion of the scheme. There was no opposition.

The plans and particulars of the project for the construction of an electric tramway from Llandudno to the top of the Great Orme were submitted at the last meeting of the District Council, and, after discussion, the principle of the scheme was approved. Mr. Enfield Taylor, of Chester, is engineer to the promoting syndicate.

Manchester.—The report recently presented by the Special Tramways Committee on the working of the local tramways was discussed at Wednesday's meeting of the City Council. An abstract of the report, together with the recommendations of the Committee, appeared in our issue of Oct. 29. Ald. Milling, who moved its adoption, said that the preparation of the report, and especially of that portion relating to mechanical traction, had entailed a con-

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siderable amount of time and thought, but the Committee had the satisfaction of knowing that it contained the latest and most up-to-date information on that most important subject. The substitution of overhead electric traction for the present system of horse haulage would no doubt be a serious step for the Corporation to take, but the arguments in favour of the adoption of this course were so strong that the most prejudiced mind, after a careful perusal of the report, could scarcely take a contrary view. An ideal form of traction for successfully operating the tramcar service of a large commercial city like Manchester should be reliable—that was to say, there should be no liability of complete stoppage of the tramcar service from any cause whatever; its initial cost should not be large; during construction and repairs it should not interfere with existing traffic or ordinary vehicular traffic; it should be cheap to operate; it should be flexible—that was to say, it should be such that the service could be increased so as to fully meet the exigencies of the traffic; it should be speedy, and the cars should be fully under control; and it should be attractive in appearance and free from external apparatus likely to offend the eye or to prove a danger to the ordinary vehicular traffic. That the overhead system reasonably fulfilled those conditions there could be no doubt. In the first place, it was reliable. Then its cheapness of operation could not be questioned, as it costs only half as much per car-mile to operate as horse traction. The cars could be brilliantly illuminated, heated if required, and everything about the system lent itself to securing in every way the comfort and convenience of the tram-travelling public. All the æsthetic objections to overhead wires could be brought to the vanishing point. The illustrations in the report conveyed some idea of the appearance the poles and overhead wires would have in the streets, and when it was known that by co-operation between the Electricity and Tramways Committees the streets were to be brilliantly lighted by arc lamps fixed to the span wires or poles, he felt sure every citizen would agree that the Council, by adopting the Committee's recommendations, would be pursuing a progressive and enlightened policy, and one tending to ensure the ultimate success of the Manchester municipal tramways. Mr. Vaudrey moved, as an amendment, that the matter be postponed until they had ascertained the terms upon which the Manchester Carriage and Tramways Company would be willing to take a fresh lease of the lines, and the cost of constructing and completing the tramway system. Alderman Higginbottom, Chairman of the Electricity Committee, supported the motion for the adoption of the report, which was eventually carried with two or three dissentients.

Mitchelstown (Ireland).—The Local Government Board have approved, with some slight modification, the area to be charged with the expenses to be incurred in the electric lighting of the town. The Mitchelstown Guardians are the first Poor Law Corporation in Ireland to adopt the provisions of the Electric Lighting Acts. A Provisional Order is being applied for.

Newington (London).—A site for the proposed electricity generating station having been acquired, construction work has been commenced.

Paisley.—The Borough Nurses Home in Oakshaw, which was formally opened on Tuesday by H.R.H. the Princess Louise, is to be lighted electrically throughout, the building having been wired by Messrs. Claude Hamilton (Limited) of Glasgow.

Patents Application.—A Bill is to be introduced next session to reinstate, continue and confirm Letters Patent 11,161 of 1886, granted to Messrs. F. L. Rawson and W. S. Rawson, electrical engineers, for improvements in the production of light by the incandescence of refractory materials, and to enable the holder and assignees of the said Letters Patent to pay the renewal fees thereon, notwithstanding that the time enlarged and limited by the Patents, Designs and Trade Marks Act (1883) for so doing has expired.

Poplar (London).—At the last meeting of the District Board of Works two communications relating to electric lighting matters were referred to the Electric Lighting Committee for consideration and report. The first was from the solicitor to the County of London and Brush Provincial Company (Mr. Sydney Morse) intimating that the Company intended to apply for a Provisional Order for the district, and the second an application for the position of consulting electrical engineer to the Board.

Postal Parcels Arrangements.—Conventions have been entered into between this country and France, providing for a parcels post up to 5 kilogrammes (11lb.) weight, without declaration of value, between France and British India and between France and Australia.

Provisional Order Revocation.—The Board of Trade notify the revocation of the Allerton, Woolton, Childwall and Garston Electric Lighting Order (1896) in so far as it relates to Garston.

Ramsgate.—The Town Council have decided to oppose "any attempt to obtain a Provisional Electric Lighting Order for the district."

Salford.—Some time ago the Town Council applied to the Local Government Board for sanction to borrow £13,000 for electric light extension purposes, but received no reply. As the delay in holding the usual inquiry was causing considerable inconvenience to the Electric Lighting Committee the Town Clerk recently repeated the application, and threatened to commence work. The Board now state that an inquiry will be held as soon as possible, and warn the Council against commencing operations before the necessary sanction has been received.

South Shields.—In moving the adoption of the Electric Lighting Committee's minutes at Wednesday's meeting of the Town Council, Ald. Rennoldson announced that the undertaking was making satisfactory progress. The output during the past five weeks was 12,466 units, compared with 4,858 in the corresponding period of last year.

St. Helens.—The Town Council have received the sanction of the Local Government Board to borrow £16,500 for carrying out extensions of their electric lighting undertaking.

St. Pancras (London).—The Vestry have decided to extend the electric light mains to the Prince of Wales-road, Malden-road, Queen-crescent, and Ferdinand-street and to light these thoroughfares by means of arc lamps. The total cost is estimated at £5,422. A circular is to be sent to all customers of the electricity department, offering them the option of taking current from the 1st January next either at the present rate or at 6d. per unit for the first three hours each day and 3d. per unit afterwards.

The Strike.—The conference between the representatives of the Employers' Federation and those of the engineering trades unions has continued during the week, but little progress is to be reported. On Friday the question of management (the first subject before the conference) was again discussed, and after frequent interchange of communications between the two sections, and when it was feared that a rupture between the parties was imminent, it was finally agreed to accept the terms of the employers' memorandum, as follows:—

> The Federated Employers, while disavowing any intention of interfering with the proper functions of trade unions, will admit no interference with the management of their business, and reserve to themselves the right to introduce into any federated workshop, at the option of the employer concerned, any condition of labour under which any members of the trade unions here represented were working in any of the workshops of the Federated Employers. It is further agreed that the discussion and mutual settlement of matters of detail which illustrate the above general principle shall be at once proceeded to at this conference. Nothing in the foregoing shall be construed as applying to the normal hours of work or to general rises and falls of wages.

It is pointed out that this and all other clauses accepted by the men's representatives will be finally submitted to the whole body of members of the unions at the close of the Conference. From Friday the Conference adjourned till Tuesday, when the subjects selected for discussion were (1) freedom in the employment of workmen; (2) piecework. The discussion for the day centred round the question of the right of the employers to engage what workmen they please, the employers asking that members of the unions should be allowed to work with non-union men. On the question of piecework rates proposals were made on behalf of the men that these should be based upon the standard rate of wages in the district, that sub-contracting should be abolished, that the men should be paid directly by the employers, that each job should stand by itself, and that deficits should not be carried forward as debits from one job to another. The discussion round these points continued on Wednesday without any final conclusion, and again on Thursday with similar results. The Conference has, when these thorny subjects are disposed of, to discuss the important questions of overtime, the employment of apprentices, the avoidance of future disputes, and the freedom of employers to engage any class of workmen on machines. At the rate of progress made to date the Conference should be sitting till the winter is over. Already there are indications that the unionists are inclined to repudiate the action of their representatives at the Conference, on the plea that too yielding a disposition is shown to the demands of the employers' representatives.

Uddington (Glasgow).—An effort is being made to form a company for the purpose of establishing an electricity station for lighting this district electrically. It is proposed to utilise the falls or weir at Blantyre Mills in the generation of current.

Weston-super-Mare.—A meeting of the District Council in committee was held on Monday to consider what modifications should be made in the electric lighting scheme which has been prepared by Mr. W. C. C. Hawtayne. Eventually a motion that the Committee recommend to the Council that Mr. Hawtayne be instructed to prepare plans and specifications, with detailed estimates, of a scheme not to exceed £20,000, was carried by the casting vote of the Chairman. An instruction to the Clerk to negotiate for the acquisition of a site for the station was also carried by one vote.

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Wimbledon.—Mr. A. H. Preece's plans of the proposed electricity supply works have been approved by the Electric Lighting Committee, and the Local Government Board are now asked to expedite their sanction to the borrowing of the necessary moneys.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published s compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

November 2, 1897.

25,400. E. MOTZ and H. F. WELCH. London. Improved electrolytic process and apparatus for the separation of metal from their ores and solutions.*

25,403. A. J. BOULT. London. Improvements in or relating to current collectors for electric railways. (F. A. Anderson and D. M. Anderson, United States.)

25,412. T. E. GAMBRELL and A. F. HARRIS. London. Improvements in electrical resistances.

25,434. P. DAWSON. London. Improvements in trolley wire hangers for use in overhead lines of electrical railways or tramways.

25,437. G. COHN. London. Process and arrangement for intensifying telephonic reproduction.

25,441. H. H. LAKE. London. Improvements in electric accumulators. (G. de Digoine, France.)

25,446. W. H. HARFIELD. London. Improvements in apparatus for electrically controlling engines, electromotors and other machinery.

25,453. F. CAIRE. London. Improvements in dynamo-electrical machines.

November 3, 1897.

25,480. A. GRAEWIGER. Manchester. Improvements in electric accumulators.

25,519. J. HARGREAVES. London. Improvements in electrodes.

25,528. W. H. AKESTER. London. Improved valve apparatus for electric batteries.*

25,537. A. M. STANSFIELD. Liverpool. Improved electrical appliance or lamp for dental and other purposes.

November 4, 1897.

25,563. W. H. STURGE. Birmingham. A new or improved adjustable cord-reel for electric pendant cords and other similar purposes.

25,581. H. CRONAN. Brussels. A lighting regulator for gas and petroleum motors lighting electrically.

25,582. H. CRONAN. Brussels. Electric lighter for gas and petroleum motors.

25,599. CHAMBERLAIN AND HOOKHAM (LIMITED) and S. H. HOLDEN. London. Improvements in electricity meters.

25,646. F. W. DUNLAP. London. An improvement in the manufacture of bulbs for electric glow-lamps.

25,647. F. W. DUNLAP. London. An improvement in the manufacture of globes and shades for electric and other lamps.

25,650. J. S. LEWIS. London. Improvements in armatures for dynamo electric machinery.

25,653. S. BIHELLER. London. Improvements in or applicable to incandescent electric lamps.

25,655. A. J. BOULT. London. Improved apparatus for making observations by means of Röntgen or "X"-rays. (J. Wertheimer, France.)*

25,659. F. H. GLEW. London. Improved manufacture of electrical vacuum tubes.

November 5, 1897.

25,674. S. T. WHITE. Bristol. Generation of electricity at gas works by utilising waste gases.

25,703. W. W. HANSCONI and A. HOUGH. Manchester. Improvements in electrical batteries.*

25,713. A. B. LOACH. Birmingham. Improvements in closed conduit systems of electric traction.

25,723. G. A. SCHREFFER. London. Improvements in alternating electric current meters.*

25,744. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) and H. M. HOBART. London. Improvements in alternate-current induction motors.*

25,745. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) and H. M. HOBART. London. Improvements in reactance coils.*

25,755. R. G. SABAT, J. DROHOMIRECKI and A. ROSENBERGER. London. Automatic electric signal-device for preventing railway accidents.

25,757. O. IMRAY. London. Improved manufacture of electrodes for electrical accumulator or secondary batteries. (La Société Anonyme pour le Travail Electrique des Metaux, France.)

November 6, 1897.

25,771. J. HIGGINS. Claremorris. An electric fire alarm.

25,805. J. T. WOOD and J. A. BODIE. Liverpool. Improvements in and relating to overhead conductors for electrically propelled tramcars and the like.

25,811. S. H. RUSSELL. London. Improvements in fusible sockets for electric lamps.*

25,818. J. MACKENZIE. Glasgow. Improvements in electric bells.

25,830. W. MENZE. Liverpool. Improvements in or connected with electric burglar alarms, also applicable as a door or house bell.

25,832. C. F. BLUNDELL. Liverpool. Improvements in dynamos, electro-magnets, and the like, and in wire, or winding for the same, and for other electric purposes.

25,869. G. MÖLLER. London. An improved system for the distribution of electric currents and apparatus therefor.*

November 8, 1897.

25,872. F. M. LEWIS. Brighton. Improvements in induction motors.

25,889. F. C. GEARY and J. H. ROBOTTOM. Burton-on-Trent. An improved cell or box suitable for accumulators or other electric batteries.

25,890. G. BELL and G. W. BELL. Liverpool. Improvements in or connected with electrolytic cells.

25,896. J. H. TUCKER. Birmingham. Improvements in electrical switches.

25,906. F. J. JONES and J. F. STEVENSON. Chester. Improvements in incandescent electric lamps or vacuum tubes for advertising.

25,941. C. BORITSCHEWSKY. London. Improved construction of electrical transformers.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

23,242. DUNLAP AND QUAIN. Electric incandescence lamps.

23,512. HOOKHAM. Electricity meters for alternating currents.

26,968. SINCLAIR AND AITKEN. Construction of spring-jacks used in telephonic switchboards.

28,139. DODD. Lead accumulators.

28,578. CROMPTON. Bonding of rails used for electrical railways or tramways.

29,499. HEYLAND. Alternating-current motors.

30,060. EDMUNDS. Manufacture and production of flexible metal bars, cables, or the like, suitable for use as electric conductors or for other purposes.

1897.

4,183. DOLLEY, HAWKINS, LIGHTFOOT and GOODWIN. Electric incandescent lamps.

9,173. MAYER. Electro-therapeutical lamp.

14,963. HOEGERSTAEDT. Trolleys for electrically-propelled cars.

19,035. JONES (Balbach). Electrolytic apparatus.

19,755. FITZPATRICK (Braudt). Curving or bending of pipes or conduits made of paper and like material used for carrying electric wires, and which are enclosed in a metallic sheathing.

20,041. GLAZIER. Metal bases for telegraph and other poles.

COMPANIES' MEETINGS AND REPORTS.

Crompton and Co. (Limited).

An extraordinary general meeting of this Company was held on Monday, under the presidency of Mr. John Trotter.

The SECRETARY (Mr. Francis R. Reeves) read the notice calling the meeting.

The CHAIRMAN said: Our meeting to-day is perhaps one of the most important that has taken place in connection with the affairs of the Company. You have, however, already had the subject-matter of this scheme placed fully before you. I will as briefly as possible sum up the question in order that we may take the votes of the shareholders in this Company as to how they wish this scheme to be dealt with. I laid before you particulars at our last meeting in July, which showed that in order to meet the case of the balance-sheet thoroughly, and to deal at the same time with the large amount that stood as representing goodwill, it was necessary that we should write off £78,396. The question then arose how we were to find that large amount of money. The Directors originated the scheme before you after very careful consideration, and, taking into account the whole of the circumstances, I quite feel that, looked at from the individual standpoint of any shareholder in any particular class of shares, and also without having regard to the general effect of the Company's business, there are many things that it might be thought might have been left out; but we considered the respective rights of the different classes of the shareholders, and as a result we recommended the scheme which is before you to-day. I would propose that we should take the three resolutions at once, but it is open to any shareholder to dissent from that, and to prefer that they should be taken separately. These three resolutions

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however, embody the scheme as a whole, and I therefore propose that we should take them together and vote on them at this meeting. The shareholders have looked upon the matter with great care, and have come forward in very large numbers to consider this scheme, in favour of which we have 24,000 votes. I do not say that with a view of influencing you in any way, but merely to show that the whole matter has been very carefully considered by the shareholders as a whole. He then proposed the resolutions *en bloc*.

Mr. R. E. B. CROMPTON seconded the motion.

Mr. T. HUNTLEY said he was sure that all present were agreed that they must make the best of a bad matter. The chairman, in order to save time, had thought it desirable that they should take the three resolutions together, but he thought it would be better to deal with them separately, as many of them might agree with one or other of the resolutions or with two out of the three, but not with all of them. There was one clause in the third resolution which said that "the holders of the 28,180 Preference shares which have been issued, and are numbered 1 to 28,180 inclusive, shall cease to be entitled to any preference or priority, either in respect of past or future dividends or capital, over the holders of the Ordinary shares," and so on. He desired to call attention to the word "past." Looking at the fact that the shares in question were cumulative, he thought that some compensation ought to be given to the holders for their arrears of dividend, and he suggested that they should receive some compensation in the shape of a certificate for Ordinary shares. With respect to the years 1896 and 1897, there were no dividends, and if they did not earn money, and there was no balance, the Preference shareholders had to go without a dividend as well as the rest. His objection was to doing away with the balance of the dividends unpaid in the previous years. He approved of the first and second resolutions, but not of the third, for the reason he had set forth.

The CHAIRMAN stated that they had had this matter before them, and a few words from him might explain the position. There was no doubt that there was a large amount of arrears in connection with the cumulative dividends; but these could only be paid out of future profits. Under the scheme now submitted to them, the Preference shareholders would get the whole of the future profits, less one-eighth. For this one-eighth which they were giving up they were receiving from the Ordinary shareholders a very great concession should the Company be successful in future. They could vote upon the three resolutions separately if the meeting wished it, but they must accept or reject the third resolution as no amendment to it could be received.

Col. STEBBING thought that if they reduced the 7 per cent. dividend to 5 per cent., and left them with a Preferred £3 share, and took away the cumulative dividend, he thought it would be sufficient. He wanted, however, to retain his position as a Preference shareholder.

Mr. EVANS remarked that the question divided itself into two parts—the reduction of the capital and the attempt to sweep away the cumulative dividends, which were a contract in the prospectus, and on the strength of which they got 10s. a share premium for their last issue of Preference shares. He thought that perhaps no one would make any strong objection to the reduction of the capital, but there were 1,928 shares with only £2 paid on them. The Directors had been borrowing large amounts of money, and paying interest for it, when they could have called up the sum of between £6,000 and £7,000 on the shares he had mentioned without paying any interest. He failed to see any advantage which they were to gain from the Ordinary shareholders giving up their rights. The Ordinary shareholders had received nothing for many years, and the Preference shareholders would be quite satisfied with their 7 per cent. dividend. As to taking away the arrears of dividends, they represented an accrued debt, and he contended that it was beyond their power to take these dividends away, and that no Court would permit such a proceeding.

The CHAIRMAN, in reply, stated that with reference to what had been said about the Preference shareholders' rights, those shareholders were having nothing whatever put ahead of them, and they were taking away the Ordinary shareholders from behind them. Any rights that the Preference shareholders possessed would be precisely the same under the scheme, excepting in so far as the one-eighth share he had referred to. The solicitor stated that if any shareholder wished the resolutions put separately, they must be so put. With reference to one remark of Mr. Evans, it might, perhaps, have been more prudent to call up sooner the amount due on the 1,928 shares referred to, but he did not think that those who held these shares had been benefited to any appreciable extent by the amount not having been called up on them sooner. He then put the first resolution, authorising the reduction of the capital from £280,000 to £168,000 "by cancelling capital to the extent of £2 per share upon all the existing 34,108 shares which have been issued, and by reducing the nominal amount of the shares in the Company's capital from £5 to £3 per share."

This was carried by 18 to 1. The Chairman then proposed the second resolution further reducing the capital to £162,000 by cancelling 2,000 Ordinary shares.

Mr. J. F. ALBRIGHT seconded the motion, which was also declared carried, with one dissentient.

The CHAIRMAN then proposed the third resolution, declaring that the holders of the 28,180 Preference shares "shall cease to be entitled to any preference or priority, either in respect of past or future dividends or capital, over the holders of the Ordinary shares for the time being, and that accordingly such Preference shares shall rank as Ordinary shares in all respects, and that the 1,820 Preference shares now unissued be Ordinary shares, and that all the shares in the Company's capital shall, as regards both dividends and capital, rank *pari passu* in proportion to the respective amounts paid up or deemed to be paid up thereon."

Mr. CROMPTON, in seconding the motion, remarked that, as the largest ordinary shareholder, he should be very glad if the resolution was not carried. He would not, however, say that exactly, but he would say that it would be enormously to his interest, although it would be most unfair to the Preference shareholders, if it were not carried, now that the first and second resolutions had been agreed to.

After a few further remarks from Col. Stebbing and Mr. Evans, again dissenting from what was proposed, the Chairman put the resolution, and stated that 17 voted for it and nine against it. It would, therefore, be necessary to take the values of the votes. There were 24,038 votes in favour, and 606 votes against. He therefore declared it carried by the requisite majority.

A general meeting of the holders of the Preference shares was afterwards held (Mr. Trotter presiding), at which a resolution was proposed confirming an agreement by which the rights of the holders of the Preference shares was modified in accordance with the conditions of the said agreement, and confirming the resolutions passed at the earlier meeting.

Mr. EVANS inquired whether, by the Memorandum of Association or the Articles of Association, the Preference shareholders had not a priority of capital over the Ordinary shareholders.

The SOLICITOR replied that under the Articles of Association, as they at present stood, it was provided that the surplus assets on a winding-up of the Company should be applied first to repaying to the holders of the Preference shares the amount paid up in respect thereof.

Mr. EVANS: Then, do you think the Court will let you do what you propose, and against opposition?

The CHAIRMAN stated that what was proposed could only be carried out by such an arrangement as that which they had met to discuss that afternoon.

Nineteen voted for the resolution and six against it. The nineteen represented 19,498 votes, and the six 318, and the resolution was therefore declared carried by the requisite majority.

A meeting of the Ordinary shareholders was held subsequently (Mr. Trotter presiding), when

Mr. CROMPTON proposed a resolution similar to that submitted at the Preference holders' meeting. He said he did not think some of the Preference shareholders had understood the position. The Ordinary shareholders probably understood it thoroughly well, but as he had already intimated, it was only fair for the Ordinary shareholders to do what was now proposed in view of the improvement made in their position by the first two resolutions which were passed at the extraordinary meeting.

Mr. ALBRIGHT seconded, and said he believed that he was the second largest Ordinary shareholder, and he thought the very best course for them to take had been adopted in all interests.

The motion was carried unanimously, and a vote of thanks to the Chairman and Directors closed the meeting.

NEW COMPANIES, STATUTORY RETURNS, &c.

AUTOMATIC ELECTRIC METER SYNDICATE (LIMITED).—This Company was registered on Nov. 25th, with a capital of £32,000, in £5 shares, to enter into an agreement with Mr. W. D. Watson and others, and to carry on the business of electricians, and manufacturers of and dealers in electric meters. The first subscribers, with one share each, are:—James B. Atherton, Thomas Snape, J.P., G. Ellis, J.P., William D. Watson, Rochdale, manufacturer, Jacob Atherton, A. E. Haptie, and F. W. Lintern. The first directors are: Thomas Snape, Jacob Atherton and George Ellis.

BRIND, GILLINGHAM AND COMPANY (LIMITED).—This Company was registered on Nov. 26, with a capital of £8,000, in £1 shares, to carry on the business of electrical engineers, dealers and workers in electrical apparatus and fittings, ironmongers, &c.

ELECTRICAL GUARANTEE AND TRUST (LIMITED).—This Company was registered on Nov. 25th, with a capital of £250,000, in £5 shares, to enter into, carry on, participate in and assist financial, commercial, mercantile, industrial, manufacturing and other businesses, works and undertakings, to carry on the business of financiers, promoters of companies, concessionaires, contractors or merchants, and to promote, construct, equip, work and control railways, tramways, telegraphs, telephones, cables, &c. The first subscribers, with one share each, are:—C. T. Price, R. Mackenzie, W. Henderson (engineer), H. H. Rhodes James, G. Graham, N. G. Newington and A. Benwell.

RYDE ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The statutory return to Nov. 8 has been filed. Seven shares have been taken up out of a capital of £10,000, in £5 shares, and no calls have as yet been paid.

SAX, SLATTER, AND COMPANY (LIMITED).—The statutory return to Nov. 22 has been filed. The capital is £10,000, in £1 shares. 5,500 of these have been taken up, and 500 are considered as fully paid. £5,000 has been paid on the others.

SOUTH AMERICAN CABLE COMPANY (LIMITED).—The annual return to July 29 was not filed until Nov. 19, when 24,707 shares were taken up out of a capital of £500,000 in £10 shares. 10,000 of these have been issued as fully paid, and £10 per share has been called and paid on the remainder.

VAUGHAN AND BROWN (LIMITED).—The annual return to Nov. 12 has been filed. The capital is £40,000, divided into 4,000 Preference and 4,000 Ordinary shares of £5 each. 3,349 of the former and 2,690 of the latter have been taken up, and 2,000 of each class have been issued as fully paid. The full amount has been called on the balance.

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WEYMOUTH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The statutory return to Nov. 8 has been filed. The capital is £10,000, in £5 shares. Seven shares have been subscribed for, but no calls have been made thereon.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 27½d. per oz. (Dec. 2). Consols (2¾ per cent.) 112¾—113 for money, 113—113¼ for account: 2½ per cent. 105½—106 (Dec. 2). Stock Exchange Settling Days: Consols, Jan. 3; Stocks and Shares Continuation Days, Dec. 13 and 28; Ticket Days, Dec. 14 and 29; Pay Days, Dec. 15 and 30; Mining Share Carry-over Days, Dec. 11 and 24.

G. R. BLOT AND CO. (LIMITED).—We are asked to state that the allotment letters of the above Company were posted on the 1st inst.

COMMERCIAL CABLE COMPANY.—The transfer books of this Company's Sterling Four per Cent. 500-Year Debenture Stock will be closed from the 24th to 31st inst. inclusive, preparatory to the payment of the quarterly dividend due Jan. 1 next.

ELECTRIC AND GENERAL INVESTMENT COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 10 per cent. on the capital paid up on the Ordinary shares, payable on and after the 15th inst.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—Applications have been invited this week for an issue of £150,000 of Four per Cent. Perpetual First Mortgage Debenture Stock (part of an authorised issue of £200,000) in this Company. This issue is intended exclusively for the purpose of replacing first mortgage debentures, and is offered to the holders of these latter securities.

DUNDEE AND DISTRICT TRAMWAY COMPANY (LIMITED).—A meeting of this Company was held on Wednesday, when the agreement between the Town Council and the Company for the municipalisation of the tramway system and the introduction of electric traction was approved.

RICHARD HORNSBY AND SONS (LIMITED).—The annual report of the Directors states that, after making reserve for doubtful debts (£4,000) and payment of debenture and other interest (£5,703), there was a profit of £2,595. No dividend is declared, the balance to the debit of profit and loss being £3,189.

GUTTA-PERCHA CORPORATION (LIMITED).—A prospectus will be found on another page of the Gutta-Percha Corporation (Limited), which has been formed with a capital of £200,000 in 80,000 7 per cent. Preference and 120,000 Ordinary shares of £1 each. The present issue is for 80,000 shares of each denomination. These are payable 2s. 6d. per share on application, 7s. 6d. on allotment, 5s. one month after allotment, and the balance 5s. when required, on not less than two months' notice. The Preference shares are cumulative and are entitled to a further *pro rata* dividend after 7 per cent. has been paid on the Ordinary shares. The Company will trade in and manufacture gutta-percha, and acquire patent processes to obtain this material from the leaves and twigs of gutta-percha trees by (the prospectus states) an efficient and economical method. Reports on the process by Lord Kelvin, Dr. John Hopkinson, and Prof. Ramsay accompany the prospectus. The Corporation has a strong directorate, which includes the Right Hon. Sir Edward Thornton, G.C.B., late British Ambassador at St. Petersburg and at Constantinople (Chairman), and Mr. Frederick Newton, a Director of W. T. Henley's Telegraph Works Company. The consulting electricians are Lord Kelvin and Dr. J. T. Bottomley, the consulting chemist is Prof. Ramsay, and the engineer Sir Samuel Canning. The secretary and offices are Mr. C. E. Kent, 77 and 78, Palmerston-buildings, Old Broad-street, London, E.C. The lists opened on Wednesday and close for both town and country on or before to-morrow (Saturday) Dec. 4.

LONDON ELECTRIC OMNIBUS COMPANY (LIMITED).—A few days ago shareholders in the London Electric Omnibus Company received a circular from Mr. William Marshall, late deputy-chairman of the Company, calling attention to "the deplorable condition into which the Company has fallen owing to the incompetency of the management." The circular stated that the company "has now been formed nearly two years, and in the prospectus you were promised that 125 omnibuses would immediately be placed upon the streets. The Company took over one 'bus from me, and although the directors, I am informed, have spent something like £25,000, beyond this there is not a single omnibus yet ready to start running." Mr. Marshall then invited those interested to attend a meeting, on Friday, Nov. 26. This meeting was held under the presidency of Mr. E. Kimber, who said that, in his opinion, the Company possessed the elements of great success, and it was for the shareholders to discuss how such success was to be arrived it. In view of the statements contained in the prospectus and of the great scientific assistance the Board had had it was surprising that so little had been done towards accomplishing what the public were, at the outset, promised. One electric omnibus was constructed by Mr. Marshall [!] and handed over to the Company, but even that had not been put on the streets except for trial trips. He thought the shareholders were entitled to information as to what had been done with the many thousands of pounds of subscribed capital, and he suggested that a committee should be formed to make the necessary investigations. Mr. Marshall explained that he took part in the promotion of the Company, and was, until some time ago, deputy-chairman. He saw at once that the Company had gone to allotment with too small a capital. According to the prospectus the Company was to have placed 125 omnibuses on the streets, and he believed that altogether they received ample capital for doing so. The management had been very bad. He characterised the efforts of the Board to acquire the "Sola" accumulator as only one of numerous indications of useless expenditure sanctioned by the Directors. The Directors had also voted themselves £3,000 a year, with a bonus on the profits, although he did not suppose they had drawn the whole of the amount, and had, he believed, appointed Mr. Radcliffe Ward engineer to the Company at a salary of £1,200 per annum. He did not believe a single director held more than his bare qualification in the Company. He urged the shareholders to take steps to put the Company on a better footing. When the Company was started they had the field to themselves, but now the London General Omnibus Company were (so the Chairman told him) negotiating for the placing of 400 electric omnibuses on the London streets. On the motion of Mr. W. T. Ware, Messrs. Ware, Flaxman Haydon (trustee in bankruptcy of Mr. Marshall), Condict, Turnbull, Kimber, and the Chairman were elected a committee of inquiry, although it is difficult to see what real investigation such a committee can effect in the absence of right of access to the Company's books and records.

OESTERREICHISCHE ELEKTRICITATS GESELLSCHAFT (VIENNA).—This Company is about to increase its capital from 6,000,000fl. to 8,000,000fl. The new shares will be offered to the existing shareholders at 132½. The increase is partly due to the growth of the Company's ordinary business, and to the decision to equip the lines of the Vienna Tramway Company electrically.

PROVINCIAL TRAMWAYS COMPANY (LIVERPOOL).—At the meeting of shareholders held last week the Chairman (Mr. G. Richardson) said the Directors had decided to set aside the following sums towards the cost of reconstructing the permanent way of some of their lines: Plymouth, £2,500; Cardiff, £3,500; Portsmouth, £2,000; and Grimsby, £2,000. A dividend of 5s. 6d. per share was declared, making 8s. for the year. Negotiations with the Town Council of Cardiff had come to an end, owing to the opposition of that body. The Provisional Order for extending the lines from Grimsby to Cleethorpes was passed, and it contained powers to enable the lines to be worked by electricity if desired.

ROYAL ELECTRIC COMPANY OF MONTREAL.—The usual quarterly dividend of 2 per cent., being at the rate of 8 per cent. per annum, has been declared by this Company.

STOCK EXCHANGE NOTICES—The Stock Exchange Committee has appointed Thursday, the 9th inst., a special settling day for the scrip (£60 per cent. paid) of £120,000 Four and a-Half per Cent. Debentures of the Direct West India Cable Company (Limited). The Committee of Management of the Birmingham Stock Exchange has appointed special settlements for the 6th and 7th inst. in the Preference shares (Nos. 1-1,888) of Townshend's Art Metal (Limited). The same Committee has granted quotations in the Official List to the shares of Thomas Parker (Limited), and to the Preference shares (Nos. 1-1,888) of Townshend's Art Metal Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Nov. 26 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited) were £2,963.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Nov. 27	3,165	+133	...	...	...
Bristol Trams & Carriage	„ 26	2,340	+422	21	55,966	+8,389
City & South London Ry.	„ 28	1,060	+ 6	22	20,783	- 112
Dover Tramways	„ 27	85	...	12	1,423	...
Dublin United (Southern)	„ 26	399	- 58	21	13,948	- 645
Liverpool Overhead Rly.	„ 28	1,257	+109	22	31,296	+4,155
Sheffield Tramways	„ 28	907	+ 88	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Nov. 24.	Price Wednesday, Dec. 1.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 27. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,125	£10	3/0	Central London Ordinary	9¾ 10¼	9⅝ 10¼	2 17 2	June and December	..	..
143,108	10	1/3	Do. (£6 paid)	5¼ 5	5¼ 6	3 0 0	„ „	..	..
£600,000	Stock	2½	City and South London Railway Com. Ordy.	69 71	69 70	2 13 6	January and July	70½	69
8,419	£10	5½	Do. 5% Perpetual Preference	15¼ 16	15½ 16	3 2 6	„ „	16¾	..
£125,700	Stock	4½	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	..	..
54,000	10	9/2½	Waterloo and City Ordinary	12¼ 13	12½ 13	2 6 1	June and December	..	..
37,500	10	2½	Liverpool Overhead Railway Ordinary	12½ 12¾	11¼ 11¾	2 11 7	February & August	..	..
10,000	10	5½	Do. 5% Preference	16 16¾	16 16¾	3 0 7	„ „	..	..
125,000	Stock	4½	Do. 4½ Debenture	110 113	110 113	3 11 6	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 24.	Price Wednesday, Dec. 1.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending Nov. 27. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£923,960	Stock	14/0	Anglo-American	58 60	58 60	4 12 6	Feb., May, Aug., Nov.	58⅜	58
£3,038,020	Stock	23/0	Do. Preferred	104 105	104 105	5 6 6	" "	105	104½
£3,038,020	Stock	5/0	Do. Deferred	12¼ 12⅜	12¼ 12⅜	—	—	12⅛	—
£137,400	£100	4%	*African Direct Telegraph (Red)	101 105	101 105	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	5½ 6½	5½ 6½	..	—	6	—
130,000	10	5/0	Brazilian Submarine	16 16½	16 16½	4 4 10	Mar., June, Oct., Dec.	16½	16½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	114 118	114 118	4 5 10	June and December	..	—
10,000,000	$100	7%	Commercial Cable Capital Stock	182 187	183 188	4 5 1	Jan., Apr., July, Oct.	186½	183
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105 107	105 107	3 14 9	" "	106¼	105¾
16,000	10	8/0	Cuba Submarine	8½ 9½	8½ 9½	8 8 5	February and August	9	—
6,000	10	10%	Do. Preference 10 per Cent.	18½ 19½	18½ 19½	5 2 7	" "	..	—
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October	..	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	10½	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞ 106⅞	103⅞ 106⅞	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10 10½	10 10½	5 14 3	Jan., Apr., July, Oct.	10⅜	10½
400,000	£10	2/6	Eastern	17 17½	17 17½	3 14 4	" "	18⅜	16⅞
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18 19	18 19	3 3 8	" "	18½	..
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	132 133	131 134	2 19 9	May and November	131½	..
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101 104	101 104	4 14 9	February & August	..	..
250,000	10	2/6	Eastern Extension	18½ 18¾	18½ 18¾	3 17 9	Jan., Apr., July, Oct.	18⅜	18⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	131 134	131 134	3 0 0	February & August	—	—
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	100 104	100 104	4 17 4	January and July	—	—
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	100 104	100 104	4 17 4	" "	—	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103 106	103 106	3 15 8	February & August	—	—
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞ 111⅞	108⅞ 111⅞	3 12 1	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	11½ 12	11½ 12	3 15 0	Jan., Apr., July, Oct.	—	—
180,042	10	6%	Do. 6 per Cent. Preference	17¼ 17¾	17¼ 17¾	3 7 7	" "	..	—
150,000	10	5/0	Great Northern of Copenhagen	26 27	26 27	3 14 1	January, April, July	26¼	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	102 105	102 105	4 15 3	March & September	..	—
17,000	25	12/6	Indo-European	52 55	52 55	4 10 11	May and November	..	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	107 110	107 110	5 9 7	March & September	—	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	107 110	107 110	3 13 5	June and December	..	—
11,889	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	136 141	136 141	4 5 1	" "	—	—
15,609	10	6/0	West African Telegraph	4½ 5½	4½ 5½	5 0 0	" "	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103 106	103 106	4 14 4	March & September	104	—
30,000	10	2/0	West Coast of America	¾ 1¼	¾ 1¼	..	..	..	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	106 108	106 108	3 14 10	June and December	108½	..
88,321	10	1/0	West India and Panama	⅝ ⅝	⅝ ⅝	..	May and November	—	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7¾ 8¼	7⅞ 8¼	7 5 5	" "	8¼	7⅞
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5 7	5 7	8 11 5	" "	—	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107 110	107 110	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian xd	9½ 9¾	9½ 10	2 19 8	May and November	9⅝	9½
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary xd	7½ 8	7½ 7¾	3 17 8	" "	7¾	7½
33,129	7½	1/6	Do. Deferred Ordinary	2¼ 2⅝	2½ 3	..	" "	2⅛	2½
£382,230	..	4%	Do. 4 per Cent. Debenture Stock	108 109	105 109	3 14 1	June and December	107⅛	—
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	103 107	103 107	6 10 10	Feb., May, Aug., Nov.	—	—
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	—	—
			TELEPHONES.						
44,000	£5	4/0	Chill Telephone (fully paid)	3¼ 3⅝	3 3½	5 14 4	August	—	—
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16 3/16	1/16 3/16	..	July	1/16	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2 2½	2 2½	8 0 0	October	—	—
484,597	5	3/0	National	6½ 6⅝	6½ 6⅝	4 12 4	February & August	6 15/16	6½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15 17	15 17	3 10 7	" "	—	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14 16	14 16	3 15 0	" "	15 1/16	14½
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6 6½	6 6½	3 16 11	" "	6 1/16	—
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104 109	104 109	3 5 0	June and December	105¾	105
171,504	1	0/4	Oriental	1/16 1/8	1/16 1/8	4 2 4	April and October	—	—
58,000	5	5/0	United River Plate	3½ 4¼	3½ 4¼	5 17 8	July	—	—
£146,733	Stock	0%	* Do. 5 per Cent. Debenture Stock (red.)	102 107	102 107	4 14 4	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.						
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	11¼ ..	10 ..	—	March	..	—
£50,000	5	..	Do. (New Issue) £3. 10s. paid	..	..	—	..	..	—
50,000	£10	14/0	City of London Electric Lighting (fully paid)	27 28	26½ 27½	2 10 11	February & August	27⅞	26⅞
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17 18	17 18	3 6 8	January and July	17⅞	17½
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131 136	131 136	3 14 8	June and December	133	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12 13	12 13	2 0 0	February & August	12 9/16	—
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6 6½	3 6 8	" "	6⅝	6½
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	— —	— —	—	January and July	—	—
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	10½ 10¾	10½ 11	3 8 2	March	10¾	10½
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113 116	113 116	3 14 7	June and December	114½	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	13¾ 14¼	13½ 14	..	..	14⅜	13⅞
20,000	£10	6/0	Do. 6% Cumulative Preference	15¼ 15¾	15½ 15¾	3 16 2	March & September	15⅜	15 9/16
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9¼ 9¾	9¼ 9⅝	..	..	9⅝	—
10,000	£5	7%	Do. 7 per Cent. Preference	11 11½	11 11½	3 0 11	March & September	11½	11⅜
111,000	£5	..	London Electric Supply Ordinary	2¼ 2⅜	2¼ 2⅜	..	..	—	—
48,050	£5	..	Do. Preference	5⅞ 6¼	5⅞ 6¼	..	..	..	—
49,900	10	5/0	Metropolitan Electric Supply Ordinary	18¾ 19½	18¾ 19⅜	2 16 5	April and October	19½	18⅜
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	18 19	18 19	..	" "	18⅜	—
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119 123	119 123	3 13 6	June and December	—	—
6,452	10	8/0	Notting Hill Electric Ordinary	16½ 17½	16½ 17⅛	2 5 9	March	16⅞	16½
275,000	1	—	Rand Electric	1⅜ 1⅝	1⅜ 1⅝	—	—	—	—
£125,000	Stock	..	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	93 98	93 98	..	..	..	—
150,000	$100	..	Royal Electric Company of Montreal Shares	148 150	148 150	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	104 108	104 106	4 5 4	April and October	105½	—
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	16½ 17½	16½ 17½	3 5 9	February & August	17⅜	16⅝
20,000	5	3/6	Do. 7 per Cent. Preference	10 11	10 11	3 3 6	" "	..	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	103 106	103 106	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	15 16	15 16	3 2 6	March & September	15½	15
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	£3	1/6	Brush Electrical Engineering	1⅝ 1⅞	1⅝ 1⅞	—	—	1⅝	1½
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	..	—	2⅛	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	107 111	107 111	4 1 8	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	98 102	98 102	4 9 7	June and December	99	..
10,000	£10	..	British Aluminium Ordinary	..	—	—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference	..	—	—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7 8	7 8	6 5 0	June and December	—	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	103 113	108 113	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½ 1⅝	1⅛ 1⅜	—	—	1 3/16	..
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1⅝ 2⅛	1⅞ 2¼	—	—	—	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	89 94	89 94	5 6 5	January and July	—	—
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2¼ 2⅝	2½ 3	5 10 0	February & August	2½	2⅜
17,139	5	2/9½	Do. (£5 paid)	4 5	4 5	5 10 0	" "	—	—
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101 103	101 103	3 17 8	June and December	—	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅜ 2⅝	2⅜ 2⅞	4 1 6	February & August	2 1/16	2 1/16
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½ 3⅝	3½ 3⅝	4 3 4	August	..	—
91,196	1	10/0	Elmore's Patent Copper Depositing	⅛ ¼	⅛ ¼	..	..	..	—
10,000	10	6/0	Henley's Telegraph Works Ordinary	20 21	20 21	4 15 3	February & August	20½	..
3,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 12 0	" "	..	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 10	" "	—	—
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	22 23	22½ 23½	4 5 1	" "	22⅜	22
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103 107	103 107	3 14 9	March & September	—	—
87,350	12	12/0	Telegraph Construction and Maintenance	36 39	36 39	4 12 4	March and July	—	—
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102 105	102 105	4 15 3	January and July	—	—
£22,500	£5	3/6	Willans and Robinson Ordinary	8 8½	8 8½	4 2 4	April and October	—	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	7 7⅜	7 7⅜	4 0 0	" "	7⅜	7⅜
£100,000	Stock	4½%	Do. 4½% First Mort. Debs. xd	106 108	104 106	4 4 11	May and November	107¼	—

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NOTES.

The chief feature of interest in the Annual Report relating to the New Zealand Telegraph Service for the year 1896-97, just to hand, is that portion of it describing the result of the reduced inland tariff on the lines adopted some years ago in this country. Down to 1890 the rates prevailing in the colony were one shilling for ten words, with free address and signature, the charge for deferred telegrams being sixpence. Two years later the maximum number of words was increased to twelve without any alteration of charge. Shortly afterwards a further extension of the maximum was granted, and this continued until June last year, when the twelve words limit, inclusive of addresses and signature for sixpence was introduced; and the report, which brings us down to March 31, 1897, gives the result. At first there was a decided run on the lower charge, the revenue profiting greatly thereby; but in a remarkably short space of time the public of New Zealand as elsewhere acquired the knack of cutting down their messages, so that the average payment, which was nearly 11d. per message in the first month, fell to little over 9d. after a ten months' run. Needless to say, a further diminution is expected; whilst a vastly increased number of telegrams is already involving the department in extension of plant and an augmented staff of operators. On the whole the outlook is not very cheerful, the Postmaster-General warning the public that concessions of this magnitude must disturb the revenue very materially and involve a largely increased expenditure for a number of years. In New Zealand, however, the postal department is suffering from similar causes, and there is no talk of the telegraph branch of the service being exceptionally unremunerative.

Methods of charging for electric supply to be commercially successful must depend upon the local character of the districts to be supplied; and, metaphorically speaking, what is one supply concern's meat is another's poison. A novel arrangement for a tariff has been devised by Mr. V. B. D. Cooper, in conjunction with Mr. E. Schenk, for the Smithfield Markets Electric Supply Company. The basis of this tariff consists in proportioning the charge per unit according to the consumption per square foot of floor space, the charges varying from 4d. per unit, for two units or upwards per square foot per quarter, to 6d. per unit for less than one unit per square foot per quarter. Irrespective of this scale, the charge to any consumer, whose yearly account shall at the lowest-named rate amount to £100, is 4d. per unit. Over and above these rates, which apply to the individual consumers, there is a sliding scale of rebates according to the aggregate annual consumption of the market. For every 100,000 units in excess of 600,000 per annum (inclusive of public lighting) the rates of 5d. and 6d. referred to above are reduced by ¼d. until one million units are reached, when the 4d. rate is reduced to 3¾d., and the higher rates are reduced by 1d. We should suppose the intelligent Smithfield butcher would be induced by this array of prices not only to put in and use as many lamps per square foot of floor space as the necessity to reserve some space for meat will permit of, but also—and chiefly—to induce his neighbours to do likewise.

Many kinds of electric furnaces have been suggested from time to time for the manufacture of calcium carbide and other similar products, but they have all shared the same defects. These are that the process is not continuous, the operation having to be stopped and the furnace allowed to cool before the manufactured product can be removed, and also that the product contains a certain amount of the raw material from which it is manufactured. The usual plan is to have the lower electrode consist of an iron plate or crucible which is fixed, while the upper electrode is formed of carbon and is movable, being raised as the charge is fed into the furnace. The consequence of this is that the resistance, and therefore the voltage, is constantly varying, and that the fused calcium carbide or other product is subjected to the action of the current whilst fresh material is being brought into the action of the arc, and the manufactured product is not always as uniform as could be desired. These defects Mr. W. S. Horry has set

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himself to overcome, but with what prospect of success experience obtained by manufacture on a commercial scale can alone determine. Mr. HORRY constructs his furnace in the form of an open hopper of firebrick, suspended from two standards so that its lower end hangs just over the space between the two carbon electrodes in which the arc is struck, and between the flanges of a rotatory spool or reel, to which movable cover plates can be attached, slots being formed on the peripheries of the flanges for this purpose. The carbons rest on the fireproof material of which the hopper is constructed, and their electrical connections are protected by it from the heat of the furnace, the edges of the carbons being bevelled so that they present vertical surfaces to the space between them. The length of the arc is thus kept constant, and does not vary, as in most other forms of furnace. The mixture of coke and lime is fed into the hopper, and is converted into calcium carbide in the arc, and when the ammeter shows that the current rises the spool is rotated to remove the product from the furnace. The action of the furnace is thus made continuous, fresh material being fed into the hopper as that converted into calcium carbide is removed in a plastic sheet, the reel being rotated as required until it is nearly full, when, by lifting off the cover plates, the portion of calcium carbide first formed can be cut off.

THE *Daily Chronicle*, pluming itself upon having been correct in its announcement of RÖNTGEN'S discovery, while other daily papers stood by and scoffed, ventures to announce the realisation, on a commercial scale, of the alchemist dream of the philosophers' stone. It states that one EMMENS, of New York, has achieved this result, and that "between April and November last 19 ingots of gold have been produced from silver," 18 of which "have been purchased by the U.S. Assay Office." This is so sudden! Only the other day we were told how many centuries it would require to "transmute" a milligram or two of one element into another, in a Crookes tube; now we are asked to believe that the thing has been done on an ingot scale in a few summer months. CAGLIOSTRO himself was more discreet, though there is something of the ring of that impostor and of other fraudulent "alchemists" in the statement that one of the preliminaries to the EMMENS' process is a hammering of the silver under conditions such that "even a temporary rise of temperature when the blows are struck" shall not take place. One is reminded of the artful conditions imposed on a certain credulous king who sought from an alchemist the secret of the philosopher's stone, viz., that the operations were to be carried on with an absolutely pure conscience. The unhappy monarch never attained that essential condition of perfection—and went without his gold.

THEORETICALLY, if the modern doctrine as to the ultimate constitution of matter be accepted, the transmutation of the elements is a scientific possibility. The fierce atomic bombardments inside a Crookes tube or an electric furnace would seem to be the most probable of known conditions whereby the operation might be carried on practically. Indeed, as we have just said, it is alleged on high scientific authority that the thing has already been done on a minute scale in a Crookes tube. But it would seem reasonable to suppose that before the pre-arranged and well-defined conversion of one element into another on a large scale could be carried on there would be evolved several intermediate stages, in which the possibilities would be less exact and on a less gorgeous scale.

Personal.—The City Council of Worcester have raised from £250 to £350 per annum the salary of their electrical engineer, Mr. E. T. Ruthven Murray.

Torquay Electric Supply System.—We omitted to state, in the description which appeared in our issue of the 26th ult., that Mr. W. H. Trentham has acted as consulting engineer for the Torquay municipal electric supply system.

Rumoured Amalgamation.—The *Globe* recently gave currency to a rumour that Messrs. Easton, Anderson and Goolden, the Fairfield Shipbuilding Company, and Messrs. Thomas Firth and Sons, of Sheffield, are about to amalgamate. We learn that the rumour is both "premature and inaccurate."

Electrically-Operated Turntables.—The *Engineering News* of New York says that electrically-operated turntables are being adopted in a number of yards by the Baltimore and Ohio South-Western Railroad, it having been found that the saving in time and cost of labour pays a good interest on the cost of the necessary machinery and power.

Royal Warrant for the E.P.S. Company.—A Royal Warrant has been granted to the Electrical Power Storage Company (Limited), appointing them makers of electrical secondary batteries to Her Majesty. We understand that this is the first royal warrant granted to any electrical firm, although electric lighting has been in use at several of the royal palaces since 1882.

Cable Interruptions and Repairs.—

	Date of Interruption.		Date of Repair.
Otranto—Vallona	Oct. 11, 1897	...	—
Pernambuco—Ceara	Nov. 22, 1897	...	Dec. 2, 1897
Emden—Vigo	Nov. 28, 1897	...	—
San Thomé—Loanda	Dec. 4, 1897	...	—
Sitia—Rhodes	Dec. 7, 1897	...	—

The Walker Company.—One of the largest and best known electrical manufacturing companies in America, the Walker Company, of Cleveland, O., has recently been bought up by "four multi-millionaires of New York." The present capital of the Company is £500,000, and £300,000 in bonds has been issued. The officers of the Company, including Mr. S. H. Short, remain as before.

Electric Lifts and Cranes.—We have received from Herr J. Springer a profusely-illustrated pamphlet on the above subject, reprinted from the *Zeitschrift des Vereins Deutscher Ingénieure*. Its title is "Motors and Accessories for Electric Hoisting Machinery," by F. Niethammer. The matter is of special interest when taken in conjunction with Mr. Ravenshaw's recent Paper on "Electric Lifts and Cranes," as it treats of a part of the subject not dwelt on by him—viz., the design of the motors, both of the continuous-current and three-phase type.

Royal Institution.—Among the lecture arrangements before Easter are announced six Christmas lectures (specially adapted for young people) on "The Principles of the Electric Telegraph" by Prof Oliver Lodge, and five lectures on "Recent Researches in Magnetism and Diamagnetism" by Prof. J. A. Fleming. The Friday evening meetings will begin on January 21st; among the names of those who will probably give discourses are Prof. Dewar, Dr. J. H. Gladstone and Mr. A. A. Campbell Swinton. Lord Rayleigh will deliver lectures after Easter.

The Automobile Club.—The inaugural general meeting of the Automobile Club of Great Britain took place on Wednesday afternoon at the club premises, 4, Whitehall-court, Mr. Roger W. Wallace being in the chair. The objects for which

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this institution has been established are described as the encouragement and development of motor vehicles and allied industries in this country. It aims at affording its members support in the protection and defence of their rights where menaced, and at being a social club where they may obtain information and advice on all matters appertaining to motor vehicles.

Royal Society.—Before the Royal Society yesterday the following papers were down for reading:—"A Note on some Further Determinations of the Dielectric Constants of Organic Bodies and Electrolytes at very Low Temperatures," by Prof. Dewar and Prof. Fleming. "On Methods of making Magnets Independent of Changes of Temperature, and some Experiments upon Negative Temperature Coefficients in Magnets," by J. R. Ashworth. "The Electric Conductivity of Nitric Acid," by V. H. Veley and J. J. Manley. "On the Calculation of the Coefficient of Mutual Induction of a Circle and a Coaxial Helix, and of the Electromagnetic Force Between a Helix and a Coaxial Circular Cylindrical Sheet," by Prof. J. V. Jones.

Obituary.—We have to record the death of Mr. E. Graves, Assistant Superintendent of the Persian Gulf and Persian section of the Indo-European Telegraph Department. Whilst inspecting the line between Jask and Chauber, at a distance of 90 miles from the former place, he was attacked in camp and brutally murdered by tribesmen, who entered his tent at dusk, and, pinning him to his bed succeeded in their fell work. The camp was looted and destroyed, but the native staff escaped. Mr. Graves was first on the list of assistant superintendents, was born December 5, 1844, and had been in the service over 30 years. He would have been entitled to a retiring pension in June next.

The Baltimore and Ohio Railroad.—In accordance with the policy of economy adopted by the managers of the Baltimore and Ohio Railroad, an electric lighting plant has been installed at Philadelphia for the purpose of lighting the passenger station, yards, freight stations, freight yards, docks, round-houses, machine shops, &c. Twice as many lights are in service now as when the Company purchased the current from local lighting companies, yet the expenses have been reduced to one-half. The Philadelphia plant consists of 150 H.P. boiler, two 50 General Electric arc light generators, which are belted to a 125 H.P. standard Westinghouse engine. It took 20 miles of wire for the overhead construction, and a submerged cable is used in crossing the Schuylkill River from the power-house to the railway station.

Electric Lighting in Paris.—The Directors of the Company lighting the Clichy district of Paris have just issued their annual report for the year ending June, 1897. The length of cable in their distributing network is now 255 miles, as compared with 232 miles last year, the number of consumers having increased from 2,161 to 2,864. The number of 10 c.p. lamps per consumer has decreased from 55 to 53. The lamp connection in 10 c.p. lamps or their equivalent is 152,846, as against 118,988 last year. Of the former number 14,622 is represented by motors, 603 by heating apparatus, and 1,150 by public lighting. It is interesting to note that 208 lifts are now at work on the mains, 90 of which are worked entirely by electricity. It is also noteworthy that the use of batteries in the sub-stations, for the purpose of regulation, has been discontinued, compensating machines being used instead. The cells have, in fact, been sold.

Earth Returns in Washington.—In a recent issue we referred to the disablement of the Washington Naval Observatory by the disturbing effects of the earth return currents from the electric tramway. It appears that the earth currents are also doing considerable damage by electrolysis in that city. The *Western Electrician* quotes as follows from a report of the inspector of the street-lighting department:

"The report gives in detail the line construction of the several railroads using electricity as a motive power, and discusses at length the damages that have resulted to the gas and water pipes therefrom. The inspector states that immediately after the installation of the Potomac Company's lighting system from a grounded circuit, the Chesapeake and Potomac Company commenced to have trouble with its cables, the resulting damage being so great that the telephone company was compelled to draw into its circuit a bare copper wire, to which it bonded all its cables. The inspector goes on to say that the solution of the whole matter is very simple. The extension of the underground electric system as is employed upon the Metropolitan railroad lines to the suburban trolley roads is too expensive to be put into operation. But its substitute, the double trolley, can be easily installed and successfully operated. . . . As long as the rails are used for a portion of the return current, the system will be grounded, and the current, to a greater or less extent, will seek other paths than those provided for it."

Military Telegraph Service in America.—Gen. A. W. Greely, Chief of the Signal Corps, U.S. Army, in his report for the year ended September 30th, states that the aggregate length of military telegraph lines operated by the Signal Corps is 802 miles. Experiments have been made with a combined telegraph and telephone apparatus, which, Gen. Greely states, was eminently successful. The apparatus can be easily carried by an operator, and while one soldier telegraphs a message to another a telephonic conversation may be carried on over the same wire at the same time, the distant operators receiving only the messages intended for each. The outfit weighs 16lb., including the battery. The system has been tested up to a distance of more than 600 miles. In Gen. Greely's opinion this was the most notable advance made during the year, and its importance, he adds, is not confined to field work alone, but its useful application may be made world-wide. Our New York correspondent states that Gen. Greely refuses to give for public information any details of the system.

"The New Brest-St. Pierre Cable."—In *The Electrician* of November 26 we referred to the failure of the "Silvertown," owing to stress of weather, to complete the laying of this cable. We are asked by the Société Industrielle des Téléphones, the makers and layers of the cable for the Cie. Française des Câbles Télégraphiques, to state that while this cable starts from Brest it does not land at St. Pierre, but goes direct to the American side of Cape Cod, near Boston. The length of the cable in single section is 3,100 miles, the longest cable hitherto laid or attempted to be laid. We are also requested to mention that although it is true that the second expedition of the "Silvertown" was delayed for about three weeks by an accident which occurred some hours after leaving port, and that the vessel subsequently encountered an uninterrupted series of storms, preventing the completion of the work upon which she was engaged, this experience did not come as a surprise to the French engineers, "since for the last ten years they have had occasion to familiarise themselves with the difficulties of the profession." The Société Industrielle point out that the first expedition of the "Silvertown," undertaken by the same French engineers, was completely successful. On the second occasion, on reaching the spot where the first expedition terminated its labours, the buoy left at the extremity of the first section of cable, laid at a depth of 2,400 fathoms, had disappeared, and it was necessary to proceed to dragging; and in spite of the difficulties of this operation, at such a depth the French engineers succeeded in lifting the cable at the first attempt, It is stated that they would have successfully brought the end of the cable on board but for the breaking of an anchor. It was only stress of weather, after three weeks ineffectual waiting, that decided the French engineers to postpone further operations to a time when success might be confidently anticipated.

A New Conduit Traction System.—In a recent issue of the *Railway World* will be found particulars of the "Mapple" conduit system for street tramways. On this system easy access to the interior of the conduit is afforded by hinging one of the steel channel rails forming the slot in which the collector runs, to the chairs or yokes holding the conduit so that by lifting the steel channel the latter may be opened. One great difficulty experienced with the conduit system at Blackpool has been the drifting of sand into the conduit, and this has made it necessary to increase its depth over that originally laid down. To facilitate the clearing of the drifted sand and obviate delay of traffic Mr. Mapple designed the hinged conduit, and a length of about forty yards was first laid at the south shore end of the promenade, and subsequently it was decided to lay this conduit on the half-mile of double track connecting the south shore station with the promenade line.

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The dimensions of the conduit are: 16in. deep by 10·5in. wide (inside). It is cast in 6ft. lengths, and when laid is bolted to cast-iron chairs spaced at 3ft. intervals. The slot is $\frac{5}{8}$in. wide.

Acetylene v. Electricity for Lighted Buoys.—According to to *Electricity*, of New York, a number of experiments are being made by the United States Lighthouse Board to ascertain the advantages, if any, of acetylene over electricity for the lighting of buoys. It is claimed that acetylene gives a more suitable light than the arc lamp, and that the gas buoy can be manufactured for a third of the price of an electrically-lit buoy and its appurtenances. It has also been pointed out that, as usually connected, a mishap on the circuit will extinguish all the electric lamps, whereas each gas buoy is independent of its neighbours. Our contemporary takes up the cudgels for electric light, and points out that even on the basis of comparing a 300-c.p. acetylene flame with a 1,000-c.p. arc lamp, the annual cost of the latter is much the smaller. The acetylene flame, it is said, would consume 7·3 cubic ft. of gas per hour at a cost of 7½ cents, whereas the cost of generating and delivering current to the arc lamp would not exceed 3 cents an hour. Further, the trouble and expense of charging the acetylene buoys is referred to, and also the element of danger in connection with all apparatus for burning or storing this gas. Our contemporary finally suggests an enclosed arc lamp as the one most suitable for use on buoys, chiefly on account of the length of time the carbons will burn. As the light is to be thrown in a horizontal direction the use of an alternating current is also suggested. The means to prevent a simultaneous extinction of all the lamps are obvious.

More Waste Water-Power.—*L'Industrie Electrique*, quoting from *Cosmos*, enlarges on the amount of waste water-power in Iceland, which island it styles "a country to be conquered." It is stated that the immense waterfalls there would suffice to supply all the 75,000 inhabitants with as much light *and heat* as they could possibly want, and might also open up the country industrially. The Gulf Stream makes the climate quite bearable, in spite of the high latitude. It is stated that the three cataracts, Allarfors, Sullfors and Godafors, could develop a power greater than the largest waterfalls in Europe, and the aggregate water-power that could be obtained in the country is estimated at a thousand millions of horse-power. Our contemporary points out that this figure, with two ciphers struck off, should still be tempting to electricians. If their repugnance to transporting the necessary plant to the country be overcome their first duty would be to heat and light the capital, Reykiawik (a town of 4,000 inhabitants, whose population has doubled during the last 20 years), making use of a roaring torrent three miles from the town. Then, again, the soil of the island, which is of volcanic origin, is rich in minerals, and water-power is everywhere available for electro-metallurgical processes. It is also remarked that if Iceland took a more serious position in the minds of the civilised world its situation is a valuable one for scientific observations, such as studying the relations existing between the *aurora borealis* and earth currents, and there is also plenty of opportunity for seismic research. Finally, by its geographical position position, Iceland should possess a meteorological observatory, which could contribute useful information as to the laws governing tempests, and might also be of practical service in telegraphing warnings of approaching storms.

A Useful System for Office Telephones.—There are many subscribers to the telephone who would have that instrument in several offices of their business premises if they could use it only when they desire to speak to a client and not when a client desires to speak with them. For such a purpose a system devised by Herr Jul. H. West, and described in a recent number of the *Elektrotechnische Zeitschrift* should prove most useful. By this system, although only one line to the exchange is needed, any one of a number of telephone instruments on the same premises has *direct* access to it, and can ring up the exchange. On the other hand, only one of these sets of instruments is provided with a bell, and each of the others, so long as its receiver is on its hook, is entirely disconnected from the line. To ring up the exchange from any instrument it is only necessary to remove the receiver from its hook and turn the handle of the magneto. The action of taking down the receiver and thus releasing the "switch-hook" closes the microphone circuit through a relay which is permanently in series with the common microphone battery in the first instrument on the line. When this relay receives current, it disconnects the bell from the line and connects a stonger battery to the "locking electromagnets" which are permanently connected in parallel. There is one of these electromagnets in each of the instruments of the system, and its function is to lock the switch-spring so that if one telephone is in use it is impossible to connect another to the line or to send or receive a ringing current from any other instrument. A disc, fixed to the lever which locks the switch-hook, appears at the same time behind a window in the case of the instrument, as a signal that the line is engaged. It should be mentioned that the relay-coil is shunted by a non-inductive resistance, as the insertion of an unshunted inductive resistance in the microphone circuit would be prejudicial to the working of the latter instrument. Five wires have to be led from the first telephone set (the one with the relay and bell) to each of the other sets, but these wires may be branched at any convenient places, the corresponding wires for the various instruments being in parallel.

Gutta-Percha.—The second Cantor lecture on Gutta-Percha, delivered by Dr. Obach at the Society of Arts last Monday, proved of great interest. The various processes to which the raw material is subjected before it is clean enough to be rolled into sheets were detailed, and the machines themselves were illustrated by excellent lantern slides and, in one instance, by an actual machine in operation, driven by an electric motor. Some instructive diagrams had been placed on the walls to show the percentages of water and dirt still contained in the material after passing through each of the machines. Figures were also given to show the relatively small amount of dirt collected and passing the strainer, these results demonstrating indirectly the effectiveness of the washing process The impurities found in the raw material include a large number of stones put in by the natives to increase the weight, and in some instances the heads of native axes have been found in the midst of hunks of gutta-percha. The most startling impurity discovered was perhaps a fine specimen of *scolopendra* which Dr. Obach has carefully preserved in alcohol. Recently Röntgen rays have been used to detect buried stones in the raw material, and by this means probably considerable damage to the blades of the slicing machine has been avoided. The lecturer then described his method of extracting the resins by treatment with petroleum spirit, and demonstrated how the mechanical properties of the material were considerably improved thereby. The three known processes for extracting the gutta from the leaves of the plant were next detailed. M. Rigole's method was first mentioned. The leaves are treated with carbon bisulphide, which dissolves the gutta, and the solvent is then distilled off. The gutta recovered by this means is said, however, to deteriorate rapidly. Prof. Serullas' process, which was recently brought before the investing public, was next dealt with. In this process the leaves are powdered and placed in toluene at a temperature of 80°C.; the gutta dissolves in the toluene, and is afterwards precipitated by treating the solution with acetone. The third process, due to Dr. Obach himself, consists in using *hot* petroleum spirit as the solvent, and then cooling the solution, when the gutta immediately separates out. At the end of his lecture, Dr. Obach touched briefly on the question of natural substitutes. He passed over the less useful ones with a mere mention of their names, and cited balata, the gum of the *mimusops globusa*, as the only one of any importance. This tree is found in English, Dutch and French Guiana, and in some of the West Indies, and the gum is collected by tapping the trees, and not by cutting them down. Some samples Dr. Obach had analysed showed a proportion of about 36 per cent. of gutta, the proportion of resin being about the same as in the poorer classes of gutta-percha. In 1861 30cwts. of this material was imported; in 1895 2,674cwts. No mention of its electrical properties was made.

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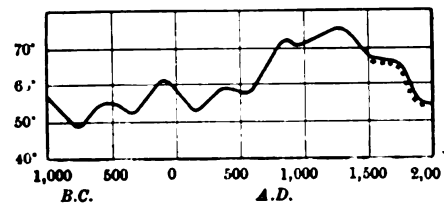
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Errors in Magnetic Surveys.—H. Wild points out some sources of error which are not always sufficiently considered. The first of these is the purity of the brass used in the instruments. This may contain a considerable percentage of iron, and Duane has recently shown what confusion an almost undiscoverable trace of iron can bring about. Not only should the whole of the instrument without the needle be tested with regard to its effect upon a unifilar or bifilar magnetometer, but every part should be separately tested at a proper distance, since screws, microscope holders and other details have been known to produce errors up to six times the amount of the limit of observation. For absolute magnetic measurements the stone of the building, especially of the supporting pillar, the dress of the observer, his spectacles, pencil cases and other instruments must be tested for freedom from iron. The building material is not of such great importance in the observation of variations. As regards dip measurements, the author is of opinion that the abandonment of the dip circle in favour of the induction inclinometer is only a question of time. The latter is capable of giving absolute values correct to within $\pm 0{\cdot}1'$. For the variation of vertical intensity Lloyd's magnetic balance is the best instrument. If the beam is placed at right angles to the magnetic meridian, however, it has a tendency to twist into the meridian at every disturbance, thus displacing the knife edge.

[Wild, *Terr. Magnetism*, September, 1897.]

Dip during the Etruscan Period.—Folgheraiter's ingenious experiments on the magnetic properties of baked clay, and his investigations of the magnetism of Etruscan vases, have attracted a good deal of attention. It will be remembered



that he attempted thereby to determine the value of the magnetic dip at the time when these vases were baked. He certainly proved that the magnetic dip holding good at the time of baking is registered in the baked objects, probably for an indefinite time. Piecing together various objects of art from the Tuscan period, he found that, if placed on their feet, their magnetic axes were nearly horizontal. From this he concluded that in the eighth, seventh, and sixth centuries B.C. the dip in Italy was zero or even negative. V. Carlsheim-Gyllensköld has examined this result in the light of a formula involving spherical functions of a high order, which is supposed to embody all the observations of the last 400 years. By a bold process of extrapolation, the curve shown in the annexed diagram is arrived at. It will be seen that as far back as 1000 B.C. no value for the dip below 48deg. is arrived at, and also that after 3,000 years we are again on a fair way towards approaching that minimum again. The formula, therefore, does not agree with Folgheraiter's conclusions. But that may be so much the worse for the formula.

[V. Carlsheim-Gyllensköld, *Terr. Magnetism*, September, 1897.]

Platinum Temperatures.—In 1887 Prof. Callendar, as the result of an elaborate and careful experimental investigation of the possibility of indicating temperatures by the variation of the resistance of platinum, devised the idea of "platinum temperatures" given by the formula

$$\omega = \frac{R - R_0}{R_1 - R_0} 100,$$

where ω is the "platinum temperature" corresponding to the resistance R of a given wire whose resistances are R_1 and R_0 at 100 C. and 0 C. Further researches by Profs. Dewar and Fleming, Griffiths, and others, go to show that for temperatures ranging from $-200°$C. to 1,300 C., however roughly a given platinum wire may be treated as regards rapid or excessive variations of temperature or long immersions in regions of either very low or very high temperatures, provided it be carefully annealed, it undoubtedly always has the same resistance at the same temperature. But the actual law of variation of this resistance appears to be very complicated. It is not a parabolic law, but distantly resembles one. J. D. Hamilton now proposes the formula

$$(R + a)^2 = p(t + b),$$

where a, p, and b are constants, and R and t the resistance and temperature respectively. This formula represents all experimental results hitherto obtained more closely than any other. The constants have to be determined for each wire by a series of observations, which should always be quoted in full.

[Hamilton, *Phil. Mag.*, December, 1897.]

Secular Softening of Steel.—Twelve years ago Carl Barus began a series of experiments on the gradual softening of the temper of glass-hard steel with the lapse of time at ordinary temperatures. The results published in 1888 covered an interval of but three years, so that the present data may add materially to the inferences drawn, and are of great importance to the makers of permanent magnets. The tempering of hard steel is accompanied by an accentuated breakdown of the magnetic configurations which may be present. In spite of its high coercitive force, glass-hard steel is therefore unsuitable for use when (as in all instruments) the magnets are to preserve exceptional permanence in the lapse of time. The changes in the state of magnetisation are best studied by the corresponding changes in specific resistance or thermoelectric power, which are much larger. It appears that atmospheric temperature acting for 180 months produces about the same degree of hardness as 66deg. acting for a period of 180min. Two hours of annealing at 100deg. would furnish the superior limit of change of the standard within ten years at the ordinary temperature. As regards the explanation of these facts, it may be assumed that in hardening a strain is imparted to the steel rod. This strain vanishes through infinite time more rapidly in proportion as the viscosity of the metal is more fully reduced by temperature. At each temperature, therefore, there is a limiting or residual strain corresponding to the reduced value of the viscosity of the rod at this temperature.

[Barus, *Phil. Mag.*, December, 1897.]

Helically-magnetised Rings.—A ring-magnet experiences a side thrust when in an external field whose lines of force are in the same plane as the ring, and conversely it exerts a thrust in the opposite direction upon the supporter of the external field. "This deduction," said Du Bois, "so astonishing at first sight, I have proved to be verified by experiment." W. M. Mordey, who came across the effect in question a good many years ago, supplies what appears to be the explanation. Magnetically, a helix traversed by currents acts as a series of rings; but, in addition, it has a minor magnetising effect at right angles to that of the rings, due to the advance of the conductor from end to end of the helix. Thus, a helix bent into a ring or wound about an annular core, forms an endless or ring magnet when traversed by a current. But in addition to this main effect the forces of the ring, regarded axially, present N and S polarity respectively, the whole closed helix acting externally (so far as this subsidiary effect is concerned), and as regards external fields, as a simple loop or ring of conductor carrying a current. This may be illustrated by a lines-of-force figure, taken from a ring helically wound with a single layer of winding. In such a figure the lines of force radiate from the centre or axis of the ring at right angles to the axis of the spirals. They represent portions of closed lines of force which enclose the axis of the spiral. In a helix wound with two layers, one forward, the other back, the external magnetising effect due to this cause is *nil*. In a single layer helix, this external may be neutralised by returning the wire along the axis of the helix. A simple straight helix acts externally as a straight conductor. A flat spiral acts like a disc or wheel, or as a number of radial conductors in one plane traversed by a current passing from or to the centre.

[Mordey, *Phil. Mag.*, December, 1897.

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ON MAGNETIC SHIELDING.—I.

BY PROF. H. DU BOIS.

Introductory.

§ 1. The shielding effect of hollow spherical shells was first investigated by Barlow* in 1820. A few years later Poisson gave a classical solution of this particular case, founded on his well-known theory of magnetic induction, and obtained by expanding the magnetic potential in spherical harmonics. The theory of magnetic shielding then appears to have been neglected for a long lapse of time, until in 1882 the late Prof. Stefan† published an interesting investigation, which is, perhaps, too little known; working on lines essentially within the domain of the theory of potential, he arrived at a solution for the important particular case of an (infinitely) *long* hollow cylindrical shell, having its axis at right angles to the lines of force of a uniform field. He also described a few experiments, "deviational" as well as "oscillational," made within *short* bits of iron tubing; however, his experimental treatment of the question is in no way to be considered complete.

§ 2. In these two typical particular cases, as well as in the general case of magnetic shielding by a hollow shell of any shape, lines of force pass into or out from the ferromagnetic substance over a more or less extended part of the surface. With the ordinary high values of the permeability the law of refraction in most cases implies a small external angle of incidence or emergence, so that for thick shells at any rate the lines of force in air may be considered approximately normal to the outside surface in its immediate neighbourhood, so far as they cross it at all. In such cases the magnetic force is therefore nearly equal to its normal component (the ratio being the cosine of a small angle); now the latter is always discontinuous at bounding surfaces; its discontinuity—divided by the ever-recurring factor 4π—corresponds to what in bygone times was called surface density of free magnetism, and it is essential in the kind of magnetic shielding here considered.

§ 3. Quite a different sort of screening action has been alleged to exist from the days of Jamin until quite recently in hard steel or even in soft iron; the crossing of lines of force through the boundary between the surrounding air and the ferromagnetic shell was not supposed to be an essential condition with this particular phenomenon. The field being in fact everywhere tangential to the bounding surface, this involves tangential continuity of the magnetic force. The work of Werner von Siemens, Profs. Grotrian and Foeppl, Drs. Beck, A. Kohn and Kirstädter, and the present writer, in connection with this vexed question, will be referred to in due time.

The evanescent—though often rather prolonged—screening effect of eddy currents on the central parts of solid metal cores, ferromagnetic or otherwise, is a phenomenon only occurring during the variable period of magnetisation, and has to be considered quite apart from the ordinary shielding phenomenon, which is essentially one of stationary *régime*.

§ 4. As regards the applications of magnetic shielding, it is well known that since 1858 Lord Kelvin protects his marine galvanometers by means of cylindrical sheaths; in the ordinary ironclad form a piece of massive bored iron is used. However, Dr. Magnus Maclean kindly informs me that sets of thin concentric hollow cylinders (one fitting inside the other) have also been tried. Such an arrangement of several shells may be called a multi-lamellar sheath.

The effect in question has often since afforded a welcome and relatively simple method of protection against all kinds of magnetic disturbance, especially in the laboratory, mostly in the shape of sheaths of cast or wrought iron or coils of iron wire. In order to reduce the unavoidable inherent polar action of the sheaths, Dr. Bruger, in 1887, proposed the use of several "guard-rings," to be turned relatively to one another so as to compensate this action as far as possible. Messrs. Hartmann and Brown adopted this plan in many of their galvanometers.

* Barlow: an Essay on "Magnetic Attractions," London, 1820.

† Stefan, *Wien Berichte* 85, Part 2. p. 613 (1882); *Wied. Ann.* 17 p. 928 (1882).

In collaboration with Prof. Rubens the writer devised a method of "differential astaticism," founded on the variation of the shielding action along the axis of a ferromagnetic guard-ring. The experience hitherto gained with this plan as applied to galvanometers enables us to see our way towards the possibility of an almost perfect protection from disturbance. With our method the separate cylindrical parts may be either adjusted one above the other, as in our semi-astatic double-coil galvanometer;* or we may arrange one concentrically around the other, as in an astatic iron-clad galvanometer exhibited to the Berlin Electrotechnical Society in March, 1896.

§ 5. In view of the general spreading of electric traction it is to be expected that over and above the blessings of the trolley the rail return will alone furnish an unlimited supply of stray earth current; the various sources of magnetic disturbance already existing on the planet and outside of it will in all probability be almost everywhere eclipsed by the newcomer. With this prospect for the near future, distressing to the nerves of the physicist, physiologist, and galvanometer observer generally, the question of magnetic shielding acquires a novel practical aspect, quite apart from its intrinsic theoretical interest; the writer therefore resolved to attempt a fuller treatment of the subject than had hitherto been deemed sufficient. This resolution was strengthened by an incident which clearly showed that several points in close connection with the theory of shielding appeared in need of further elucidation. The incident alluded to was the publication of the section "Drag on Buried Conductors" of Mr. Mordey's Paper on dynamos.† This proved the starting-point of a lengthy dis-

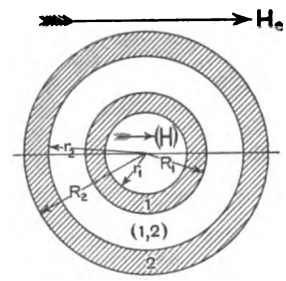

Fig. 1.

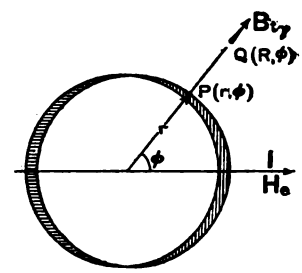

Fig. 2.

cussion on tunnel armatures, which has been proceeding ever since, and which may be considered to show the interest attaching to such questions. So far as the writer knows, Messrs. Swinburne, Von Dolivo-Dobrowolsky, Baumgardt, Menges, J. Russell, Prof. Baily, and himself contributed to this discussion‡; it was, moreover, foreshadowed in Section IV. of Stefan's Paper on magnetic screening referred to above, as will be explained further below. We shall now proceed with the different theoretical and practical aspects of our subject.

Theory of Spherical and Cylindrical Bi-lamellar Sheaths.

§ 6. In the first place the case of a bil-amellar sheath of homogeneous isotropic material has to be mathematically investigated. In order to be able to proceed at all the permeability μ has to be supposed constant and single-valued; this, of course, implies absence of hysteresis or retentiveness with inherent polarity of the shells. This limitation, so often introduced without further preamble by the light-hearted mathematician, even though in our day he may know better, happily exerts a less pernicious influence in our present case than in many other magnetic problems; as a matter of fact, shielding is mostly applied against disturbances falling within a narrow range of field, or more often of super-impressed small increments of force, for which the condition of constant susceptibility is actually fulfilled (say $H < 0.1$ C.G.S. units).

* Du Bois and Rubens, *Elektrotechnische Zeitschrift* 15, p. 321 (1894).

† Read at the Institution of Electrical Engineers, May 20, 1897. See *The Electrician*, Vol. XXXIX., p. 190.

‡ See the columns of *The Electrician* and *Elektrotechnische Zeitschrift*, June-Dec., 1897; also Mordey, *Phil. Mag.*, Dec., 1897. [See p. 217 of this issue for an abstract of the latter paper.—Ed. *E.*

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§ 7. We shall consider pairs of shells either spherical or cylindrical; the notation for their radii may be seen in Fig. 1, which represents a normal section of the sheathing arrangement. In order to simplify the equations the following abbreviated notation is used:—

	Hollow spheres.		Hollow cylinders.	
(1.)	$p_1=\frac{r_1^3}{R_1^3}$	$m_1=1-\frac{r_1^3}{R_1^3}$	$q_1=\frac{r_1^2}{R_1^2}$	$n_1=1-\frac{r_1^2}{R_1^2}$
(2.)	$p_2=\frac{r_2^3}{R_2^3}$	$m_2=1-\frac{r_2^3}{R_2^3}$	$q_2=\frac{r_2^2}{R_2^2}$	$n_2=1-\frac{r_2^2}{R_2^2}$
(1, 2.)	$p_{12}=\frac{R_1^3}{r_2^3}$	$m_{12}=1-\frac{R_1^3}{r_2^3}$	$q_{12}=\frac{R_1^2}{r_2^2}$	$n_{12}=1-\frac{R_1^2}{r_2^2}$

The eight fractions in the first and second lines of the above table are determined by the relative dimensions of the first (inner) and second (outer) ferromagnetic shell. The four fractions in the last line, on the other hand, refer to the intermediate non-magnetic shell (1, 2). They all depend upon the *ratio* between thickness and diameter of shell, not upon the absolute dimensions, geometrically similar shielding combinations exerting the same effect. The p's and q's represent the ratio between the volumes enclosed by the inner and outer surfaces of each spherical or cylindrical shell; on the other hand, the m's and n's give the ratio of the actual volume of the shell—to which its mass and weight are proportional—to the volume enclosed by its outer surface. As regards the cylinders, this evidently holds for a definite piece, say, of unit length. In the mathematical investigation, however, the cylinders are supposed to be infinitely long and placed at right angles to the direction of the field. As a matter of fact, we shall find that the theoretical equations still hold for the central part of hollow cylinders, the length of which is only about double their diameter.

§ 8. If we now place our bi-lamellar in a uniform external field of intensity H_e, the field inside the inner shell will be uniform and parallel to the former for reasons of symmetry; its intensity may be denoted by $(\mathsf{H})_1$ in brackets. The "field-ratio"

$$g=\frac{\mathsf{H}_e}{(\mathsf{H})_1}$$

affords a measure for the shielding effect; this ratio being evidently unity without any shielding, and infinitely great for the ideal case of perfect protection corresponding to a single sheath of infinite permeability or to an infinite number of sheaths of finite permeability. The ratio g, thus representing the "figure of merit" of the sheathing, has to be expressed as a function of the permeability and geometrical data. The suffixes e and i affixed to the vectors B, H or I indicate their external or internal origin respectively, the suffix t the total vector sum of the two parts; normal components are marked with the suffix n. Accents on letters call attention to the vector being considered inside the ferromagnetic substance.*

§ 9. We shall first re-consider the known case of a *solid sphere* uniformly magnetised. The distribution of I_n, the normal component of magnetisation ("surface density of free magnetism" in orthodox language) is shown by the shaded portions † in Fig. 2, and given by the formula

$$\mathsf{I}_n=\pm\mathsf{I}\cos\phi.$$

The demagnetising intensity inside the sphere is known to be given by the formula

$$\mathsf{H}'_i=-\frac{4\pi}{3}\mathsf{I}. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Therefore the following value of the total induction inside the sphere is obtained

$$\mathsf{B}'_i=\mathsf{H}_e+\mathsf{H}'_i+4\pi\mathsf{I}=\mathsf{H}_e+\frac{8\pi}{3}\mathsf{I}. \quad . \quad . \quad . \quad (2)$$

On account of the continuity of the normal component B'_{in} of the latter vector its value for a point P, whose polar co-ordinates are r and ϕ (*see* Fig. 2) on the spherical surface, viz.:

$$\mathsf{B}'_{in}=\mathsf{B}_{in}=\left(\mathsf{H}_e+\frac{8\pi}{3}\mathsf{I}\right)\cos\phi, \quad . \quad . \quad . \quad (3)$$

* For notation, compare table on p. 361 of "The Magnetic Circuit," by the Author (London, 1896).

† Vertical shading corresponds to I_n being directed outwards ("north pole"), horizontal shading to I_n being directed towards the centre ("south pole.")

is the same on both sides of the boundary; outside in the air it is moreover identical with the corresponding component of the total field. For a point Q at a greater distance R from the centre of the sphere it may be shown that

$$\mathsf{B}_{in}=\left(\mathsf{H}_e+\frac{8\pi}{3}\mathsf{I}\frac{r^3}{R^3}\right)\cos\phi. \quad . \quad . \quad . \quad . \quad (4)$$

For a *solid cylinder* normal to the plane of Fig. 2 it may be shown that the following formulæ have to be substituted for those bearing corresponding numbers in the case treated before.

$$\mathsf{H}'_i=-2\pi\mathsf{I}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1^*)$$

$$\mathsf{B}'_i=\mathsf{H}_e+\mathsf{H}'_i+4\pi\mathsf{I}=\mathsf{H}_e+2\pi\mathsf{I}, \quad . \quad . \quad (2^*)$$

$$\mathsf{B}'_{in}=\mathsf{B}_{in}=(\mathsf{H}_e+2\pi\mathsf{I})\cos\phi, \quad . \quad . \quad . \quad (3^*)$$

$$\mathsf{B}_{in}=\left(\mathsf{H}_e+2\pi\mathsf{I}\frac{r^2}{R^2}\right)\cos\phi. \quad . \quad . \quad . \quad (4^*)$$

The first of these formulæ represents the value of the demagnetising intensity for a cylinder transversely magnetised, *e.g.*, as obtainable from the well-known general expression for ellipsoids. (2*) and (3*) are deduced from (1*) by the same reasoning as for the sphere. The fact that in (4*) the squares of the radii r and R occur, instead of their cubes as in (4), is intimately connected with the essentially two-dimensional character of the cylindrical problem as against the three dimensions of the corresponding case for a solid sphere.

ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.†

BY J. ELTON YOUNG.

(Continued from page 160.)

On board ship, where it is often difficult to read deflections correctly, a null method of measuring the potentials is preferable. The following will serve the purpose (it is a modification of that given by Mr. Wilkinson in "Submarine Cable Laying and Repairing," par. 49, which does not allow for the E.C.). The testing battery, which should be constant and of low resistance, is joined to a Thomson-Varley slide resistance by a reversing key, and is also put to line when switch S is moved to the right (Fig. 33). The index of the slides is connected through a galvanometer to a two-way key or commutator, of which one side is joined to the cable end and the other to the standard cells. Balance is first obtained by adjusting the slides so that G is not disturbed on closing K_2; let the slide reading be m. The battery is then applied to the cable by moving S to the right, and potential v balanced by closing K_1, and getting equilibrium on G; let this slide reading = P. After the reading has been observed to have become sufficiently steady, or after a mean of its values has been got, switch S is moved to the left, putting the cable to earth. The E.C. potential is now measured by K_1 and the slides, their reading to balance being now p. If the sign of the E.C. be contrary to that of the battery pole applied to the cable, the current going into the slides will now require reversing to obtain balance p. Then, if e be the E.M.F. of the standard cells,

$$V=\frac{10{,}000e}{m}\text{ volts}, \quad . \quad . \quad . \quad . \quad (20)$$

and

$$r=\frac{e(P\pm p)}{m}\text{volts}, \quad . \quad . \quad . \quad . \quad (21)$$

the + sign being used if the E.C. required the current to be reversed to the slides in order to get a balance.

Example:—Current on at ship.

R, corrected to temp. of test = 1,003 ohms.

e, consisting of two Clark's cells, corrected to temp. = 2·88 volts.

m, slide reading = 1,160.

† Extracted from a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights reserved.

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Hence $$V = \frac{10{,}000 \times 2{\cdot}88}{1{,}160} = 24{\cdot}827 \text{ volts.}$$

P, slide reading with Z to cable = 5,775.

p, current off cable and *reversed* to slides = 685.

Hence, the E. C. being of *contrary* sign to v,

$$v = \frac{2{\cdot}88\,(5{,}775 + 685)}{1{,}160} = 16{\cdot}039 \text{ volts.}$$

At the same time the value of v_1 was observed ashore by the high resistance deflection method as follows: Deflection

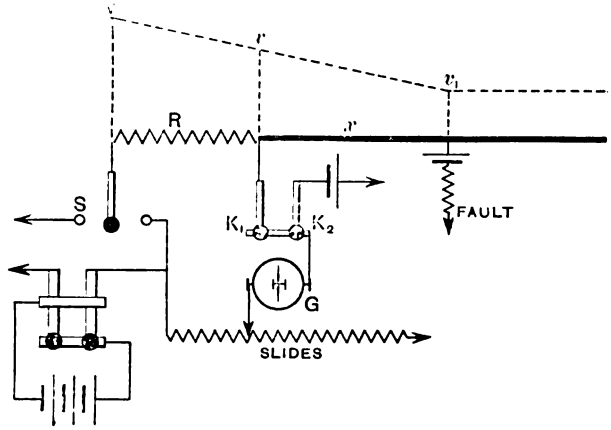

Fig. 33.

·96 divs., E. C. after current off 20 *against*, and two Clark's cells = 2·80 volts gave 32 divs.; therefore

$$v_1 = \frac{116 \times 2{\cdot}8}{32} = 10{\cdot}150 \text{ volts.}$$

Hence the distance of the fault was

$$x = 1{,}003\frac{16{\cdot}039 - 10{\cdot}150}{24{\cdot}827 - 16{\cdot}039} = 672 \text{ ohms.}$$

When a second good cable is available, by looping at station B the potential v_1 can be observed by A as well as v and V. It then becomes unnecessary to convert the potentials into cells or volts, and the formula is worked out from the values of the readings in scale divisions. The Varley loop test would, however, generally suffice in this case for the localisation of the fault.

Other Potential Methods.—The following is a modification of Clark's test, sometimes useful in cable work, and known as the *bridge potential* method. A (Fig. 34) measures the

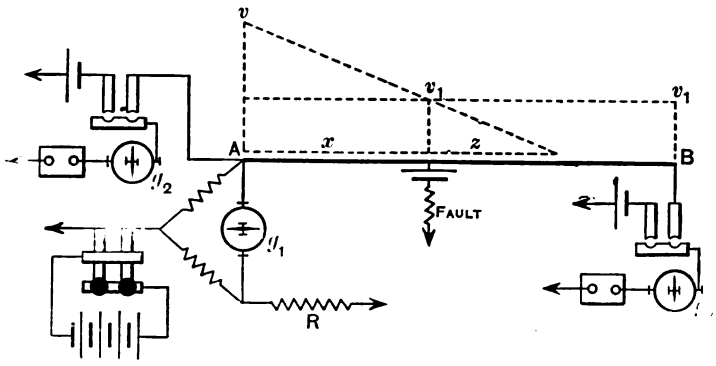

Fig. 34.

resistance $x + z = R$ up to and through the fault by bridge test on g_1; and on getting a balance observes the potential v by means of g_2 and a high resistance; whilst B, as before reads v_1. It is easily proved from the dotted triangles that

$$\frac{v - v_1}{x} = \frac{v}{x+z} = \frac{v}{R};$$

therefore,

$$x = R\frac{v - v_1}{v}. \quad . \quad . \quad . \quad . \quad . \quad (22)$$

A series of bridge and potential readings being taken by two observers at A, while B continuously records v_1, the best simultaneous values of v and v_1 can be advantageously selected with the aid of the exact knowledge of the state of the fault afforded by the bridge reading R. Moreover, v can be made a large deflection, instead of a small one as in the ordinary potential test, so that an error of one division in reading it will have less effect. But, since R enters directly into the expression for x, against the advantages just stated, must be set the consideration that changes in z, that is in R, cause equally great changes in the value of x as found by this formula; whereas in the previous potential test the results are less vitiated by variations of fault resistance.

When the loop is available the following refinement of the bridge potential method has been suggested by Kennelly and tried with very good results on some long submarine sections.* (Fig. 35) $b_1 d_1$ is a set of slide resistances, to the index of which the second cable is connected through the galvanometer g_2. If now both galvanometers be balanced to *false* zero, the one by adjustment of the bridge coils d, the other by the slides, then

$$x + z = \frac{ads}{bs - ad}, \quad \text{where } s = b_1 + d_1$$

and

$$x = \frac{ab_1 d}{bs - ad} = \frac{b_1 d}{s - d}, \quad . \quad . \quad . \quad . \quad . \quad (23)$$

when $a = b$.

s should be as great as possible, and $g_1\, g_2$ as sensitive as possible.

In Siemens's potential test batteries are applied at both ends of the cable (*see* Kempe's "Handbook," Chap. XVII.); but this has not been found such a useful practical method as Clark's.

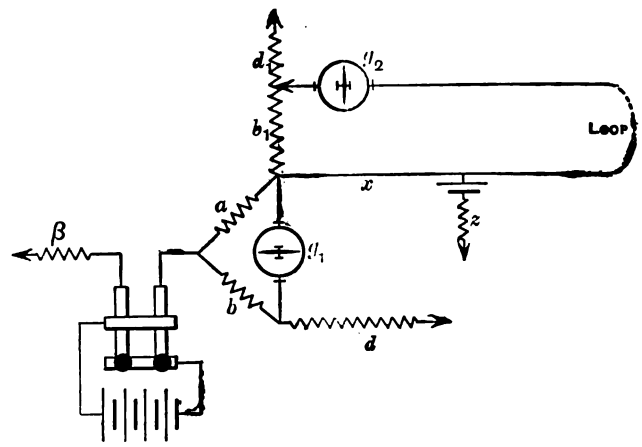

Fig 35.

The amount of battery employed in potential tests should be that which keeps the fault steadiest, a few cells sometimes doing this better than many. Unless the battery resistance be very low a compensating resistance of equal amount should be joined to the earth side of the battery key (as β, Fig. 35), to ensure accuracy in observation of the E.C.s. When a bad fault lies very near the testing station, so that the resistance up to and through it is small enough to cause the battery to "run down," a coil of extra measured resistance may be added to the cable, and treated as forming part of it; but the better plan here would be to employ some "Thomson tray" cells, if available.

Ayrton and Perry's Test.—A plan of localisation which is neither a resistance nor a potential method, but depends on the observation of current strength, is Profs. Ayrton and Perry's "Duplex Partial Earth Test." It is carried out as follows:—Batteries of resistances $B_1 B_2$ and galvanometers having, when shunted, resistances $G_1 G_2$ are oppositely connected to each end of the line as in Fig. 36, so that currents $c_1 c_2$ are registered by the galvanometers. It is only necessary to read the deflections from true zero produced by these currents on $G_1\, G_2$ at a given instant mutually arranged between the two observers: this gives (by Kirchoff's second law) the equation

$$e_1 + e_2 = c_1(x + G_1 + B_1) + c_2(y + G_2 + B_2). \quad . \quad . \quad (24)$$

The remainder of the operations are then performed independently, the line being disconnected, thus:—Having noted the reading c_1 the observer at that end joins up a resistance in

* *The Electrician*, Vol. XI., p. 85.

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place of the line and adjusts it until he accurately reproduces his reading. The other station similarly reproduces c_2. The

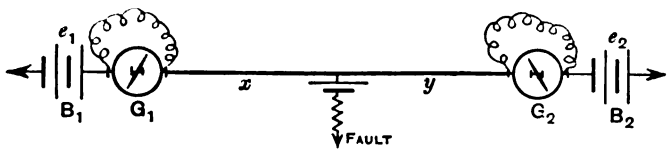

FIG. 36.

resistances respectively required for this purpose being R_1 and R_2, we have

$$c_1 = \frac{e_1}{R_1 + G_1 + B_1} \quad . \quad . \quad . \quad . \quad . \quad (25)$$

$$c_2 = \frac{e_2}{R_2 + G_2 + B_2} \quad . \quad . \quad . \quad . \quad (26)$$

The potential e_1, which caused current c_1, is then measured by the null method. To do this a standard cell or battery, and another galvanometer (g_1) are joined up as in Fig. 37, and the point found in the resistance R_1 (which must be subdivided or slide) at which g_1 is balanced on the depression of K. Let

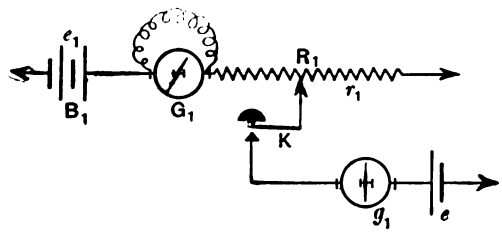

FIG. 37.

the resistance intercepted between this point and earth be r_1, and let r_2 be the corresponding quantity determined by the other observer; then, calling e the E.M.F. of the standard batteries at each end, which are made equal,

$$\frac{e_1}{e} = \frac{R_1 + G_1 + B_1}{r_1}, \quad . \quad . \quad . \quad . \quad . \quad (27)$$

and

$$\frac{e_2}{e} = \frac{R_2 + G_2 + B_2}{r_2}. \quad . \quad . \quad . \quad . \quad . \quad (28)$$

From these five equations,

$$x = \frac{r_2 R_1 + r_1 (R_2 - l)}{r_2 - r_1}, \quad . \quad . \quad . \quad . \quad (29)$$

$$y = \frac{r_2 (l - R_1) - r_1 R_2}{r_2 - r_1}, \quad . \quad . \quad . \quad . \quad (30)$$

where l is the true C.R. of the line.

It will be seen that this test is independent of the condition of the fault, provided it remain steady during the brief period required for the simultaneous observation of c_1 and c_2.

Schaefer's Methods.—In a contemporary contribution to *The Electrician*,* Mr. A. W. Schaefer proposes a modification of the Ayrton and Perry test, and at the same time describes an original development which he has made of a somewhat similar method, known as "Kempe's Loss of Current Test."† For an account of this the reader is referred to the article cited. In the same paper he calls attention to the capabilities of a new "scale zero" system of fault testing, where the false zero plan has been hitherto usually employed. Instead of balancing to the natural and fault potentials, or "E.C.," in any test (which is the "false zero" system), his plan is to measure them, make the test to true or "scale" zero, and then correct for the "E.C." He applies the same method to breaks, but the details are omitted here, pending their publication.‡ In this way the localisation of faults may be rendered easier of execution. Considerable skill and judgment are required to balance accurately to false zero, especially on long submarine cables, whilst a scale zero observation can be made by the inexperienced. It remains to be seen how the E.C. observations and allowances apply in practice.

(To be continued.)

* "*The Electrician*," Oct. 29, 1897.

† "Handbook of Electrical Testing."

‡ Mr. Schaefer's article describing this application was published in *The Electrician*, Vol. XXXIX., p. 811.—ED. *E.*

AN ELECTRIC CURVE TRACER.

BY PROF. EDWARD B. ROSA, PH.D.

(*Continued from page 128.*)

Series and Shunt Resistances.—A convenient form of adjustable resistance for AB and A′B′ is illustrated in Figs. 7 and 8. Four resistances are so arranged that by dropping connecting links into mercury cups, any one or more of them may be used in parallel. Fig. 8 shows a plan of the top of one of the resistance boxes. Four mercury cups, C, D, E, F, are the terminals of the four resistances (the other ends of which unite at the binding post A), and they may be joined to the central cup G by copper links. The resistances are 1, $\frac{1}{2}$, $\frac{1}{5}$th, $\frac{1}{10}$th ohm respectively, and hence the current would be 1, 2, 5 and 10 amperes per volt difference of potential of the terminals, these numbers expressing the conductances of the several coils. From what has been said it is evident that the scale of the curves would be 1, 2, 5 or 10 *amperes per inch*, according to which of the four resistances was used. If the first and second were used together, the scale would be 3 amperes per inch; if the first and third, 6 amperes per inch; if all were used at once, 18 amperes per inch. For heavier currents smaller resistances of greater carrying-capacity would be used. The small binding posts *a b* are connected with the large posts AB, as indicated, and from them wires pass off to the switch S of figure 6. The resistance of AB may be altered so as to have the current drawn to a suitable scale without breaking the circuit, and the scale is read off directly without any other numerical calculations than adding the conductances, as already indicated.

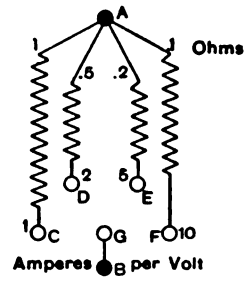

FIG. 7.

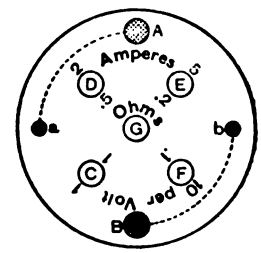

FIG. 8.

If the non-inductive resistance R is 2,000 ohms, and r, a part of it, is 20 ohms, that is $\frac{1}{100}$th of the total, then since the difference of potential of A″B″ is drawn out on the second sheet on a scale of one volt per inch the scale of the electromotive force will be 100 volts per inch. If A″B″ is 10 ohms, then the scale of the curve is 200 volts per inch, &c. In a similar manner power curves, magnetic induction curves, and hysteresis curves are drawn to a known scale.

Derived Curves.—Magnetic induction curves are not drawn directly, but are derived from the electromotive force curves. Writing down from the curve the instantaneous values of the electromotive force for a single period, and summing them up, we get a series of values of the induction which are laid off upon a strip of paper. This is placed upon the curve tracer precisely as when duplicating curves, and the curve of magnetic induction is printed upon the record sheet, showing its proper phase relation to the other curves Its position is determined by the consideration that the induction is stationary, usually a maximum, when the electromotive force is zero.

Hysteresis curves are derived from the curves of current and magnetic induction already drawn, and include the eddy current loss with the hysteresis loss. The current which has magnetised the iron under investigation is printed on a narrow strip of paper and attached to the end of the record cylinder at right angles to its position when printed. Two persons are required. One sets the pointer attached to the carriage upon the first point of the strip of the induction curve, while the other observer, taking the ratchet wheel in his left hand, sets the cylinder so that the first point of the current curve comes directly under a fixed line above the cylinder. A point is then

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printed on the record sheet, when the two observers advance to the second points, print a second dot, &c. The result is a closed curve, such as is shown in figure.

Power Curves.—Power curves, like curves of current and electromotive forces, are drawn directly while the generator is

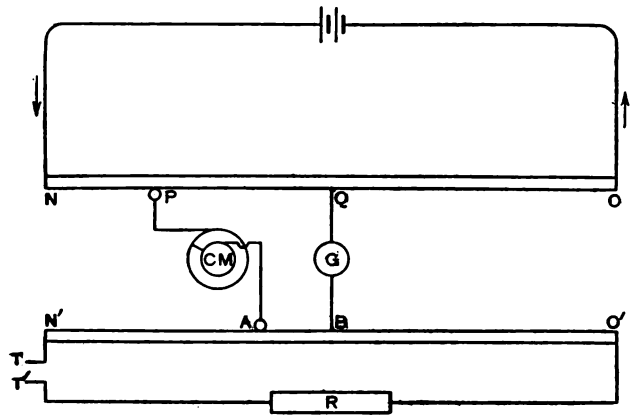

Fig. 9.

running. A second solenoidal coil, 80 cms. in length, is mounted in the instrument parallel with the first. It has a sliding contact propelled by a rack and pinion, shown in the figure. This second coil is of german-silver wire, and is in series with a larger non-inductive resistance, R; it carries a current proportional to the electromotive force, the terminals TT' (Fig. 9) being joined to the dynamo, or to the terminals of the circuit of which the power curve is to be drawn. Instead of using a fixed resistance, A B, as in other cases, the resistance whose terminals are AB is varied, being in each case proportional to the current at the instant of contact. This is effected by having B fixed at the middle of N'O'; and then setting A by the points printed by the extra electromagnet on the strip of paper when the current curve was drawn. When the current is negative, A is on the right hand side of B. The difference of potential between AB is proportional to the distance AB and also to the current passing through the coil N'O'. Since the former is proportional to i (the current) and the latter is proportional to e (the electromotive force) the difference of potential of AB (and therefore of PQ) is clearly proportional to the product ie, which is the instantaneous power. Advancing the contact brush gives contact at a later instant of phase, when both i and e have changed. Setting the contact A to the new value of the current and moving P until a new balance is obtained, a second point of the power curve is obtained. Obviously the power curve will cut the zero line whenever the current is zero (for then A comes to B), and also whenever the electromotive force is zero (for then there is no current in N'O'). It has a positive loop when current and electromotive force are both positive or negative, and a negative loop when only one is positive. Thus are power curves accurately drawn to a predetermined scale, and the labour of multiplying the corresponding ordinates of current and electromotive force is avoided.

The Contact-Maker.—Much of the success of the curve tracer depends upon the contact-maker, and great care has been taken in perfecting it. The shaft of the contact-maker is joined to the shaft of the dynamo (or perhaps to a synchronous motor) by a coupling shown in the figure. At the nearer end of the connecting rod the latter is joined to the plate (which latter is fastened rigidly to the shaft by a collar and set screw, as shown) by a flexible steel diaphragm, so that perfect alignment of the contact-maker and dynamo is not necessary. At the farther end the plate carries two steel pins, one at its centre and one near its edge, which fit loosely into two corresponding holes in a plate clamped to the end of the dynamo shaft. Thus the end-play of the armature is not communicated to the contact-maker, and when the latter is clamped to a firm base the shaking and jarring of the dynamo are not transmitted to the contact-maker. Two oil cups carry a good supply of oil, and the shaft carrying the hard rubber disc runs as smoothly as a top hour after hour, if desired, with very little attention.

The galvanometer current, which flows momentarily when

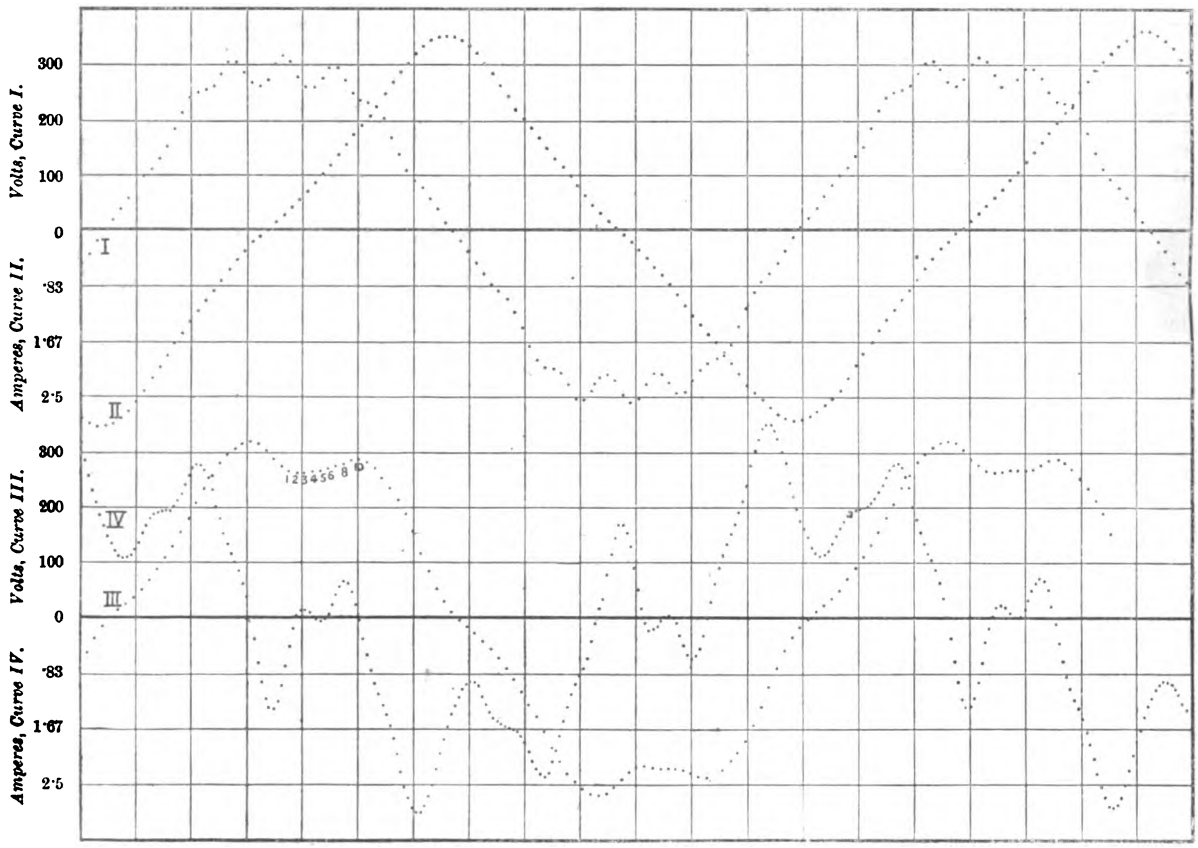

Fig. 10.—Curve I. Secondary E.M.F. of a Transformer.
„ III. Secondary E.M.F.
Curve II. Current through an Induction Coil having an Iron Core.
„ IV. Current flowing into a Condenser.

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the knife edge in the hard rubber disc passes under the contact brush, enters at the binding post which is seen behind the left-hand oil cup, passes through a brush to a slip-ring on the left of a large disc, and from there to a steel knife edge or contact piece let into the edge of the hard rubber disc. Passing to the brush and insulated brush-holder, the current flows to a second slip-ring, and away by a second brush and binding post on the right. The mechanism which advances the brush can be understood by comparing Figs. 3 and 4. The teeth of the ratchet and large gear are numbered, so that the initial position of the brush can be recorded, and the brush returned to the same position for the beginning of successive curves. The milled head on the end of the spindle which carries the ratchet wheel and pinion enables one to set the brush quickly by hand at any desired place. The two binding posts seen at the back of the base are the terminals of the coil of the electromagnet which operates the ratchet.

Sample Curves.

Fig. 10 shows four curves drawn in August, 1896, using a small eight-pole Westinghouse alternator. The generator was joined to the primary of a transformer, and to the secondary of the transformer was first joined a coil of wire having a fine iron-wire core, and then the coil was replaced by a Stanley condenser, having a capacity of about 7 microfarads. Curve I. is the electromotive-force of the secondary of the transformer, impressed upon the inductive coil, and it is precisely similar in form to the electromotive-force of the generator. The peaks, or ripples, which appear in this curve are due to the teeth in the armature of the dynamo. The induction through the air-gap from the pole-pieces to the armature is not uniformly distributed, but is tufted, and the induced electromotive-force shows fluctuations of a corresponding periodicity. The distance apart of the teeth in this case is one-seventh of the distance between two consecutive poles, and hence the distance apart of these peaks is one-seventh of half a wave length, or one-fourteenth of a whole wave length. But since the positive and negative half-waves are alike in form as well as in average value, there can be no even harmonics present in the wave. These ripples, in fact, consist chiefly of two odd harmonics, one having 13 and the other 15 times the frequency of the fundamental. But apart from these higher harmonics, which are attributable to the teeth of the armature, the curve would not be a single sine curve, and upon analysis we find three other harmonics of frequencies 3, 5, and 9 times the fundamental. The equation of the curve is:

$$e = 30{\cdot}66 \sin(x - 0°56') + 0{\cdot}80 \sin(3x - 6°17') - 1{\cdot}65 \sin(5x - 14°22') + 0{\cdot}40 \sin(9x + 7°50') + 1{\cdot}11 \sin(13x - 30°45') - 1{\cdot}18 \sin(15x - 38°40') \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Curve II. is the current flowing through the inductive coil. The effect of induction is to damp out of the current to a greater or less extent the harmonics of the electromotive-force, and to damp out the highest harmonics most completely. On the other hand, the effect of an iron core, because of its variable permeability during a cycle of magnetisation is to put into the current some upper harmonics, especially that of frequency, three times the fundamental. Hence Curve II. shows the third harmonic* strongly, while all others are very small. The equation of the curve is:

$$i = 30{\cdot}49 \sin(x - 1°8') - 4{\cdot}14 \sin(3x - 23°13') + 0{\cdot}38 \sin(5x - 51°21') - 0{\cdot}15 \sin(9x - 34°45') + 0{\cdot}12 \sin(13x - 48°23') - 0{\cdot}14 \sin(15x - 10°12') \quad . \quad . \quad . \quad . \quad (2)$$

The coil being now replaced by the condenser, the current and electromotive-force are both found to have changed their form. The dynamo is otherwise unloaded, and the armature reaction of this current is considerable. The electromotive-force (Curve III.) has nearly lost its highest harmonics, while the third and fifth are greater than before. The equation of the curve is:

$$l = 31{\cdot}48 \sin(x - 3°40') + 1{\cdot}38 \sin(3x - 18°) - 3{\cdot}46 \sin(5x - 55°) - 0{\cdot}38 \sin(9x + 2°) - 0{\cdot}25 \sin(13x + 20°) + 0{\cdot}18 \sin 15x. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

(To be continued.)

* For brevity I shall speak of the harmonic having three or five times the frequency of the fundamental as the third or fifth harmonic, &c.

THE ENGINEERING CONFERENCE.

The following is an epitome of the proceedings at the Conference between the representatives of the Employers' Federation and the Amalgamated Society of Engineers, as furnished by the former to the press:—

Freedom of Management.

1. *Freedom of Employment.—Employers' Proposal.*—"Every workman shall undertake to work peaceably and harmoniously with all fellow employés, whether he or they belong to a trade union or not."

Counter Proposal by the Men.—To add, "Every employer will undertake to make no distinction between, or give preference to, non-union as against union workmen."

Employers' Extended Proposal.—"(*a*) Every workman shall be free to belong to a trade union or not as he may think fit. (*b*) Every employer shall be free to employ any man, whether he belong or not to a trade union. (*c*) Every workman shall undertake to work peaceably and harmoniously with all fellow employés, whether he or they belong to a trade union or not."

The men's further proposal was the acceptance of (*a*) and (*b*) and the deletion of (*c*).

Result.—The employers' decision was to stand by their extended proposal.

2. *Piecework.—Employers' Proposal.*—"The right to work piecework at present freely exercised by many federated employers shall be extended to all members of the Federation, and to all their workmen."

Counter Proposal by the Men.—"That where employers work their shops on the piecework system the district rate of wages shall be guaranteed, and wages and balance shall be paid through the office according to time worked, and all contracts shall be worked out on their own merits."

Employers' Extended Proposal to add to their Proposal.—"The prices to be paid for piecework shall be fixed by mutual arrangement between the employer and the workman who is to perform the work. The Federation will not countenance any piecework conditions which will not allow an efficient workman to earn at least the wage at which he is rated. The Federation recommend that all wages and balance shall be paid through the office."

The men submitted a further proposal, omitting the word "freely" from the employers' original proposal, and substituting the word "may" for "shall." They also suggested the omission of the word "efficient" from the description of the workman contained in the employers' extended proposal.

Result.—The employers' decision was to stand by their proposal as extended, deleting the word "freely."

3. *Overtime.—Employers' Proposal.*—"As overtime is necessary the federated employers recommend the following as a basis and guide: That no man shall be required to work more than forty hours overtime in any four weeks after full shop hours have been worked. In the following cases freedom is not to be restricted, viz., breakdowns in plant, shop repairs, repair and replace work, whether for the employer or his customers, and trial trips. No alteration, restriction, or extension of this basis shall be made except by mutual agreement between the employer and the individual workman concerned. This basis is to apply only to the members of the trade unions who are represented at this conference. All existing restrictions as regards overtime are to be removed."

Men's Counter Proposal.—"That as overtime is only necessary unde exceptional circumstances, and overtime restrictions have operated with satisfactory results in many districts, we agree to a general regulation by which overtime may be restricted as follows: No workman shall be required to work more than eighteen hours in any period of four weeks, except in case of shop breakdowns, trial trips, and repairs to plant and machinery, but overtime shall be avoided as much as possible on all work."

Result.—The employers' decision was to maintain their proposal, but to substitute the words "general repairs, including ships," for the words "shop repairs."

4. *Rating of Workmen according to Ability.—Employers' Proposal.*—"Every workman shall be paid according to his ability, and no employer shall be restricted in employing any workman at any rate of wages mutually satisfactory to them. N.B.—It must be distinctly understood that by the foregoing there is no intention whatever to reduce the rate of wages paid to efficient workmen. The following are some illustrations of the necessity of the employers having the freedom above referred to: In most works there are old servants—men up in years, or men whose efficiency is impaired by partial disablement or indifferent health—who are not able to earn the same wages as younger or stronger men. There are also men who, although they may have had a mechanical training, are not, from various circumstances, worth as high a rate of wages as other more able men; but still, all this class of workmen may be worth a lower rate of wages. The employers must have the option of engaging or retaining these or other men at such rates of wages as are mutually satisfactory, rather than refuse them employment on work on which they could be advantageously employed."

Men's Counter Proposal.—"The trade unions are primarily concerned with the terms and conditions of the workmen's remuneration. They maintain that their members have a right to bargain collectively, instead of individually, as to the conditions on which they will accept work. They hold that there should be a standard rate of wage in each district, below which no member whom the employer thinks competent enough to employ at all should be engaged."

Result.—The employers' decision was to maintain their proposal.

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5. *Apprentices.—Employers' Proposal.*—"There shall be no limitation of the number of apprentices."

Men's Counter Proposal.—"We recommend that the ratio of apprentices to journeymen shall be as one to three, and that the average number of men employed during a period of five years shall form the basis of calculation."

Result.—The employers' decision was to abide by the terms of their proposal.

6. *Selection, Training, and Employment of Operatives.—Employers' Proposal.*—"The machine tools are the property of the employers, and they are responsible for the work turned out by them. They, therefore, will continue to exercise their discretion to appoint the men they consider suitable to work them, and determine the conditions under which such machine tools shall be worked. The employers consider it their duty to encourage ability wherever they find it, and shall have the right to select, train, and employ those whom they consider best adapted to the various operations carried on in their workshops, and will pay them according to their ability as workmen."

Men's Counter Proposal.—"In regard to workshop organisation, the trade unions here represented recognise the employers' right to decide what appliances shall be adopted, provided that in all cases the recognised classes of operatives working machinery be paid the standard rate of wages as agreed upon from time to time for the particular class of work to be done. N.B. The trade unions desire that the standard conditions should be settled, and from time to time revised by representatives of employers and employed, and that due provision should be made, such as exists in other industries, for the prompt and equitable decision of any difficulties that may arise as to the interpretation and application of such settlements. They further undertake to remain uninterruptedly at work in the event of difficulties arising while such are being adjusted by the appointed authority."

Result.—The employers kept to their original proposal.

FUTURE DISPUTES.

Employers' Proposal.—"With a view of avoiding disputes in future, deputations of workmen will be received by employers or their representatives by appointment for the mutual discussion of questions in the settlement of which both parties are directly concerned. But only the local associations of employers will negotiate with trade union officials. Failing settlement by the local association and the trade union of any question brought before them, the matter shall be forthwith referred to the Executive Board of the Federation and the central authority of the trade union, and pending the question being dealt with, there shall be no stoppage of work, either of a partial or a general character, but work shall proceed under the current conditions."

The men's counter proposal was in the same terms, except that they proposed to insert the words "or their representatives" after the word "workmen" in the early part of the first sentence.

Result.—The employers decided to adhere to the terms of their proposal.

HOURS OF LABOUR.

The following is the resolution which was passed across the table by the men's representatives: "That, having regard to the increasing efficiency of labour, due to improved machinery and greater intensity, the trade unions here represented claim the introduction of an eight-hours' day, or forty-eight-hour week."

The following was the employers' reply: "The employers have carefully considered all the arguments which have been advanced in support of a forty-eight-hour week, and as this did not in any way change the views already expressed by the federated employers, they have resolved that they cannot consent to any reduction in the hours of labour. All experience goes to show that any diminution of the hours of labour, even with reduced wages, entails diminished production, unless an amount of pressure and severity is used towards the men, which is injurious to them and distasteful to the employers. The trade of the country, also, will not bear any increase in the cost of production, which increase must inevitably follow any reduction of the hours of labour. Although the trade of this country is still supreme over that of other countries, the alarming extent to which orders are passing from us proves that our supremacy is rapidly diminishing. While our trade increases at a certain rate, that of almost every other civilized country is increasing in a far greater proportion, and therefore foreign competition cannot be dismissed as a bugbear. In every branch of our trade we find that the competition of America, Germany, Switzerland, and other countries is rapidly increasing. We would point out that the employers spend a great part of their lives and energies in personally studying these questions, and being in direct communication with the Government officials and leading business men in other countries, they know from actual experience where the encroachments come in and how they increase; and they also know by what efforts they have been able to save trade that would otherwise have passed away from this country. We are convinced that in the interests of our workmen as well as ourselves, and in the interests of the trade of this country, no reduction of hours of labour can be entertained, even apart from the question of wages. We cannot but recognise from the discussion which we have had this morning on the subject of shortening the hours of labour that the real difficulties which underlie this important question have not been thoroughly considered by those who advocate it. Taking one instance only, we point to the fact that you have admitted that the question of how to work double shifts on the forty-eight hours' system without resorting to overtime has not ever been considered by you. The necessity for working double shifts is one which frequently presents itself to employers, especially those engaged in the production of heavy engineering work, and it is one to which they have to give most anxious consideration. The employers have means not available to the public of knowing and understanding how very serious is the element of foreign competition. Beyond all foreign competition it must also be borne in mind that engineering appliances of all kinds are conveniences which are adopted in proportion to their cheapness, and that even a very slight increase in price will cause them to be dispensed with to a serious extent, and thus reduce the volume of production, which is the best safeguard for the employment of a large number of the working classes. Any course which does reduce the cost of any article ensures a considerable increase in its production, and to that extent increases the demand both for skilled and unskilled labour. If this country is restricted in reducing the cost of articles of general consumption, it follows that not only will the consumption decrease, but the countries which are not so restricted will be placed on more advantageous terms than ourselves, and secure an increasing proportion of the existing trade, and therefore increase their opportunities of finding employment for their working population."

ELECTRIC LIFTS AND CRANES.

DISCUSSION.

Sir J. WOLFE BARRY, President, thought this was the first time a Paper had been read before the Institution on the application of electricity to such mechanical contrivances as lifts and cranes, and it appeared to mark an era of considerable interest. The application of hydraulic power to lifts and cranes had been so universal for so many years, and had been so extremely successful, that it would be very interesting to have some definite comparison both of first cost and of the cost of working between hydraulic and electrical gear.

Mr. DANIEL ADAMSON, of Hyde, remarked that, for lifts, Messrs. Joseph Adamson and Company had been accustomed to use a shunt-wound motor with additional series coils, as mentioned by the author; but it was found that when high speeds were required, the conditions of running the motor with additional series coils were such that a varying load gave a variation in the speed, which affected the momentum of the moving cage, so that when it was stopped it travelled further, against the resistance of the brake, sometimes than others, and missed the landing. He had overcome that difficulty by arranging the automatic switch to cut out the series coils after cutting out the resistance; thus the motor ran at a fairly constant speed after starting. With regard to travelling cranes, the three-motor type had been preferred, the series motor being always used, on account of its greater starting power, and also its characteristic—which was an advantage in that case—of running faster under lighter loads. It also enabled the change of gear, for giving a higher speed with lighter loads, to be dispensed with. In connection with the lifts, the arrangement they had used for cutting out the resistance was to connect the sliding-switch with some moving portion of the mechanism, so that as the motor started, it gradually cut out the resistance. This was found to work well, and was much simpler than either of the arrangements mentioned in the Paper. As to choice between single and separate motor-cranes, his opinion was, he thought, confirmed by practice in the United States, where greater attention appeared to be paid to the matter than in England. On the occasion of his last visit, he noticed that Messrs. Sellars, of Philadelphia, who had first advocated the one-motor crane, had begun to make cranes of the three-motor type. He did not hear of any makers of three-motor cranes commencing to make a single-motor crane. The principal reason for preferring the three-motor crane was the reduced wear and tear on the mechanical portion, owing to the fact that, even when the crane was nominally in use, there was a considerable amount of idle time, as, for instance, when adjusting the chains. During those intervals, when the crane was not actually hoisting or travelling, with the three-motor crane the mechanism was at a standstill; whereas in the single motor crane, or in any other type of power-driven crane, some portion of the mechanism was running, and there was thus wear and tear, varying with the type of crane. The maintenance of clutches and such arrangements for mechanically controlling power was very costly. He called to mind an example of a steam-driven crane, in a girder-yard in which the square cross-shaft was used to transmit some of the motions, which lasted 11 weeks, so that four were required in the year. Another advantage of the three-motor crane was that, each motor being fitted with starting resistance, the man working it was able to start very gradually; and, in case he wanted to travel only a small distance, that was a great advantage; with other kinds of power-driven cranes it was much more difficult to travel a short distance and stop again with precision. Cases also arose in which the motion was required to run slowly for a short time, as when drawing patterns. That was not so easily effected with a clutch or strap-driven crane. The switches of their first three-motor crane had lasted just two years, at the end of which time they were taken down to be refaced and replaced. Progress had since been made, and no doubt the switches now made embodied considerable improvements, but how much was a matter for time to prove. The only results given by the author had reference to tests of a crane of an unusual type. He noticed that the efficiency came out quite as high as in some of the tests he had made 12 months ago, with five overhead travellers. In those cranes the speed-reduction between the motor and the hoisting barrel was effected by means of three sets of spur-gear, two of those sets having machine-cut teeth; whereas in the arrangement shown in Fig. 6 the motion was transmitted through a worm-wheel, a bevil-gear, and two sets of spur-gear. This should not be such an efficient arrangement as the three sets of spur-gear mentioned; yet the efficiency appeared as high as he had obtained. His tests, however, had been made when the cranes were comparatively new, and possibly better results could be obtained now. Still, his experience, judging from other tests he had

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seen, was that the efficiencies stated were high. He would ask the author to give details as to the method of taking the measurements, and also as to the care taken to see that the instruments were accurate.

Mr. E. B. ELLINGTON thought that, notwithstanding the progress of the past 15 or 16 years, in its application to hoisting, electricity was, as he had pointed out in 1881,* subject to the same defects as steam, gas and compressed air. When electricity or any of the other powers were applied to lifting, dependence had to be placed, first upon the brake, secondly on gearing, and thirdly on various controlling mechanisms. All those things were avoided by the use of hydraulic power. A simple valve sufficed to control all the motions; no brake was required, and practically no gear. A diagrammatic illustration of a complete hydraulic lift, the ram, the cylinder, and the supply-pipe, was given in Fig. 9. The whole machine might be said to be a modification of the supply-pipe. That apparatus, with the addition of a simple valve, controlled in the ordinary way, formed as perfect a type of lifting machine as it was possible to conceive. The only objection the author had stated to the use of the hydraulic lift was that it was not economical. That type of lift, Fig. 9, was necessarily an uneconomical machine. Not only did it require the same power for a light load as for a heavy load, but, from the nature of the case, the useful load was only a small proportion of the total load. That was the perfect type of lift from the mechanical point of view, apart from economy. The next step was the introduction of multiplying gear. Fig. 10 showed the ram and the cylinder, and, with the addition of the cage, a suspended lift, in which the chains or ropes were introduced. In that machine the ideal simplicity of the first type was departed from and its relative economy increased. The economy of that second type of lift was limited by the fact that it required the same power to raise a light load as it did to raise a full load. To that extent he agreed with the author. From the earliest times, nearly 50 years ago, when introduced by Lord Armstrong, it was seen, however, that greater economy might in many cases be advan-

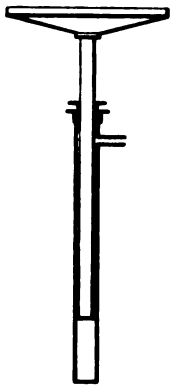

FIG. 9.—Diagram of the Direct-Acting Lift.

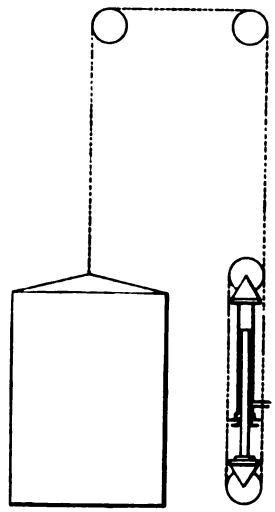

FIG. 10.—Diagram of the Suspended Lift.

tageously obtained by dividing the rams into two, three, or more, by suitable mechanism. In the two machines he had described there was a condition of things which was *sui generis*—altogether different from the application of any other power to lifting. But it was not necessary to use those types of lifts when employing hydraulic power. A hydraulic engine could be used and fitted with the Hastie gear which automatically adjusted the throw of the crank when there was almost perfect adjustment of the hydraulic power used to the load. But, although a greater economy was secured, a more or less complicated mechanism was introduced. No brake or other controlling details had been introduced, but the machine had been complicated. But it was not necessary to use a hydraulic engine at all; in a properly adjusted turbine perfect control was secured, as well as economy resulting from the adjustment of the power used to the load lifted, but the troublesome and often dangerous details necessary when using steam, gas and electricity, such as had been depicted in the Paper, had to be resorted to. There was no controlling power apart from the brake. Owing to their great simplicity a large number of the first type of lifts he had described (Fig. 9) were in use. They, no doubt, would continue to be employed where practicable for all lifts of only 10ft. to 20ft. notwithstanding their relative large consumption of power. He now wished to consider in more detail the question of economy. In the Paper to which he had alluded, particulars would be found of a trial of a lift which was commensurable with the Otis electric lift. The load lifted in that case was 886lb., with 790lb. pressure on the square inch. The multiplying power was 10 to 1, the height of the lift being 71ft. 8in., so that it was not so economical as it would be if it had been made for a height of 36ft. as given in the Table. The quantity of water used would be 6gals. for the 72ft., and 3 gals. for the 36ft. Using for the purpose of discussion electric units, units of energy, it would be found that the cost of 3gals. at 4d. per unit, the standard taken by the author, worked out at 0·078d. for each double journey. This cost was lower than the lowest cost of the electric lift, even when there was no work being done by the lift up or down; the figures were 0·082d. as against 0·078d., notwithstanding the fact that there was an increased load in the hydraulic lift of over 2cwt. If the load were reduced to the 648lb. mentioned in the Table, by reducing the area of the rams by the amount required, with an efficiency of 100 per cent. for the additional 2cwt., the quantity would be 2¾gals, and the cost would be 0·071d. As a rule, lifts were not worked with a full load or the full height. If they ascended with a full load, they did not descend full, but generally with only the attendant. Therefore a proper comparison was to take the lift, worked at half-load up and down with the attendant two-thirds of the height. Under those circumstances, using the author's table, he found that the cost would be 0·072d. in the case of the electric lift; and that the cost of the hydraulic lift, the particulars of which he had given, was 0·048d., or 18 watt-hours and 12 watt-hours respectively—a difference of 50 per cent. It was true that a simple hydraulic lift took exactly the same power at all loads, but it took with a full load less than the electric lift with the lightest load, according to the table. There was nothing in the question of economy, because the hydraulic machine was so extraordinarily economical at full load that the work could not be done more cheaply at any load. So economical an electrical machine was not available, even with the advantage due to the fact that there was no variation of power according to the load in the hydraulic lift. If mechanism was introduced which would reduce the work done in proportion to the load, there would be still further economy in the use of hydraulic power. With regard to the cut-out resistances, he might mention that a year or two ago he had examined some electric lifts in Berlin, where there were a great many at work on the electric mains, and he was much struck by the peculiar action, which at first he could not account for. For instance, a lift hoisting about 10cwt. worked well with a load of three persons under the action of the pulling of the rope by the attendant; but with full load it was several seconds after the rope was put into the position for lifting before the lift moved. That was very dangerous, and he hoped that the matter would be fully explained. As far as he could see from the Paper, that difficulty existed in the machines described, viz., that the current could not be applied directly, but time must be given. There was an automatic cut-out arrangement, which took a certain time while the current was being switched on, and that was liable to lead to accidents. When passengers entered a machine, expecting it to move on, and it did not, the first thing they did was to try and get out. At the Allgemeine Electricität Gesellschaft's work also, where everything was done by electricity, and three-phase motors were used, he was shown the traveller going about 120ft., lifting four or five times. He was asked to work it, that he might see how easily it was manipulated. He started to work it as he would any other crane or any hydraulic crane, but the machine broke down and failed to move. He was informed that he must apply the current much more quietly, and had to wait five minutes before it was put to rights again, and the same difficulty of control was experienced. He thought the proper application of electricity to the purposes of lifting was indicated by what he had said as to the necessity of complication when endeavouring to realise high economy. There were many cases in which hydraulic power was supplied by hydraulic engines. When a hydraulic engine or a turbine was used, it was a fair question whether electricity or hydraulic power was the better. He thought there was confusion in the Paper as to the term "travelling crane," and "traveller." He understood by a "traveller" what the author had described as a "travelling crane," moving a long distance. For "travellers" he believed electricity was the proper power to use. In timber yards he thought it was the best kind of apparatus that could be used. The fact was that electricity was splendid for traction, but where energy was required for lifting only hydraulic power was better.

Mr. F. S. COURTNEY thought that for a lift of short stroke, where hydraulic power was available, it should be used; but for a long stroke electric power had advantages. In the starting of an electric lift there was a large increase of current beyond that necessary when once the lift was running, and this became a considerable factor in short journeys. In Appendix I., taking the tests of this electric lift as representative of any other electric lift under similar conditions, he found that with full load the starting current was 13 amperes, while the running current was 11½ amperes; with a light load the starting current was 11 amperes, and the running current 7 amperes. With so short a stroke as only 26½ft., the larger current at starting told materially on the mean current used for the complete journey, whereas with a longer stroke the percentage of increase due to starting was materially diminished. With the electric lift there was the further advantage that the amount of current varied in proportion to the work to be done, and this, with varying loads, was a strong point in favour of electric power. There were differential hydraulic lifts which gave greater economy in water consumption than the single-acting lift; but they began to lose somewhat in efficiency, and they also required more attention. The question then arose whether the attention necessary for a differential hydraulic lift was materially less than that in an electric lift; he did not consider that this was so. The electric lift certainly could be made to work under perfect control. With shunt-wound motors, with a series starting coil, they started smoothly, and they could be regulated to stop at the landing-stages without jerks, so that in that respect they could compare with the best hydraulic lifts. There was in the electric lift a high-speed running dynamo, and care was necessary in the reduction of the gearing to render it sufficiently noiseless to be placed in positions where it had frequently to be placed, such as in the centre of a staircase and the like. With ordinary gearing it was difficult to do away with the noise, but with worm gearing this might be done effectively. It was not agreed by the author that it was difficult to have worm gear running without vibration, as there were lifts with worm gear which were running without any vibration in the cages and working quite smoothly. The question of ball bearings had been alluded to by the author for small lifts; where the load on them was light a very high efficiency

* *Proceedings* of the Institution of Mechanical Engineers, 1882, p. 122.

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could be derived from them. But there was very much greater difficulty in getting the balls evenly tempered and absolutely to gauge than there was in making a well-running path. He would venture to sacrifice the little difference of efficiency that there might be between a good thrust bearing and a ball bearing for larger lifts, in order to get the greatest simplicity in the thrust bearing. Their extreme adaptability to standardising also commended electric lifts from a manufacturer's point of view. The length of stroke did not enter into the element so far as driving gear was concerned. The motor had simply to be run so much longer, and the increased length of stroke was obtained; whereas with the hydraulic lift it became necessary either to increase the length of stroke of the ram or increase the number of multiplying sheaves. It was essential in an electric lift that the controlling arrangements should be precise, and it should be possible to stop the lift absolutely at its proper level; because if they did not, and stopped a little short of the landing-stage and had to start again, that excess of current, which was unavoidable at each time of starting, recurred. Those were points which only had to be realised to be mastered, and in practice there was little difficulty in controlling the lift so that it could stop precisely where required. With regard to the electric crane described in the Paper, that was an adjunct to an existing crane, and therefore there was more gearing about it than would have been the case had it been a complete design, and its efficiency was to a certain extent sacrificed. In his own works there were two electric cranes, one of 15 tons, and another of 20 tons, which had been running regularly nine years and eight years, and worked without the slighest trouble either in the electrical or mechanical parts.

Mr. T. D. HOLLICK observed that the gear for which he was responsible, a view of which the author had thrown upon the screen, gave, when used on electric cranes, much higher results than those of the crane described in the Paper. The crane which had been exhibited had an efficiency of 74 per cent., as compared with 53 per cent. It was tested under ordinary conditions; the weight of the hook had not been subtracted, and there was about 150ft. of wiring. Those results had been obtained, not by increasing the electrical efficiency of the motor, but by increasing the efficiency of the gearing—the mechanical arrangement between the motor and the load. With regard to lifts, the author's tests showed an efficiency of about 20 per cent. or 25 per cent., and that the cost per ton raised 36·5ft. was 1·015d., the price of the current being 4d. per unit. That was a high cost per ton, but he would expect to find a high price when the efficiency of the lift was considered. In the case of the lift the losses probably took place between the motor and the load. With regard to the efficiencies of the cranes, the crane described in the Paper lifted 20 tons 15ft. per minute, whereas the crane which had an efficiency of 74 per cent. lifted six tons 15ft. per minute. The motors in each case ran at about the same speed, and the load was raised at about the same speed; therefore there was the same reduction of speed between the motors and the load. He thought the author would have secured a higher efficiency had he used his arrangement in that position. The current capable of raising 6 tons 15ft. per minute was about 31 amperes; there was no rush of current at starting, as had been mentioned by some of the speakers. The variation during the run was about 2 amperes, probably due to inequalities in the gearing, the spur-gearing, the rope or barrel, but there was not a large jump at starting. The recording ampere-meter was checked with an ordinary meter, and the results gave about 74 per cent. efficiency. He did not agree that electric cranes were inferior to hydraulic cranes, on the three grounds of efficiency, simplicity and finality. In the matter of efficiency, the hydraulic cranes and lifts had about the same efficiency as those mentioned by the author, which would be about 50 per cent. With regard to the 74 per cent. efficiency, that, he thought, was a fair average test, though higher efficiencies had been obtained. It was taken in the ordinary way of work and exceeded that of the hydraulic cranes. The question of simplicity, however, was more difficult to deal with; it appeared to be more a matter of opinion. If there were switches with resistance and such complications, it followed that the apparatus appeared complex. But he thought that if a shunt-wound motor, with a simple mechanical gear like that which he had arranged, were compared with an ordinary hydraulic arrangement, say with a series of cylinders in order to increase the efficiency at the smaller load, it would be found that the simplicity was in favour of the electric gear. It should be remembered that in all those matters people had become used to hydraulic cranes; they had been in use for perhaps 40 years, while, on the other hand, electric cranes were new. He already knew many instances in which employers had become used to the electric cranes. The cases in which they had not become used to them were generally those in which the cranes were not applied properly, or the switching arrangements were complex. In the crane he had referred to, the switching arrangement was most simple. Anyone could switch it on, and it was impossible to fail. In regard to finality, he did not think there was such a thing, especially in the case of machines having an efficiency of only 50 per cent.

Mr. F. W. WALKER thought the simplicity of hydraulic machinery was even greater than had been pointed out by Mr. Ellington; and he did not think the direct-acting hydraulic hoist would be more wasteful than an electric one. It was assumed by Mr. Ellington that the direct-acting hydraulic hoist would only be a ram and table or cage—the ram working in a cylinder; therefore the ram would have to lift the moving parts before it lifted the load. If the electric hoist was allowed a wire-rope or chain, he wished to know why a hydraulic hoist might not be allowed the same privilege. He submitted that if the hydraulic hoist with a direct-acting ram had wire-ropes from the top of the cage, or from the corners of the cage, connected with balance weights, such a direct-acting hoist could be made to work more economically than an electric hoist. His firm were in the habit of making coal-tips, where 20-ton waggons were continually lifted, not with the expense of water necessary to lift a 20-ton coal waggon, in addition to the weight of the moving parts; but the moving parts, either by hydraulic cylinders in constant communication with the accumulator or by balance weights in connection with wire-ropes or chains, were balanced within about two tons of the total load to be lifted; therefore the hydraulic power only had to lift the actual coal, the waggons being a constant quantity. It was not fair to compare the two things, unless on parallel lines, and he submitted that if the hydraulic hoist was allowed to have a wire-rope, and then to add its own power in its own way, it was simply a plain cylinder and a ram, which was not only worked much more safely and simply, but more economically than any power which could be applied to it by an electric motor. The jiggers referred to by Mr. Ellington consisted of a cylinder which did not require attention, a ram and a gland. In addition there were two pins, one at the top and the other at the bottom, with a number of sheaves working on them. In machinery of that kind, the smallness of the number of working parts was of immense value, not only because it made the machine work better, but also because it made it easier to keep in repair. The fact that it could be controlled and worked by much cheaper labour was an additional advantage of hydraulic machinery. He thought results as to the question of relative economy would be of great value, because economy, first in capital outlay, secondly in maintenance, and thirdly in working, was of primary importance. He hoped that some electrical manufacturer would give the Institution the benefit of his experience and state not in electrical terms, but in plain old-fashioned horse-power or foot-pounds, how much it cost to generate the power, and how much was lost when it was used. In dealing with such a question, which was influencing large dock and railway companies in the consideration of the machinery they were to employ, that subject should be settled once and for all. How much did the power cost to produce, and how much was produced and then wasted? He thought it would be generally admitted that if electrical power was to be utilised in large installations, such as docks and railways, it must be used in some way by which it could be stored. He thought it would be impossible to drive direct the machinery at the Bute or the Barry Docks, or at the North-Western, or the Midland, or any other large railway company's works. In one dock at one minute there would be 20 coal-tips working as hard as they could, and the next minute, perhaps, when the dinner-signal was given, hundreds of horse-power suddenly disappeared. He should like to know what an electric engine would do with this power? A hydraulic engine put it into the accumulator, and used it after dinner. He did not know what an electric engine would do with it; was it to stop instantaneously? Was the man always there ready to stop it, and what was going to happen if some industrious tipper went on working and still required power to work the machinery? That was the great problem which should be dealt with clearly and distinctly. With regard to accumulators, he did not think that the value of the hydraulic accumulator, indeed, its absolute necessity on a dock, was generally understood. In some docks there might be pumping engines with 1,000 H.P. continually at work; but in addition to that there would be hydraulic accumulators in all parts of the dock, storing many thousands of horse-power which, when 20 coal-tips, and 50 capstans, and 30 cranes, and the dock-gate machinery all required to be moved at the same time, would be supplied by those accumulators. He wished to know whether there was any arrangement by which electrical machinery could accomplish the same results. As to the general working, he should like to ask if it did not require much more skilful labour to keep it in order, and if it did not cost very much more, also if the difficulty of working it either slowly or quickly at pleasure was not much greater? Could an electric crane be worked when picking up the loads slowly, and when it had felt the load let it shoot up at 300ft. a minute? Could the operator lower it at no cost, or was it necessary to work the machinery? When lowering, had the operator only to let loose the handle in order to stop it? That was all that was necessary with a hydraulic arrangement. Could all that be done with equal simplicity in the case of an electrical motor?

Mr. P. I. UNWIN desired to refer to results as to the working cost of passenger and goods lifts, and of machines similar to those used in hotels, warehouses, private houses, and other high buildings, in London and other great cities. Hydraulic lifts had been well known for many years, and they had been brought to a high pitch of excellence. The safety gear had been perfected, and, although no such thing as finality was possible, he did not think that much improvement could be expected in the future. The advantage of electric lifts was, as the author had stated, that power was used in proportion to the load. With the hydraulic lift it was necessary to fill the cylinder, whether the load was light or heavy; but with the electric lift the current was in proportion to the number of persons carried. To give an instance, the Otis Elevator Company had been asked two years ago to design a machine for a large establishment in London to carry a given load, possibly 1,000lb., to a height of 70ft., at a certain speed. It was found that the current to drive the electric lift at 4½d. per unit would cost between £19 and £20 per annum; and that a hydraulic elevator under similar conditions, with a similar load and lift, and doing similar work, would cost £47 per annum. The electric lift had then been decided upon, and the anticipations had been amply confirmed by results. The accounts for current for the first few months were at the rate of between £20 and £22 per annum, and at present, although the number of trips had increased from 200 to 300 per day, and although the loads had increased the average cost of current was about £24 or £26 per annum. The Otis Company had made in past years a great many more hydraulic than electric elevators. They were compelled to place the best article before their employers, and if they were tied down to low cost of maintenance, they would advise electric instead of hydraulic lifts. As to the question of reliability, a hydraulic lift was simple, but an electric lift was equally simple, the switch-gear being the only part open to criticism on the score of complication. With regard to the question of initial cost of lifts, it was difficult to give exact figures, because every case had to be separately considered, as it depended upon different conditions. He might say that electric lifts for high buildings were, as a rule, between 10 per cent. and 15 per cent.

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more expensive in first cost than hydraulic lifts, depending on the height. The 10 per cent. or 15 per cent., whichever it might be, when capitalised, was saved over and over again in the difference in the cost of working. Taking an ordinary load of 800lb. or 900lb., twelve trips could be made with an electric machine against six with a hydraulic machine.

(To be continued.)

PHYSICAL SOCIETY.

At an ordinary meeting of the Physical Society on November 26th, Mr. Shelford Bidwell, President, in the chair, Mr. ROLLO APPLEYARD read a Paper on

"The Failure of German-Silver and Platinoid Wires."

The mechanical defectiveness, and the consequent electrical instability of alloys used for electrical wires, may be discussed from two points of view:—(1) As to the constitution and metallurgy of the alloy; (2) with regard to the subsequent treatment and environment of the wire. In stating the case the author gives instances of the failure of german-silver and platinoid wire that have occurred among several thousands of resistance coils distributed over widely different latitudes. In periods of time, varying from six weeks to several years after manufacture, the wire on some of the bobbins became brittle, and broke, not only on the outer layers, but also within the coils. The towns where the faults appeared are all within the tropics, and included nearly within the isotherm of 25°C. Other coils of nominally the same material, manufacture, and environment, have retained their original good condition. It follows that metallurgical differences exist between different samples of the same nominal quality of alloy. Examples are given to prove that failure sometimes occurs with platinoid through which no electricity has passed. Provided that the wire is good, the effect of environment is almost insignificant, *i.e.*, the question is one of metallurgy rather than of instrument making.

The author introduces a distinction in regard to brittleness. He discriminates between "primary" and "secondary" brittleness. "Primary" brittleness is characteristic of certain alloys (for instance, of gold-lead or of gold-bismuth) from the moment of their solidification. But the brittleness of german-silver and of platinoid is of a different order, it is a subsequent phenomenon. "Primary" brittleness is thus an accident of birth, and "secondary" brittleness is a disease that develops with age and circumstance. The fracture of bad specimens of german-silver and platinoid shows patches of dark metal, crevices, and fissures. It may be supposed that, during the process of cooling, "liquation" occurs—the metals that first solidify rejecting yet molten portions, as ice rejects foreign matter. Consequently the strength of the final alloy varies from point to point of its mass, and in passing afterwards through the die, the weaker portions give way and the general structure is loosened. Moisture can then intrude through the capillary channels. At all fissures and crevices the electric current produces undue heating; this accounts for the failure of resistance coils on arc-light and other circuits. As regards the protection of coils against moisture, paraffin-wax is of no use whatever, it is highly absorbent. Shellac varnish is greatly to be preferred. Ebonite does not seem to have any deteriorating effect, but it may be well to keep the alloys out of actual contact with it. In conclusion, Mr. Appleyard expressed a hope that British metallurgists would give electrical alloys special consideration. Already British cable manufacturers are importing thousands of tons annually of sheathing wire from Germany; this is sufficiently to be regretted. He had good reason to know that instrument-makers were beginning to get the wire for their resistance coils also from Germany. He had not enough experience of manganin to say whether that material would stand rough service in the tropics.

Prof. AYRTON said the Paper had raised the extremely interesting question of the permanency of metals used for resistance coils. Some time ago he had immersed bare platinoid wires in running water in metal tanks, and the wires all broke into short pieces. He thought, at the time, this might be due to electrolysis. On another occasion he had found that by raising the temperature of platinoid to a dull-red heat in the air by an electric current, any acquired faults in the wire were corrected and the original resistance and flexibility were restored. Even when such metals are in good condition the resistance-temperature curve does not return upon itself, it encloses a loop indicating two distinct values for resistance at each temperature. He had been told by Dr. Muirhead that coils intended for hot climates should be enclosed in air-tight metal cases. English manufacturers were still dubious in regard to manganin. In 1892 he had 20 coils of this material, each of a thousand ohms; the wire was silk-covered. There were 2,000 volts between the terminals. Their resistance had certainly not changed by 1 in 1,000, although there was some amount of vagueness regarding the fifth figure, which might be due to molecular alteration, for they were heated more than was good for resistance coils. He confessed that this manganin had come from Germany.

Dr. S. P. THOMPSON mentioned an alloy that was proposed in Germany under the name of "Constantin." He would like to know whether any information could be obtained as to the employment of cast-iron wire. It was a metal that in some respects commended itself. He had observed the failure of some german-silver coils, but he had generally attributed it to rough handling.

Mr. W. WATSON referred to the recent work done at the Reichsanstalt with regard to german-silver and platinoid. It was there found that all alloys containing zinc were liable to erratic change of resistance, and were unsuitable for standard coils. Moreover, even the slight amount of zinc introduced into manganin during soldering with soft solder robbed that alloy of its constancy. Silver solder, containing 75 per cent. of silver, should be employed for manganin. If Prof. Ayrton's coils were soldered with soft solder, that was sufficient to account for the change in the fifth figure. Shellac varnish was undoubtedly the best protection for coils. Absolute alcohol should be used as the solvent, and the coils should afterwards be heated for some hours at 140°C. If a heating current was passed through german-silver or platinoid coils immersed in water the general result was to produce brittleness. Mr. Watson then described a thermostat which he had contrived for drying the coils after applying the shellac varnish. A hot-air oven contains a thermometer with a platinum contact at the 140deg. mark and an 8 c.p. lamp. The thermometer is in circuit with a relay actuating a mercury-key for the 8 c.p. lamp. The key consists of two mercury cups and a corresponding U-piece of copper, inverted, one limb to each cup. It is important to keep the heating circuit always made; for this purpose a 32 c.p. lamp is permanently connected between the two cups.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, December 10th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) An exhibition of an apparatus for self-acting temperature compensation of a Standard cell, by Albert Campbell; (2) "On Lord Kelvin's Absolute Method of Graduating Thermometers," by Mr. Rose Innes.

SATURDAY, December 11th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7 p.m. Graduate Section. The Third Meeting of the Ninth Session in the Institution Lecture Hall, 4, St. Nicholas-buildings West, Newcastle-upon-Tyne. Business: (1) Mr. C. W. Cairns will reply to the discussion on his Opening Address; (2) Paper on "Some Methods of Filtering and Heating Feed-Water," by A. H. Burbidge, will be read and discussed.

MONDAY, December 13th.

SOCIETY OF ENGINEERS.

7:30 p.m. Annual General Meeting at the Royal United Service Institution, Whitehall.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting at the Palatine Hotel, Hunt's Bank, Manchester, when the discussion on Mr. Wordingham's Paper will be resumed. A Paper will also be read on "The Management of Boilers and Steam Plant, including details of Steam Pipes and Fittings," by A. B. Mountain.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III. "Gutta-Percha," by Eugene F. A. Obach.

CAMERA CLUB.

8:15 p.m. Meeting at 28, Charing Cross-road. Paper to be read: "The X Rays Up-to-Date," by William Webster.

WEDNESDAY, December 15th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Notes on the Dover Tramways," by J. M. Donaldson.

FRIDAY, December 17th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Papers to be read: (1) "The Elastic Properties of Steel Wire," by Archer Keigwin; (2) "The Elasticity of Portland Cement," by W. L. Brown.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting in the Rooms of the Chemical Society, Burlington House, W. Continuation of discussion on Mr. L. Epstein's Paper, "Accumulator Traction on Rails and Ordinary Roads."

The Patton Electric Locomotive.—A locomotive designed by Mr. W. H. Patton, of Chicago, has been given an official trial in that city. *Electricity*, of New York, hears that the results are claimed to have been satisfactory, but no details of the tests are yet forthcoming. The locomotive is on a similar system to the Heilmann, with the exception that a gas engine replaces the boiler and engine, and that a battery of accumulators is added.

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THE ENGINEERING DISPUTE.

The prolonged struggle between masters and men in the engineering trade of this country reached an acute crisis on Friday afternoon last, when the Conference between their representatives was adjourned for several days to enable the vote of the trades unions to be taken on the issues finally decided upon by the employers. We print in another column the text of the employers' proposals, the men's counter proposals, and the final form decided upon by the masters, the text agreeing with that officially furnished to the Press on behalf of the Employers' Federation. Unhappily, the firm adherence of the masters to the spirit, if not the actual letter, of their original proposals, coupled with the abrupt adjournment of the Conference and the apparent determination of the unions to stick to their demands, would seem to indicate that in this latest stage of the negotiations we have a deadlock even more inflexible and bitter than has hitherto existed. Instead of seeing the rival forces arrange a satisfactory termination of a struggle which already has seriously hampered the engineering trades of the country, we have the sorry spectacle of neither side granting a single substantial concession, and are face to face with the prospect of a still greater blow being dealt at our national engineering trade. And, although the mischief already done is not sufficient permanently to lower our commercial supremacy, yet it cannot be denied that an important trade has received a serious set-back, from which it will take some time to recover. Deplorable, however, as is this aspect of the question, it does not directly affect the main principle as to the right of the men to combine, or as to the necessity for the management of engineering works being vested in the employers alone. The evil that may temporarily attend a labour dispute furnishes no valid argument that the dispute should not arise, or, having arisen, should not be effectively settled.

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Trades unions in the past have produced immense benefit to working men and, indirectly, to the condition of trade and commerce. It would be foolish to deny to men the right of combination, and madness nowadays to aim a blow at the principle of trades unionism. But an equal freedom must be claimed for those who do not wish to enter the combination, and who desire to carry their labour into the market on their own responsibility alone. The doctrine of "the greatest good for the greatest number," admirable when not carried too far, becomes tyrannous and illogical when it is made to countenance the extinction of the individuals in a minority. The only proviso that, in all fairness to the individuals of the majority, should be insisted on is, that the minority should not attempt to undersell the majority by hiring themselves out at lower than a minimum wage agreed to by the majority. Having this in view, we sympathise with the Amalgamated Society of Engineers in so far as they desire to prevent employers from bargaining with individual non-union men for lower than the standard wage. The masters state that they would only do so with such men as are too old or otherwise incapable to justify their being rated at full value. A manifest defect in the general working of trades unionism is here indicated, viz., that it makes no provision for men whom age or misfortune has placed below the standard of competence; that, in fact, it imposes an uniform minimum wage for all degrees of competence in the men engaged, which raises the important question, whether trades unions might not with advantage to the men recognise more than one grade of competence, with standard *minimum* wages for each.

Regarding the other matters brought before the Conference, two of these are of vital importance, namely, the questions as to the adoption of the eight-hours' day and the "selection, training and employment of operatives"; the other questions are subsidiary. It appears reasonable that the proportion of apprentices to efficient workmen should be limited, as proposed by the representatives of the men; while the determination of piecework terms naturally depends upon the first principle of an absolutely irreducible minimum wage. Overtime arrangements will also naturally depend on the decision as to the normal number of hours, and it is notable that the labour representatives do not appear to have put forward any scheme by which a double eight-hours' shift might be worked without a large increase in the proportion of overtime, to avoid which, in a 24-hours' day, the adoption of a treble eight hours' shift would be necessary. It is, in fact, this relation of overtime to the eight-hours' day that strikes at the root of the eight-hours' question. Apparently in full acquaintance with the financial aspect of the question, employers declare that the trade will bear neither payment of nine-hours' wages for eight hours' work nor an increase in the proportion of overtime. Apparently, also, the introduction of an eight-hours' day is put forward with a view to a largely increased overtime during which to earn wages on the higher scale. The contention of the men in regard to the eight-hours' day is tantamount to a declaration that the normal trade of the country can be got through on that plan; but this argument leaves entirely out of consideration the advantage that would accrue to foreign nations where the eight-hours' day does not operate. We do not now propose to estimate the magnitude of that advantage, but may observe that it is contended by the employers that the adoption of the eight-hours' day would seriously handicap Great Britain in regard to foreign competition. If that allegation can be substantiated, the final and irrevocable decision of the employers not to agree to the eight-hours' day was perfectly justified, and was, indeed, the only course they could take.

REVIEWS.

The Theory of Electricity and Magnetism. Being lectures on Mathematical Physics. By ARTHUR GORDON WEBSTER, A.B., Ph.D., Assistant-Professor of Physics and Director of the Physical Laboratory, Clark University, Worcester, Massachusetts. (London: Macmillan and Co., 1897.)

Dr. Webster has given us a very able book on the subject of electricity and magnetism, treating it as a department of mathematical physics. So far is this idea carried out that the book leaves the impression that it is rather a storehouse of applied mathematics than a treatise on electricity. We are sorry that this should be the case, for many will feel that there is a distinct need of a book giving some of the developments of Maxwell's theory, due to Hertz, Oliver Heaviside, J. J. Thomson and others, in which, though the method must be mathematical, the aim should be intensely physical. No doubt a considerable amount of mathematical training is necessary if the consequences of electrical theory are to be traced to their fullest development, but yet a very moderate mathematical knowledge will suffice to carry the student through many interesting parts of the subject. And it is often the case that it is in quite simple applications that the principles of the subject come out most clearly, and it is just here in consequence that the greatest advance is made in gaining a grasp of the essentials of the theory.

To meet the needs of the "graduates of our American Colleges" who "are, as a rule, insufficiently prepared in the departments of mathematics necessary in approaching the subject of mathematical physics," Dr. Webster has given a mathematical and dynamical introduction occupying practically half the volume. This introduction contains a considerable amount of difficult analysis. We doubt whether, without that practice in the interpretation and manipulation of mathematical symbols, which is only gained by several years of mathematical study, the student will be able to make any real or *safe* use of many of the methods given in the introduction. The time, "not exceeding one year," which the author assigns for the study of the book, seems much too short, unless there has been a long period of preparation.

Dr. Webster gives a brief account of vector quantities, introducing them from the point of view of complex numbers, thereby making the square of a unit vector to be -1. He afterwards replaces this by Heaviside's system, in which the square of the unit vector is $+1$, for he admits that there is no practical connection between a physical vector and a complex number. It is a pity that Heaviside's simple system is not adopted from the first, and also that simple vector methods are not more often employed in the work. There is no confusion or mystery about Heaviside's system, and, best of all, it is thoroughly practical.

Two very useful chapters are those on "Work and Energy" and on "Lagrange's Equations and Hamilton's Principle." A short description is given of the models devised by J. J. Thomson and Boltzmann for illustrating the dynamical properties of electric currents. The last two chapters of this part contain an account of the theory of the potential due to forces which vary according to Newton's law of the inverse square. The attraction of ellipsoids and the mathematical properties of polarised bodies are also discussed.

The real subject of the book is then attacked. In Part II., after a description of the fundamental experiments of electrostatics, there follow articles on the energy of electrical systems, on coefficients of induction and on the theory of electrometers. A number of electrostatic problems are solved by the methods of electrical images and of conjugate functions.

Ohm's law is dealt with in Chapter VIII. Here the current density is defined as the quantity of *electricity* which passes per second through a unit area inside the conductor. This sort of definition may be all very well from a purely mathematical standpoint, but is a little puzzling to a student who tries to explain to himself how it is that any electricity gets inside the conductor when a current is flowing, or tries to find out how it is *known* that there is any electricity there at all. His confusion will be complete when on reading to the

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end of the paragraph he finds it proved by Ohm's law that in the case of steady flow there is no free electricity in any portion of a homogeneous conductor. The progress of science is hindered just as much by overestimating our knowledge as by throwing away what has been gained. All who have had any experience in teaching physics will know how often difficulties occur because writers of text-books are not sufficiently careful to make their language bear some relation to ascertained facts.

There is a close resemblance between dielectrics and magnetisable bodies, and to bring this into greater prominence Dr. Webster considers the properties of both classes of substance in the same chapter. This is an excellent plan, provided that the essential differences between electricity and magnetism are sufficiently kept in mind. At the end of § 181 lines of force are spoken of, when lines of induction are meant. We can find no statement that the *tangential* electric or magnetic force must be continuous at an interface between two different media. This condition is, of course, implied by the condition that the potential must be continuous at the interface, but it is often the more convenient condition for use in the solution of problems. We think many students will find a good deal of difficulty in the paragraphs relating to permanent magnets. At the beginning of § 182 it is stated that the induction "possesses the solenoidal property," viz., $\mathrm{div}\,\mathbf{B}=0$, but Dr. Webster has not stated here that he does not consider this true always. He deals with the magnetic induction as if it sometimes has divergence, and makes $\mathrm{div}\,\mathbf{B}=4\pi\rho$, where ρ is the density of "*true* magnetism." His induction is, therefore, something different from Maxwell's, which always satisfies $\mathrm{div}\,\mathbf{B}=0$. The difference only occurs, however, in considering the internal state of permanent magnets. And a permanent magnet is so strange an object when regarded from a purely mathematical point of view, that it is not wonderful that Helmholtz and Hertz, whom Dr. Webster follows, should hold views differing from those of Maxwell. But Faraday claimed that his experiments on the induction of currents by the rotation of permanent magnets proved that the quantity whose variations give rise to E.M.F. was continuous within and without the magnet. A more detailed examination of this point would have been very useful, for we must give the same name to the same quantity in magneto-statics and in the induction of currents.

Part III. of the treatise is devoted to a study of the electromagnetic field. After the usual propositions on the properties of closed linear currents there follow some articles on current-elements. If a second edition is called for we hope Dr. Webster will give an account of Heaviside's "Rational Current Element,"* a definite physical conception quite free from all the ambiguities which belong to the ordinary sort of element. The magnetic properties of the "Rational" element follow at once from the relation $\mathrm{curl}\,\mathbf{H}=4\pi\mathbf{C}$, which is deducible from the experimental laws of complete circuits. Another physical element is a moving charge, the theory of which (at least in the case of slow motion) can be treated just as simply as that of a rational element, the mathematics being identical in the two cases. Dr. Larmor, in his "Theory of Electrons,"† shows how important a place the theory of moving charges occupies in electrodynamics. It is evidently much better to adopt an element whose properties can be investigated without ambiguity, by laws already established, than to break up a circuit into parts in a manner which is physically impossible.

In § 219 the mechanical force experienced by an element of the current in the presence of a pole is deduced "by the principle of reaction" from the force which the pole experiences due to the magnetic action of the element. The two forces may be parallel, equal, and in opposite directions, but they are not in *the same straight line*. What becomes, then, of the *couple* to which they give rise? A great element of uncertainty is introduced by this method. We know, indeed, the force experienced by a complete circuit, but, as a rule, very little care is shown in deducing the force experienced by *each part* of the circuit. It is essential to know this if we are to have a good theory for current weighers and such like instruments where the mechanical force on *a part* only of the circuit is measured. What the *magnetic* force due to an element of a circuit may be does not matter in the least, as long as we get the right result for the whole circuit, for we cannot, if we would, deprive part of the circuit of its magnetic power. In finding the *mechanical* force on an element an appeal must be made to experiment before the results can be deduced from the theory of magnetic shells.

The theory of induced currents is treated after Maxwell's manner, by dynamical methods, assuming that the kinetic energy of two circuits is expressible by $\mathrm{T}=\frac{1}{2}\mathrm{L}i_1^2+\mathrm{M}i_1i_2+\frac{1}{2}\mathrm{N}i_2^2$.

The last chapter on the electro-magnetic field is one of the best in the book. The propagation of disturbances in insulators and conductors, and also Poynting's theory of the transfer of energy, are duly considered. Poisson's solution of $\nabla^2\phi=\mathrm{K}\mu\, d^2\phi/dt^2$ is given, by which it is shown that ϕ is propagated with velocity $1/\sqrt{\mathrm{K}\mu}$. This will be useful to many students, for the proof does not usually find a place in treatises on electricity. A neat solution of the oscillations of a charge on a conducting sphere is also given. Then follows a series of articles on the propagation of disturbances along wires. In the middle of these articles there is a curious personal sentence referring to Mr. Heaviside, the meaning and object of which seem quite inexplicable.

Some of the figures are naturally mere diagrams. There are, however, some figures of lines of force beautifully drawn. The labour expended in making really good diagrams of this sort is only known by those who have attempted the task.

In spite of what seem to us to be defects, the book is full of excellent mathematical matter, and will no doubt prove useful to many students. We owe a personal debt of gratitude for real assistance gained from it in the solution of some magnetic problems. The student who is capable of understanding the book will read it with great profit, and will be glad to give the volume a place in his library by the side of his Maxwell.

G. F. C. S.

Die Isolierten Elektrischen Leitungsdrähte und Kabel. Ihre Erzeugung, Verlegung und Unterhaltung. By Hugo Wietz. (Leipsic Oskar Leiner. 1897.)

Had the author given us a complete account of the production, laying and maintenance of electric wires and cables, it would have needed a much larger work than the 230-page demy octavo now before us. The volume is of value as an educational treatise, as it gives a very good idea of the methods employed in the manufacture, laying and testing of electrical conductors; but to be a thoroughly serviceable handbook or book of reference for practical engineers, whether makers or users, more detailed technical information would be necessary. Taking due account, however, of the differences in practice in English and German cable manufacture, we have no hesitation in recommending the book to all classes of readers, as its faults are chiefly those of omission, and not of commission.

The first half of the book is devoted to a short description of the various processes used in manufacture. Machines for stranding, lapping, serving, braiding and taping are described, also the methods of rubber-covering and vulcanising, and those used in the production of gutta-percha core and lead-covered cable. One or two points here and there require to be corrected. The author states, for instance, that in England and America the term *cable* involves the idea of a *covered* wire, even if it only consist of a single strand; but we are of opinion that in England, just as in Germany and Austria, a number of wires stranded together is necessary to form a cable, whether insulated or not. It is also hardly correct to say that the method of lead covering is independent of the class of cable, for although the hot lead-press may be used for nearly all types, the lead-covering of gutta-percha core is nearly always pressed on cold—at all events, we should not like to use for this purpose the Huber press described in the book, a form happily little used in England. We think that the invention of the first practical air-space cable may safely he credited to Prof. A. E. Dolbear, although he sold his patent for a ten-pound

* "Electrical Papers," Vol. II., p. 500; "Electromagnetic Theory," Vol. I., p. 64.

† *Phil. Trans.*, 1895.

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note; at all events, his name might well have been mentioned in this connection before that of Messrs. Felten and Guilleaume. Again, it is stated that the largest telephone cables have but 104 conductors. The cables in connection with the Manchester telephone system are nearly all 153 pair; there are some at Leeds containing 408 wires; we believe that a 806 pair cable is to be used shortly in London, and we have even seen a sample of a "dry-core" cable containing 1,000 wires. There is, however, one serious error to which we must call attention. The author says nothing about the fall of potential in cable for lighting and power currents, but states that the maximum heating of a conductor serves as a basis for calculating its dimensions. We trust that this is only a slip of the pen, and that "the invention of the so-called *three-wire system* for three-phase installations" is another. We are also surprised at the misuse of the term "specific resistance" made by the author; we should not use it for the resistance of a wire 1 metre long and 1sq. mm. section, as the author says is customary.

However, with a few exceptions such as these the book is very good reading. The chapter on the laying of underground cable gives a fair account of the methods in use in Germany, but hardly extends to English and American practice. Then follow 18 copiously illustrated pages on the laying of submarine cables, and the reader is referred to Mr. H. D. Wilkinson's book for further information on this subject. The third part of the book is on the electrical phenomena occurring in cables and on measurements. What occurs when charging a long cable is treated very clearly with abundant use of curves, the mathematical theory being purposely left alone. The section on measurements is short. The methods of measurement commonly employed are described, with the exception of submarine cable tests, but a few practical hints as to the execution of the tests might with advantage have been added. Three methods of fault localisation are given, Murray's, Varley's, and Warren's, but the practical method very largely used for unsheathed cables in cable factories is omitted. The apparatus required for this latter test is only a drum with an insulated contact ring, a 100-cell battery, and a sleepy boy. The end of the faulty cable is connected to one pole of the battery through the contact ring, the other battery pole being earthed. The cable is then wound on to the drum, the sleepy boy guiding it with a wet cloth. When the fault comes over, the sleepy boy wakes.

In conclusion, we would suggest that when preparing his second edition the author should add some actual cable specifications as an Appendix.

THE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

BY F. CHARLES RAPHAEL.

Liverpool.

The central exchange in Liverpool, although being a "mixed circuit" one, differs in many respects from the Leeds exchange. The difference is chiefly occasioned by the use of three-point instead of five-point jacks on the subscribers' section of the board, although five-point jacks are fitted on the trunk and junction sections.

This exchange is the largest and busiest in the United Kingdom. There are at present about 4,350 subscribers connected directly to the exchange, and there are 183 junction lines to the 23 sub-exchanges in the Liverpool district. Fourteen of these sub-exchanges are on the Liverpool side of the Mersey, and the other nine, which include the Birkenhead exchange, are on the opposite side of the water. An idea of the activity of the exchange and the popularity of the telephone at Liverpool is given by the number of originating calls which were recorded on Friday, April 9th (a day chosen at random). The number was 104,400, which is equivalent to 24 calls per subscriber per day.

The lines are at present overhead, and they end in a derrick above the exchange, being connected to the distribution boards by 104 and 50-wire cables in the usual manner. At the back of the testboard are mica gap lightning arresters and also resistance coils of 500 ohms resistance, through which the B lines from the jacks of the single-wire subscribers are connected to earth. In the front of the board are the usual type of test jacks, and on the testing table in the same room are the instruments for continuity, resistance and insulation tests, the connections being arranged so that these tests can be made quickly in succession either on single or double-wire circuits. Fig. 51 shows the switchboard connections. The lines are brought first to the trunk and junction boards on which five-point jacks are used in conjunction with three-way plugs. When one of these jacks is plugged the line is disconnected from the jacks on the subscribers' sections, the barrels of these jacks being connected to one pole of an earthed battery through the sleeve of the plug and the third wire in the cord. Two-way plugs are used for the subscribers' sections in conjunction with three-point jacks, whose method of construction is apparent from the diagram, Fig. 51. On the insertion of a plug, contact is made between the spring of the jack and the tip of the plug, and between the barrel of the jack and the sleeve of the plug.

The simple connections of the subscribers' jacks necessitates, however, an important modification in the operator's keyboard. As arranged at Liverpool (Fig. 52) there is a separate pair of ringing keys for each set of cords, this ringing-key being in direct connection with the plug, and not being connected through the listening key. The construction of the

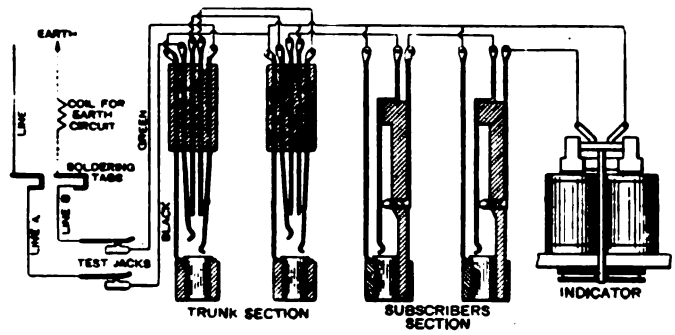

FIG. 51.—Liverpool Switchboard Connections.

listening key is also somewhat modified. It is shown diagrammatically in Fig. 52. In its normal position in the diagram the answering plug is connected to the operator's instruments, the circuit of the calling plug being broken at the right-hand spring of the listening key. When the operator has ascertained the number required, she plugs the corresponding jack (if disengaged) with the calling plug, presses the left-hand ringing key, and, after hearing the second subscriber's reply, turns over the listening key, thus leaving the two subscribers through and cutting her instruments out. On referring to Fig. 51 it will be seen that when a subscriber is engaged, the barrels of all his jacks will be connected to the sleeve of the plug. In Fig. 52 it is seen that the sleeves of both plugs are connected through a resistance coil and two battery cells to earth. This resistance coil has 600 ohms resistance and a high inductance, to prevent the earth-connection from having a detrimental effect on a metallic circuit. The tip of the calling plug is in connection with one terminal of the operator's receiver when the listening key is in its listening position, as shown in the figure, and therefore if the tip touches an engaged jack it is brought into contact with the 600 ohm test coil just referred to, the circuit is completed from the two cells through the test coil and one side of the operator's differentially-wound induction coil and receiver to earth and back to the battery, and the operator hears a click.

It is seen in Fig. 52 that the connection between one of the contacts of the listening key and the operator's set is made through a condenser. This condenser has a capacity of one microfarad, and its necessity must be explained here. If the condenser were replaced by a direct connection, or short-

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circuited, on plugging a metallic circuit with the answering plug connection would be made from the battery through the test coil to the sleeve of the answering plug, through the subscriber's instrument and back to the tip of the plug, and thence through the operator's receiver to earth and back to the battery. When she subsequently touched the barrel of *any* earthed subscriber's jack with the tip of the calling plug it would make connection to earth at the test jack (*see* Fig. 51). The tips of the two plugs would be connected through the listening key (Fig. 52) were it not for the condenser, and part of the current through test circuit would flow to earth through the tip of the calling plug and the barrel of the jack. This would vary the amount of current flowing through the operator's receiver, and a click would be heard whether the wanted subscriber were engaged or not. By the insertion of a condenser, as shown in the diagram, this false click is avoided. It should be mentioned that when any single-wire subscriber is plugged with the answering plug the test circuit is closed through the sleeve of the plug the barrel of

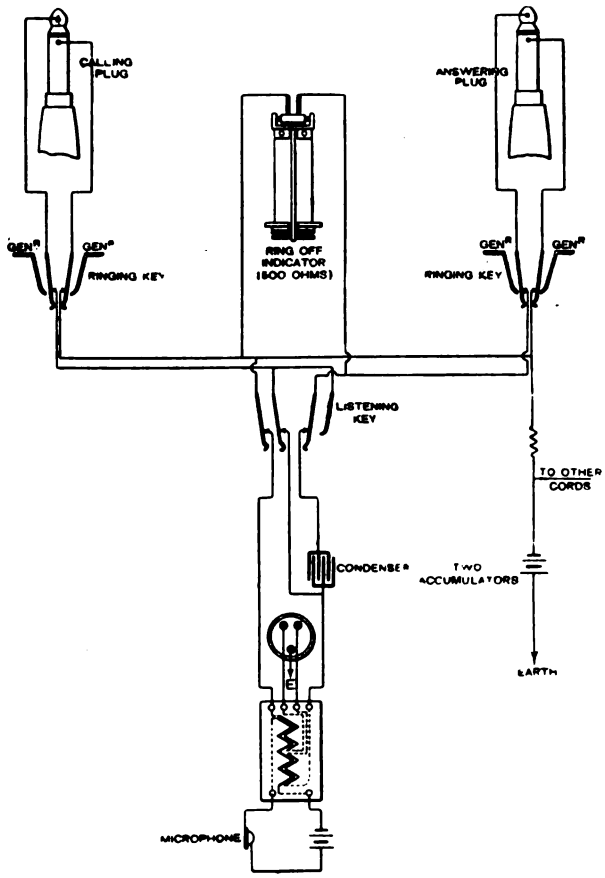

FIG. 52.—Operator's Connections on Liverpool System.

the jack and the resistance coil at the test jack to earth and back to the battery. A current therefore flows all the time the plug is in the jack, and thus another reason for giving the test coil a high resistance is to diminish this current as much as possible.

The switchboards are divided over two rooms. In the smaller room is accommodation for 1,700 subscribers, and place for an additional switchboard if necessary. In the larger room, which is practically full, 8,800 subscribers can be provided for, and the junction and trunk boards are placed here as well. Each section of the board serves 200 subscribers. The section has three operators' positions, so that each girl has 66 subscribers to attend to. In spite of all the 4,350 subscribers being multipled on every section every jack is well within reach of the operator without it being necessary for her to rise from her chair. The keyboard is placed 2ft. 8in. above the floor, and the plug shelf 9in. above the keyboard. The topmost jack of the multiple is 2ft. 6in. above the plug shelf. Every operator on the subscribers' boards has 15 cords and sets of keys. All the jacks of the metallic circuits are marked with a white circle on the face of the board.

The method of junction-working is slightly different to that in use elsewhere on account of the employment of three-point jacks on the subscribers' boards. Every outgoing junction wire is multipled on the trunk and junction boards in five-point jacks in the same way as are the subscribers' lines. After it has passed through these sections it ends in one winding of a repeater, and the terminals of the other winding are connected to the subscribers' boards and multipled on each section just as the subscribers' lines are. The barrels of all the jacks, both five and three-point, are in metallic connection. Thus any subscriber, whether single-circuit or metallic, requiring a junction connection, is put through a repeater to the junction wire without any different operating to the usual being required.

The incoming junctions are brought straight to the junction board, on which, as already stated, all the subscribers' lines and outgoing junctions are multipled in five-point jacks. Here the condenser is not needed in the operator's set, but a translator key is added in a somewhat similar way to that in use at Leeds. The incoming junction wires are connected to plugs through the listening and translator keys, as in Fig. 84 in Article IV., but with the translator key connections added and automatic clearing signals are received. If a metallic-circuit subscriber is wanted, the connection is made direct; if a single-wire subscriber, the translator key is pulled over. The incoming junction boards in the sub-exchanges are not yet fitted with automatic clearing signals, and it is necessary for the originating operator at the central exchange to plug into the speaking wire to instruct the junction board operator at the sub-exchange that the line is free. There are in all 183 junction wires to the various sub-exchanges, including both incoming and outgoing, but not the speaking wires. At busy times of the day there are seven operators at the junction board at the central exchange, each having, therefore, 18 lines to attend to.

On each subscribers' section are three or four "ticket lines" connected with the record table at the post office. These are used to convey the desire for a trunk connection to the post office. When the call has matured the subscriber is called up from the post office on the trunk switchboard. This board is divided into two sections and served by four operators, each of whom has 24 lines to attend to, there being in all 96 post office junction lines.

In all, nearly 100 operators are employed at Liverpool. These are supervised by seven "supervising operators," five in the larger room and two in the smaller, and a head operator in each room. In entering the exchange the observer is struck by the extreme youth of a great number of the operators, this being also the case in Manchester. The age at which they start is from 15 to 17, it taking about two years' training before a girl can be considered an expert. The beginners are placed in the less busy sections, and are helped, if necessary, by the girls next to them. In Leeds and in London the age at which the girls start is greater—from 17 to 19 years.

The usual relay board is provided, by means of which each section is connected to a bell and indicator at night, the relay circuit being closed by a contact beneath the flap of the subscriber's indicator. The number of operators is reduced after business hours in the evening, there being six at work up to 10 o'clock, two during the night, three from 6 to 7 a.m., and five from 7 to 8 a.m.

In the machine and battery room extreme precautions are taken against vibration, as the room is on the top floor of the building. The magneto is driven by a $\frac{1}{8}$ H.P. electric motor, and these are contained in a glass-covered case suspended from the ceiling. At night a smaller magneto is used, driven by a water motor.

BOOKS RECEIVED.

"Die Elektrischen Beleuchtungs-Anlagen." By Dr. Alfred R. von Urbanitzky. (Leipzig: A. Hartleben.)

"Elektromechanische Konstruktionen." By Gisbert Kapp. (Berlin: Julius Springer.)

"Motoren und Hülfsapparate für elektrisch-betriebene Hebezeuge." By F. Niethammer. (Berlin: Julius Springer. Price 2 marks.)

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ELECTRICAL DRAWBRIDGES IN AMERICA.

(BY OUR SPECIAL CORRESPONDENT.)

During my tour through Canada and the United States I had several opportunities of examining electrically-operated drawbridges of various kinds. There are three, if not four, distinct types of drawbridge in America. There is the somewhat rare vertical lift-bridge, in which the entire bridge structure, when opened, is hoisted bodily upwards between towers by means of ropes, counterweights and tackle; there are the various forms of bascule or tilting bridge, in which the bridge is tilted upwards in two parts from opposite piers; and there is the swing bridge, in one type of which the bridge swings about a central, or nearly central, island pier, and in other forms the pier is very near one end, and is on one bank of the river or channel spanned by the bridge. An example of the first class of drawbridge is to be seen at South Halsted Street, Chicago, the bridge in this case being lifted to a sufficient height to allow of masted vessels passing from Lake Michigan up the Chicago river. But as bridges of this class are rare —and, fortunately so, from an electrical point of view, for they absorb a tremendous amount of power to open them—I will pass on to describe one or two of the more common types.

Electrical drawbridges are more common in the United States than in any other country. This, however, is scarcely to be wondered at; for the trolley lines of the tramways carry motive power everywhere, and the only wonder is that all the bridges are not operated electrically. The alternative methods of operating drawbridges in America are: by steam or gas engines, by hydraulic rams or by hand-power. A steam plant is the most common of these; but in all directions one hears of steam, hydraulic and other forms of power being supplanted by the more convenient electric motor. In the majority of cases the bridges are opened only after long intervals, so that the expense of keeping a separate steam plant under steam tells heavily against this form of power. The same consideration, however, tells in favour of the electric motor; for, since this is required to operate for only a few seconds at a time with long intervals of rest, it is not necessary to construct it to have a high efficiency, but all the parts may be cheap and simple, and the electrical equipment as a whole may cost far less than for any ordinary motor plant of equal maximum power.

Several examples of electrically-operated bascule bridges may be found in Chicago. Two of these are shown in Fig. 1, the bridge in the foreground being a road bridge on Van Buren Street; the one in the distance being the four-track bridge on the mainline of the Metropolitan West Side Elevated Railroad. Both bridges are of the Scherzer rolling lift-bridge type, as also is an electrically-operated drawbridge on North Halsted Street in the same city. The four-track drawbridge of the Metropolitan West Side Elevated Railroad is in reality two independently-operated bridges, each carrying two tracks; this construction having been adopted with a view to prevent complete stoppage of traffic in the event of one set of operating gear breaking down. As a rule, however, the two parallel bridges are controlled simultaneously by interlocking the controllers of the two sets of motors. A view of the West Side Elevated Railroad bridges, when closed, is given in Fig. 2, while in Fig. 3 is shown two of the bascules on one side of the river, these being tilted nearly into a vertical position. In Fig. 3, by-the-way, is clearly shown the third-rail conductor construction of this railway, together with the switch and signal equipment. With the bascule bridge it is impossible for a car to over-run the track, as happened at Cleveland some time ago, for a barrier is effectively formed by the bridge itself.

The Chicago drawbridges, illustrated in the accompanying figures, are counterweighted in such a manner as to cause each half of the bridge to tilt of itself, and without the use of a motor, to an angle varying from 30deg. to 40deg. Further opening and the entire closing of the bridge are performed by the motors. Ordinary series-wound railway motors are generally used, and where two motors are required they are controlled by a series-parallel railway controller, operated by a man in a cabin beside the bridge, or in the case of swing bridges actually on it. The motors for the bridges, shown in Figs. 2 and 3, are capable of actuating from either side of the river, separately or from the two sides simultaneously. They are supplied with current at 600 volts from the third rail (see Fig. 3) of the tracks; and notwithstanding that this bridge is opened on an average about twenty times a day, the consumption of energy is so trifling that it is not metered, and no charge is made for it. The bridge usually requires 30 seconds for opening or closing; and the operation of closing it and completing the electrical and other connections at the centre takes about one minute from the time the bridge starts to close.

There are a number of electrically-operated swing drawbridges in America, the majority of which have the electric motors mounted on the central pier about which the bridge swings. A departure from this practice has recently been introduced by the Walker Company, of Cleveland, in a large drawbridge at Toronto. The bridge spans the Burlington Bay

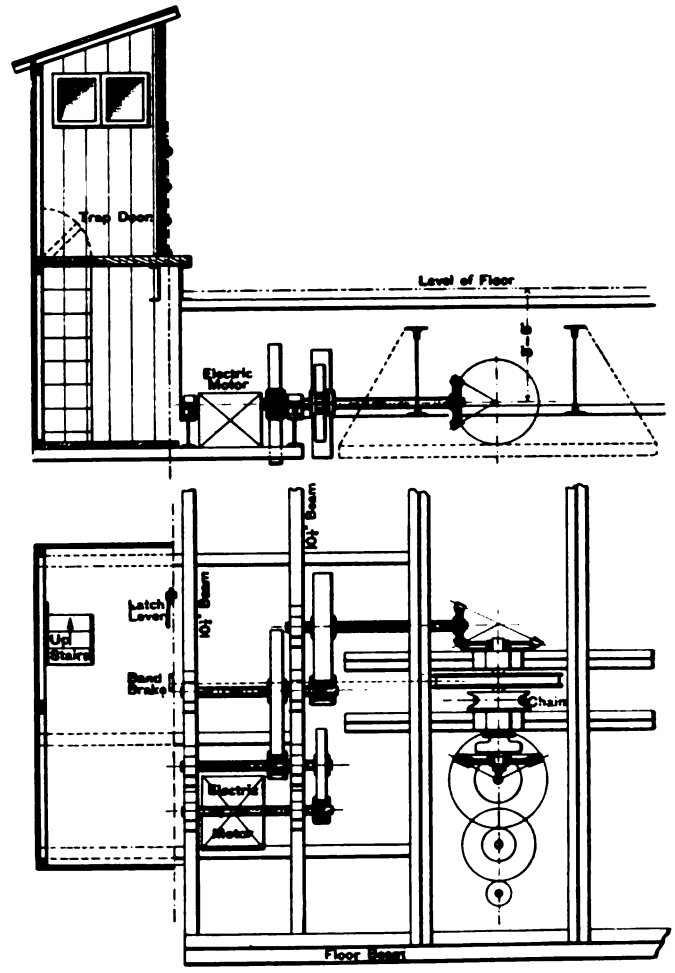

FIG. 5.—Plan and Elevation of Motor and Gearing for the Electrical Drawbridge at Toronto.

channel, and is carried on a pier which is 159ft. 9⅝in. from one extreme end, and 100ft. 1⅜in. from the other end. The peculiarity in the electrical driving of this bridge is that it operates at the end of the bridge, and not, as usual, at the pier. A general view of the bridge, which is of the through-girder type commonly adopted in America, is shown in Fig. 4. The electric motor is carried below the shorter cantilever of the bridge at its extreme end. Fig. 5 gives, in plan and elevation, the arrangement of the motor and its gearing. A 12½ H.P. Walker motor is connected by treble-reduction spur gears and a bevel-wheel gear to a winding drum having a V-shaped groove adapted to hauling a chain. The chain makes a single turn round the drum and is attached at both ends to fixed anchorings on the ground. The chain path is, roughly, the arc of a circle, over which the bridge moves; and guide pulleys serve to keep the chain in its proper position. It is scarcely

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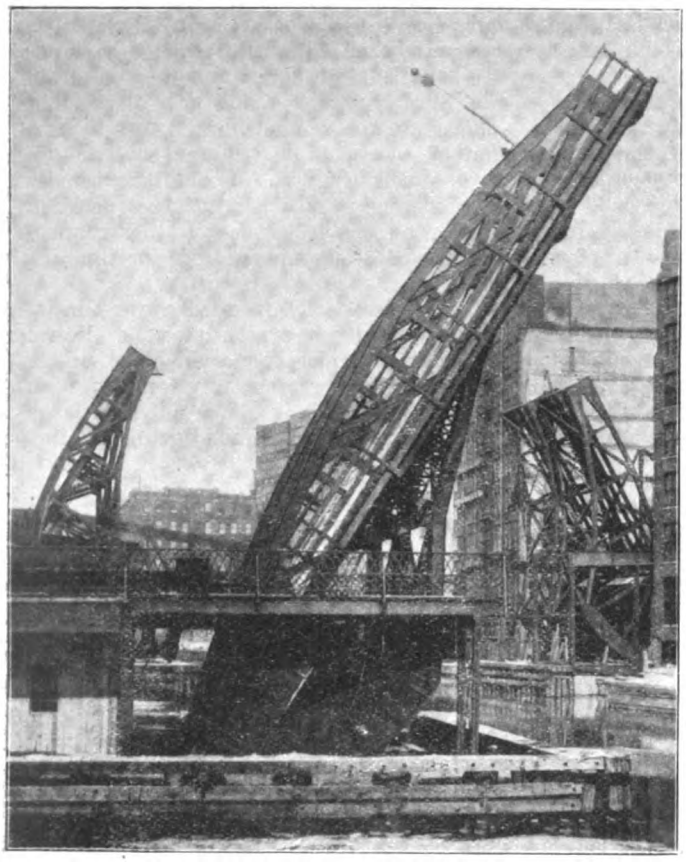

FIG. 1.—Rolling-lift Bascule Drawbridges, operated by electricity, at Chicago.

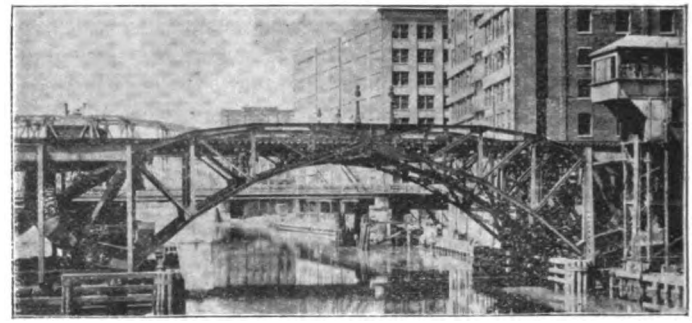

FIG. 2.—Electrically-operated Rolling-lift Bridges of the Metropolitan West Side Elevated Railroad at Chicago.

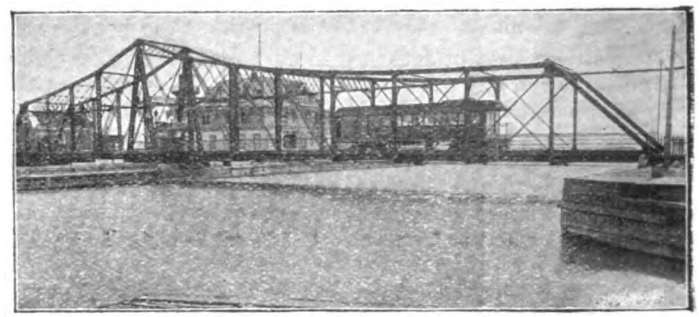

FIG. 4.—Electrically-operated Drawbridge at Toronto.

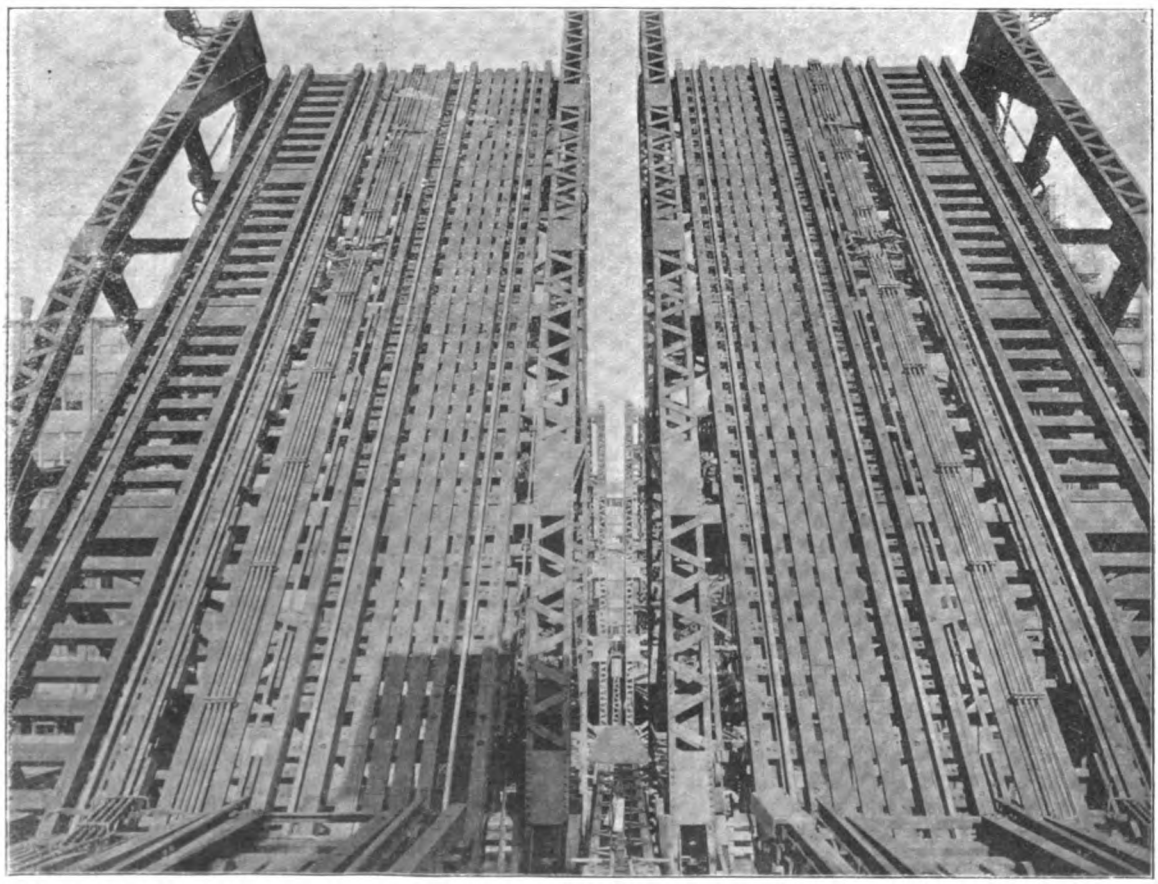

FIG. 3.—Twin Bascules of the electrically-operated Double Drawbridge on the Metropolitan West Side Elevated Railroad, at Chicago.

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necessary to add any further explanation of the action of the motor gear. When the bridge is to be opened the latch lever is first thrown up; current is then switched on to the motor from the trolley system which operates the tramway over the bridge, and the motion of the motor winds the chain over the drum and "slews" the bridge round. Reversal of the motor moves the bridge to close it.

I have to add that for the illustrations of the Chicago drawbridges accompanying this article I am indebted to the Scherzer Rolling Lift-Bridge Company of Chicago, by whom the bridges were erected.

CORRESPONDENCE.

THE ELECTRO-CHEMICAL COMPANY'S PLANT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the report of the proceedings at the annual general meeting of the shareholders of the Electro-Chemical Company (Limited), which appeared in your last issue, the Chairman of the Directors, Col. Holland, C.B., is said to have stated "that though the commencement of their business had been impeded owing to the inefficiency of the first machinery supplied, they now had excellent engines and dynamos and a good workable plant, giving the best possible results. The machinery of five installations, amounting to 3,500 E.H.P., were all fixed and in position on the premises, and arrangement had been made for a further 1,600 H.P."

As we built the whole of the dynamos that are now running so satisfactorily, and are building the additional machinery referred to, and as we had nothing whatever to do with the first electrical plant to which Col. Holland referred, we think it only fair to ourselves that we should make this explanation.—Yours, &c., P. R. JACKSON AND CO. (LIMITED).

J. Slater Lewis, General Manager.

Salford Rolling Mills, Manchester.

A DISCLAIMER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Our attention has been called, from several quarters, to the prospectus of the Chitty Dynamo and Motor Company (Limited), which, marked "for private circulation only," has, we know, been widely distributed. In it are printed, on pages 8 and 9, two tables of tests carried out by us upon a small Chitty dynamo, and on page 13 a diagram of certain curves of efficiency. The other diagrams at pages 10, 11 and 12 were not compiled by us.

The last paragraph of the prospectus, page 6, states that "copies of the reports and tests by Messrs. Willans and Robinson are appended." No copies of reports by us are appended.

The paragraphs on page 7 are headed "The Chitty Dynamo: Messrs. Willians and Robinson's Tests," and the first paragraph commences, "Following, are copies of the records of Messrs. Willans and Robinson's tests." It appears to us that these words coupled with the statement on page 6, that "Reports" by us are appended may be taken to mean that the statements on page 7 are in the nature of a report from us. We shall be greatly obliged if you will allow us to state publicly in your columns that we are responsible only for the facts set forth in the tables on pages 8 and 9 and in the diagram on page 13 of the prospectus.—Yours, &c.,

WILLANS AND ROBINSON (Limited).

(C. S. Essex, Secretary).

Victoria Works, Rugby, Dec. 8, 1897.

AN APPLICATION OF THE COHERER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The attention which you gave to the coherer in your issue of Nov. 12 leads me to trust that you will consider my little work with this instrument described in the *Journal* of the Russian Physical and Chemical Society, Jan., 1896. The contents of my article were communicated to a meeting of the Physical Section of our Society in April, 1895. I translate, with abbreviation, some extracts of it:—

"Repeating some of O. Lodge's experiments with the coherer, I constructed an apparatus very useful for the demonstration of the properties of the Hertzian electromagnetic waves and rays in a large lecture-room, also fit for registering atmospheric electric disturbances. . . . I found to be the best form of iron filings tube coherer, having sufficient and constant sensitiveness—that shown full size in Fig. 1—two platinum leaves, A B and C D, stuck inside the glass tube at the distance from 1mm. to 2mm. apart. On using a sensitive relay in the circuit with the coherer tube, and an ordinary electric bell in a collateral line for sound signal and as an automatic tapper for the coherer, I receive an apparatus which exactly answers every electric wave by a short ring and by rhythmical strokes, if electric vibrations be excited continuously. . . . (*see* Fig. 2).

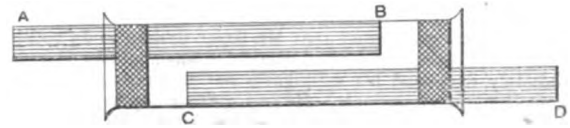

FIG. 1.

"On connecting in parallel with the bell an electromagnetic recorder, tracing a straight line along the paper-band, which is moved by a 12-hour time cylinder of Richard Brothers, I obtain an instrument registering by a cross line on the moving band every electric wave that reaches the coherer from across the atmosphere. . . . Such an apparatus was placed in a room at the Meteorological Observatory of the Forest Institution in St. Petersburg in July, 1895. One of the electrodes of the coherer was connected by an insulated wire with an ordinary lightning conductor, standing on a turret between anemometers, &c., the other electrode of the tube-coherer being connected with the ground. An ordinary lightning guard protected the apparatus during powerful discharges. . . .

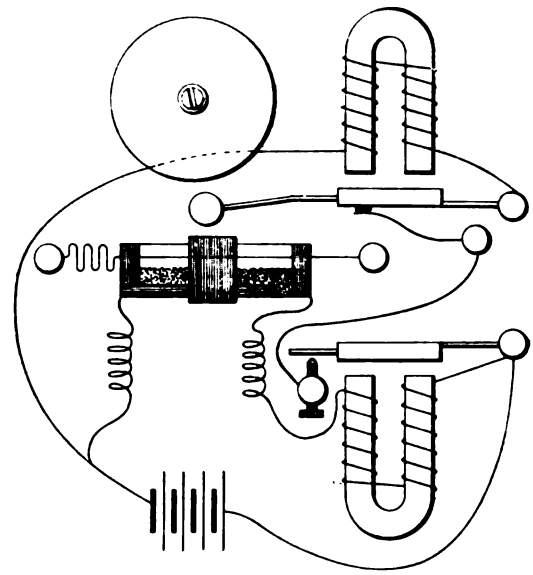

FIG. 2.

"In conclusion, I can express my hope that my apparatus will be applied for signalling on great distances by electric vibrations of high frequency, as soon as there will be invented a more powerful generator of such vibrations. From July, 1895, until now my apparatus has worked very well as a lightning recorder, which can be seen on the photograph (Fig. 3) of various records of thunder-storms made by this apparatus during the last summer. . . . By using in the coherer tube a steel bead instead of iron filings I

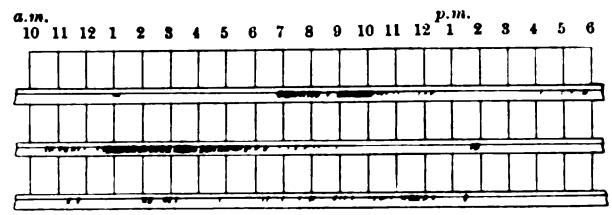

FIG. 3.

receive a good coherer, by which I can detect electromagnetic waves at the distance of 1 kilometre, if I work with Hertz's vibrator with 30cm. spheres and with the ordinary Siemens-Halske relay. With the Bjerknes's vibrator of 90cm. diameter, and a more sensitive relay, I reach 5 kilometres of good working without exhausting the tube and without any other resonance than by using the arrangement in my registering apparatus."

From the foregoing remarks may be inferred that the arrangement of Marconi's receiver is a reproduction of my lightning recorder.—Yours, &c., A. POPOFF.

Torpedo School, Cronstadt, Russia, Nov. 26, 1897.

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LEGAL INTELLIGENCE.

Dispute between Electrical Firms.

In the Chancery Division, Mr. Justice Romer heard this case, Warburg, Dymond and Co. *v.* Walter V. Scott and Co. (Limited). Plaintiffs asked for an injunction to restrain the defendants from representing by circulars that they are carrying on the business of Crompton and Co. (Limited), of Mansion House-buildings, so far as it related to wiring for electric lighting, on the ground that the plaintiffs had bought this particular branch of Messrs. Crompton's business, and that the defendant, Scott (who was in the employ of Crompton and Co.) had started business for himself, and he was representing that he was continuing to carry on this particular branch of Crompton's business, which the plaintiffs had purchased from Messrs. Crompton.

For the defence it was stated that Mr. Scott desired to do nothing the Court would think wrong, and when complaint was made by the plaintiffs he immediately expressed his willingness not to represent that he was carrying on Crompton's business. He was quite ready to meet the plaintiffs, and he was prepared to give an undertaking until the trial of the action not to further issue the circulars complained of. He, however, legitimately desired to make as much as he could of his connection with Crompton's, but he did not desire to do anything which would lead to the belief that he was carrying on their business.

Eventually, upon his lordship's suggestion, an order was agreed upon, under which the defendants undertook until the trial of the action not to further issue certain of the circulars complained of, or any circulars calculated to lead to the belief that the defendants were continuing to carry on the particular branch of Crompton's business now carried on by the plaintiffs.

Sheffield Corporation v. the Sheffield Electric Light and Power Company (Limited).

This case was heard before Mr. Justice North in the Chancery Division on the 3rd and 4th inst., a reserved judgment being delivered by his lordship on Tuesday. It was an action claiming specific performance of an agreement for the sale of the defendants' undertaking in Sheffield, and payment for which was to be made by the issue of Sheffield Corporation Stock, the interest or dividends on which was to purchase an annuity of 5 per cent. on the sum properly expended by the undertaking. The defendants refused to carry out the contract on the ground that the stock referred to in the local act was irredeemable stock, and that the Corporation had no power to issue the same. In answer the plaintiffs said that prior to June 27, 1892, the day on which the Electric Lighting Confirmation (No. 4) Act of 1892 received Royal assent, the Corporation had express power under the Sheffield Corporation Act, 1883, to issue irredeemable stock, and by the provisional order altering the Sheffield Corporation Act, 1883, which also received Royal assent on June 27, it was provided that so much of the Sheffield Corporation Act, 1883, or of any act or provisional order amending that act had conferred upon the Corporation the power to create the issue of irredeemable stock should be repealed. The plaintiffs contended that the stock referred to in the Sheffield Electric Lighting Order, 1892, was such redeemable stock as the Corporation had now express power to issue under the Sheffield Corporation Act, 1883. In the alternative they submitted that notwithstanding the provisional order altering the Sheffield Corporation Act, 1883, they had power under subsection 1 of Clause 60 of the Sheffield Electric Lighting Order, 1892, to issue redeemable stock for the purposes of this particular contract.

Mr. SWINFORD EADY, Q.C., said that his two short points were: first, that the stock meant redeemable stock, but if it meant irredeemable stock then the Corporation had power to issue it. He understood that his learned friend (Mr. Cripps, Q C., for tho defence) negatived both of those propositions.

Mr. CRIPPS said there was no doubt that was the point.

His LORDSHIP: Does it make much difference which it is?

Mr. EADY: On the figures it would make a very great difference. Suppose they had power to issue a redeemable three per cent. stock, then according to the terms of purchase they had to give them a five per cent. annuity, and to bring in £5 they would have to issue £166. 13s. 4d. of their three per cent. stock. Then when they came to redeem and pay off, because the rate of interest was constantly altering, and they might be able to borrow on better terms, they would only have te pay £166. 13s. 4d., otherwise they might have to pay about £200. The learned counsel said his submission was that when the order of 1892, confirmed by statute, said that the Corporation were to have power to purchase the undertaking of the undertakers, and that they were to pay for it in Sheffield Corporation Stock, which meant such an amount of Stock as the Corporation had power to issue, one could not impute to Parliament that they meant that that purchase could only be by the issue of an irredeemable stock which the Corporation were deprived of the power to issue. Such a construction as that would be an absurdity, and that was the construction suggested by the other side. It was obvious that it was intended that the Corporation should be empowered to purchase the undertaking of the defendants and to pay for it by stock which they could issue—that was Sheffield Corporation stock. Sheffield Corporation stock although redeemable did not cease to be Sheffield Corporation stock. His submission therefore was that the undertakers were bound to take Sheffield Corporation stock that they had power to issue. There was nothing whatever in the order to say that the stock must be irredeemable or that the annuity was to be a perpetual one.

His LORDSHIP: I suppose that the defendants want to avoid selling to the Corporation?

Mr. EADY replied that that was so.

His LORDSHIP: I suppose you would rather purchase the undertaking by the issue of irredeemable stock than not at all?

Mr. EADY replied in the affirmative.

Mr. CRIPPS, in arguing the case for the defendants, said that the point in dispute turned upon the proper construction of sub-section 1 in sub-section 60 of the Provisional Order of 1892, and his learned friend's argument clearly showed the true construction of the section, namely, that that purchase must be by the issue of irredeemable stock. The Act stated that the defendant Company should sell their undertaking to the Corporation upon the terms of the latter issuing or transferring to the undertakers such an amount of Sheffield Corporation Stock as would produce by the interest or dividends thereon an annuity of 5 per cent. per annum upon the sum properly expended by the undertakers upon the undertaking. Therefore what the defendants were to receive was an annuity—which meant a perpetual annuity of 5 per cent. He submitted that there was no ground for saying that his learned friend (Mr. Eady) was entitled to read the two Acts together in the manner that had been suggested.

His LORDSHIP, in giving judgment, said that he was of opinion that the Corporation Stock, according to the true construction of the Act, was to be issued to the defendant Company as irredeemable stock, and that the plaintiff Company was not now able to issue such stock. The action accordingly would be dismissed, but without prejudice to any action which the Corporation might be advised to bring to enforce such contract if they were able at a future time to issue irredeemable stock.

Donnison and Others v. Beresford.

This case came before Mr. Justice Mathew and a special jury in the Queen's Bench Division, on Tuesday last, and was an action brought by Frederick A. Donnison Berlyn and Co., electrical engineers, of Great Portland-street, London, against Lord Charles Beresford, to recover £140. 6s. 2d., balance of an account alleged to be due for fitting up defendant's house in Lower Berkeley-street, with an electric light installation. The defence was that in various respects the work was carelessly and negligently done; that certain charges were excessive; that certain other charges made were included in the specification and were not properly chargeable again. There was also a counterclaim by the defendant for the account of another electrical engineer who had been called in to make good the defects in the plaintiff's work. The plaintiffs in answer to this denied that there were any defects in their work.

Mr. H. REED, Q.C., for plaintiff, said the case, having regard to the defence set up, was of extreme importance to the plaintiffs. They had worked to a specification which had been submitted and approved, but during the progress of the work Lady Charles Beresford had suggested various alterations outside the specification, and these having been carried out brought the bill up to a great deal more than the original estimate, and the completion of the work was of course considerably delayed. All the time the work was going on there were builders and others at work in the house, including a person named Rocke who he (Mr. Reed) believed was an electrical engineer. Defendant, under the specification, had the right to buy her own fittings, and it was the duty of the plaintiffs to fix the fittings so bought. In some cases the fittings were actually set up by Mr. Rocke, who also, in some instances, altered the original work done by plaintiffs. The work was duly completed and arrangements made by the defendant with the local Electricity Supply Company to have a thorough test of the electrical installation and the current turned on. The result was highly satisfactory, and nothing more was heard of the matter until March 1st last. The plaintiffs' bill, in consequence of the various alterations they had made, came to £240, and two cheques of £50 each had been received on account. On March 1st Messrs. Ellis and Ellis, solicitors, wrote to the plaintiffs. Written reports had been obtained from two consulting electrical engineers, with the result that they (the solicitors) could come to no other conclusion than that the work was not in accordance with the contract; that it was, in the state in which it was left by plaintiffs highly dangerous; that it would cost a considerable sum to put the work in working condition; and that it would not, therefore, be advisable, or indeed safe, to allow plaintiffs to rectify or complete the work. Under these circumstances, they had advised that the work should be put into the hands of some competent person, and that Lord Charles Beresford should deduct from the amount claimed by plaintiffs the expenditure to which he would be put. The work, the letter proceeded to state, was being set right under the supervision of the two consulting engineers who had inspected and reported on the installation, and that if the plaintiffs desired to see its then condition, arrangements could be made for their doing so. This, the learned counsel stated, was the first intimation plaintiffs had had that there was the slightest complaint as to their work, and they were then told in effect that they would not be allowed to set it right, but that somebody else must do it, as they were not competent persons. On March 2nd plaintiffs wrote asking for leave to inspect the work, and on that day Mr. Donnison accompanied by an employé and an engineer of the Metropolitan Electric Supply Company went and made an inspection. They found that a great deal of the work done by plaintiffs had been altered since they had completed it with fittings which had been replaced and various alterations made. No complaint was then made of the plaintiffs' work, and no defect of any real importance was pointed out, nor anything which could give rise to danger. As the matter between the parties could not be arranged the present action was brought.

Mr. FREDERICK A. DONNISON stated that there were to be 110 lights put into the defendant's house, no light to carry more than 10 amperes unless otherwise desired. Mr. Rocke was present when the firm's workmen were engaged, and when witness went to inspect the work with his foreman and the engineer of the Metropolitan Company on March 2nd, Mr. Rocke and a Mr. Segundo were present on behalf of the defendant. They were taken into Lady Charles Beresford's bed-room where the

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lining had been stripped, and they were pointed out a nail which had inadvertently been left in the casing by one of the workmen. It did not interfere with the wires or affect the installation in any way and could not possibly cause any damage. Outside the bed-room he was shown a distribution board, or rather the place where the distribution board had been, and complaint was made that the wires had been bunched there, and that consequently there was danger. There certainly was some bunching, but there certainly was not any danger. The sectional circuit system was adopted, and there were some 20 circuits in the house, and where such a circuit was adopted bunching was inevitable; but neither the London County Council or the fire officers objected to the methods. Witness was also shown joints of which complaint was made that they had not been soldered. Originally all the joints had been soldered, but so many alterations were suggested by Lady Charles Beresford that it would have been impossible to have continued soldering the joints, as the wires would have to be cut at each subsequent alteration. It was in those circumstances that the dry joints were used, and there was no danger arising from them. No further complaint was made. When the final position of the brackets was decided upon they should have been soldered and not left dry-jointed. If witness had been left to complete the work the joints would have been soldered, but when they had finished it had not been decided where the joints were to be fixed. There was no danger in the joints being left dry, nor was it necessary that they should be soldered, as they were so well made. He admitted there was some bunching at certain points; but this was inevitable, and did not prevent the installation being both perfectly carried out and perfectly safe. He was aware that the Phœnix Fire Insurance Office required in their rules that in case of insurance policies effected with them all the joints in connection with electric light installations should be soldered. The brackets in this case were temporary.

Mr. H. E. BARKER, inspector for the Metropolitan Electric Supply Company, gave evidence as to examining the installation in question, and said that he gave a certificate that the character of the work was good. He had seen similar instances of bunching, and no danger could arise from it. There was no over-loading of the circuits at the time of his inspection. If the wire was porperly insulated there was no real danger from temporary dry joints. He was satisfied with the installation and passed it.

Mr. LOWRY, an electrical engineer and the managing foreman of the plaintiffs', said the men who did the work were experienced and competent workmen. He was not aware of any of the circuits crossing, and there was no bunching except where it was absolutely necessary under the system adopted by the plaintiffs. At the date the plaintiffs' workmen left the house there was no over-loading at any of the circuits. He insulated the dry joint before leaving the defendant's house. That was to say, he covered them up with india-rubber, and it would not be apparent on sight that they were dry joints.. The plaintiff firm fixed altogether 123 lamps in the defendant's house.

Mr. A. H. WALTON, acting engineer to the Metropolitan Electric Supply Company, said that early in December last year he went with Mr. Donnison to inspect the installation at defendant's house, the defendant's solicitors in a letter having stated that it was in a dangerous condition. He examined the installation carefully, and saw nothing whatever that was dangerous. At the suggestion of a Mr. Segundo, who was present, a piece of the flooring was taken up in one of the bedrooms in the third story, Mr. Segundo remarking that it would be a fair test of how the work had been carried out. This was done, and the joints were found to be everything that could be desired. Segundo then volunteered the information that he had taken up the floor in another bedroom and had there found work equally satisfactory. Bunching was no source of danger but an every-day occurrence. One or two dry joints were pointed out to him in the case of brackets which he understood were temporary and from which there could be no danger. He should not consider it good workmanship to leave dry joints and then insulate them so that it could not be discovered that they were dry joints.

Mr. ABRAHAM COLLINS, consulting electrical engineer, said that he had seen the plaintiffs' account and specification and the defendant's counterclaim. The system adopted by the plaintiffs for the installation was both safe and sound. It was usual to have the joints dry until the final position had been settled upon, so as to prevent damage by continual cutting of the wires and soldering. The position of a bracket, however, having been determined the joints should be soldered. There was no objection or danger in bunching, nor was there any danger in wires crossing each other. In some cases it was absolutely impossible to prevent there being cross-circuits.

Mr. LAWSON WALTON, for the defence, said Mr. Rocke had been engaged to fix certain fittings, and had other other work outside that for which the plaintiffs had contracted. The plaintiffs had left the place, and stated that they had absolutely completed their work, when Mr. Rocke discovered that one or two brackets were jointed by means of dry joints, which was a serious defect. The plaintiffs had never suggested to anybody that the joints were left dry, but had covered them up with india-rubber, so that it could not be seen they were dry jointed. From other observations he made Mr. Rocke came to the conclusion that the distributing board would not bear more lamps but was already overloaded, and on pulling away a bracket or two, he found there was no casing for the wires. Seeing this he formed the opinion that the work was of such a character that he ought not to touch it. He communicated with the private secretary of Lord Charles Beresford, and submitted the names of six engineers, any one of whom he suggested might be asked to examine and report upon the installation Mr. T. E. Gatehouse was selected, and this gentleman saw the dry joints, which he regarded as inexcusable. He had also shown to him indications of defective casing and one or two other matters. Upon this he advised that the whole installation should be overhauled, and in the meantime ordered the light to be cut off altogether. The plaintiffs were advised of this, and Mr. Donnison and Mr. Walton came to defendant's house. The specification provided that the wires should be cased in American wood, and separated from one another, but on taking down the plaster of the walls it was found that the wires were not cased, but ran down the walls and under the floor without any protection. A great deal of the wiring was in a dangerous position. There were a dozen or sixteen cases of dry joints, some of which could not in any sense be said to be temporary, but were clearly intended to be permanent. Besides the wires being uncased there was serious bunching. Other persons were there employed to do the work which ought to have been done by the plaintiffs. The defects in the plaintiffs' work were of such a nature that they would have prevented any insurance office passing the house.

Mr. T. E. GATEHOUSE said he was invited to inspect the installation. He was told some defects had been discovered in the work, and he found that the joints between the sub-mains and flexibles were simply twisted together and left unsoldered, which was dangerous. There was just a tape put over them but no braiding to protect them from any mechanical injury. When joints were left as these were the resistance became too great. By reason of there being no insulating collar provided, abrasion would take place between the sharp edge of the holes and the flexible wires. That was a danger from which many fires occurred through the ignition of the insulation of the flexibles. The edges could have been rounded off, but it was better to put in an insulating metal collar as a conductor. It would have made little difference in the expense whether the edges had been rounded off or an insulating coller put in. He also found under the boards the wires without any casing and all bunched together. The absence of casing was entirely against the rules of the fire offices. It was absolutely necessary that the wires should be apart. There was a real danger if that precaution was omitted; casing or tubing was absolutely necessary.

His LORDSHIP: Would that insure absolute safety?

The WITNESS: I would not say that. Positive and negative conductors should be kept well apart everywhere, except in the case of flexibles, where they could not help themselves. He formed the opinion with regard to the installation as a whole that the house might catch fire in any one of a number of different points, and recommended that the whole installation should be thoroughly overhauled by some competent contractor. The system adopted by the plaintiffs was right enough if it had been properly carried out. The testing adopted by the Metropolitan Supply Company was absolutely useless to enable one to ascertain whether the joints were soldered or unsoldered. It simply showed that the insulating covering of the wire was good enough, but did not show the condition of the wires themselves.

Lady CHARLES BERESFORD said Mr. Rocke was requested to do certain work which was quite apart from plaintiffs' contract, such as putting in extra lights, and so on.

Mr. SEGUNDO said that Mr. Rocke had stated that he was of opinion that additional lights could be put upon the board, and it was this which led to the whole investigation. He knew that the plaintiffs had only put up 110 lamps. He did not know that Mr. Rocke had fitted up a number which was largely in excess of this. Mr. Donnison had said, when particular things specified were shown to him, that they had not been done by his firm, but were the work of somebody else. Asked was the work which he now said had been done, of running back an additional cable from the main and so making two distinct circuits provided for in the specification, the witness said no.

Did you ever suggest that the plaintiffs should be called in to set right the defects you discovered?—I do not not think I made the suggestion. I cannot recollect, but I may have done so. I discussed the matter at length with Messrs. Ellis and Ellis, the defendant's solicitors, and suggested that Messrs. Donnison should be called in to see the work, and that nothing should be done before they had seen it. I said to Messrs. Ellis and Ellis that, judging by the character of the work I had seen, it had been so carelessly done that I did not consider they ought to insist on calling in the same people to put things right if they could not do better work than that.

His LORDSHIP asked the witness if at the time he knew the plaintiffs were the contractors, and the witness replied in the negative.

Do you tell the jury that you had no knowledge that the plaintiffs were the contractors?—Yes. The witness added that he believed he advised that they should not be called in to set right the defects in consequence of the manner in which the work had been done.

Mr. REED: Did you not see the plaintiffs' name on the distributing board?—I did not notice it there.

Continuing, WITNESS said he called Mr. Donnison's attention to all the defects which he had mentioned, and Mr. Donnison then said that he was not responsible and that evidently somebody else had been doing work there.

Mr. ROCKE said he was asked, just as the plaintiffs' work was completed, to put in certain brackets, and altogether he fixed six before Messrs. Gatehouse and Segundo were called in. Later he was asked to put in certain additional lamps, and he had not interfered with the plaintiffs' wiring in any way. He never touched the wires in any way until he commenced the work of putting the installation right. He did nothing whatever except what Mr. Segundo told him to do, with a view to putting the installation right.

After further evidence, the jury returned a verdict in favour of the plaintiffs, and it was arranged that the question of amount should be determined after consultation between the parties, the matter to be again mentioned to his lordship if an agreement was not arrived at.

The "D.P." Battery Company v. Scott Anderson.

This was an action in the Westminster (London) County Court on Wednesday, to recover a balance of account for work done and goods supplied to the order of defendant. Mr. Mallinson, for the Company, said his case rested on the correspondence, which he read, to the effect that the Company's works were at Charlton, and the work was done for defendant in Somerset. The Company estimated £385 for the supply and erection

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of electrical instruments, and defendant had paid £200 odd. A claim for £25 for part of the work, defendant said was agreed at £18, and that sum was now claimed. There was also £6. 10s. for carriage of empties, £3. 18s. for glass covers, not in the estimate; £1. 12s. for connectors, and £1. 11s. for seven broken acid carboys. Defendant said the order was dated June, 1896, and was for a complete battery of accumulators to be erected on wooden stands for £385, less 10 per cent., which he had paid, and the Company now wanted to be paid for extras. He admitted the item of £1. 12s. for connectors. Plaintiffs' counsel went through the tenders, and contended there was nothing in them agreeing to include the items of the claim in the lump sum of £385. Defendant said he objected to pay for the glass covers on the ground that it was not the custom to pay for them, as they were part of the estimate, and the carboys were broken in transit.

After criticising the various items of the claim, Judge Lumley Smith gave judgment for plaintiffs for £27, with costs.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES" Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. New and enlarged edition, 3s. 6d. net.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. *New Edition now ready.* These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins can be supplied. price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"SECONDARY BATTERIES."—By E. J. WADE. *In the Press.*

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced, and all the usual important articles, &c., which have made the book indispensable to the industry, will be brought up-to-date and amplified where necessary.

Electrical Laboratory Notes and Forms.—"The Electrician" Company have now ready the cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

Tenders Invited.—The Corporation of Barrow-in-Furness invite tenders for the supply and erection of (*a*) boilers, pumps, steam and wates pipes, tank, crane, economiser, and ironwork; (*b*) engines, generators, switchboards, instruments, accumulators, motor transformers, and sub-station equipments; (*c*) high- and low-tension feeder and distributor cables and house-connection boxes; (*d*) conduits and drawing-in boxes. Our advertisement columns contain some further particulars, and specifications, &c., can be obtained at the Town Hall, Barrow-in-Furness, or at the offices of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. Tenders must be sent in to the town clerk (Mr. C. F. Preston), Town Hall, Barrow-in-Furness, by noon on Wednesday next, Dec. 15.

——— The Hammersmith Vestry invite tenders for the supply of two 375 H.P. slow-speed vertical engines, and two 300 kilowatt fly-wheel alternators coupled direct. Copies of specifications, &c., can be obtained at the office of the Vestry Clerk (Mr. W. P. Cockburn), Town Hall, Hammersmith, W., and tenders must be delivered at the Town Hall by 5 p.m. on Wednesday, 22nd inst. Further particulars are given in our advertisement columns.

——— The Corporation of Bootle invite tenders for the supply and erection of (1) Lancashire boilers and Green's economisers; (2) engines, dynamos, switchboard, condensers, condensing and feed-water pumps, balancing transformers, boosters, piping, tanks, crane, meters, wiring of electricity supply works and alterations and additions to wiring at Town Hall; (3) secondary batteries and accessories; (4) feeder and distributing mains, potential leads, network and service boxes and service connections; and (5) running of the electricity supply works for a period not exceeding three years. Some further particulars appear in our advertisement columns, and specifications, &c., can be obtained at the office of the Town Clerk (Mr. J. H. Farmer), Town Hall, Bootle, while any further information can be obtained from the consulting engineer, Mr. Thos. Miller, M.Inst.E.E., 7, Tower-buildings. N., Water-street, Liverpool. Tenders, addressed to the Chairman of the Watch Committee, must be sent in by 12 (noon) of Monday, Jan. 10.

——— The Electric Lighting Committee of the Borough of Bedford require tenders for the supply and erection of a 420 B.H.P.

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double-acting compound enclosed engine, and a 250 unit alternator, with stationary armature. Further particulars are given in an advertisement elsewhere, and specifications, &c., may be obtained at the offices of the Town Clerk (Mr. T. S. Porter), to whom tenders should be sent, at the Town Hall, Bedford, by Monday, Jan. 10 next.

Tenders Invited.—From our advertisement columns it will be seen that the Dundee Gas Commissioners require tenders for a supply of service fuse boxes for their electric lighting department. Specifications and forms of tender may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Electric Lighting Station, Dudhope Crescent-road, and tenders must be lodged with the clerk of the Commissioners (Sir Thomas Thornton), City Chambers, Dundee, by Monday, the 20th inst.

——— The Electricity Supply Committee of the City of Gloucester invite tenders for the supply and erection of (*a*) Lancashire boilers and accessories, mechanical stokers, feed-pump, injector, economiser and electric motor; (*b*) steam dynamos and accessories; (*c*) overhead travelling crane; (*d*) switchboard and instruments; (*e*) accumulators; (*f*) insulated cables and trenching; (*g*) arc and incandescent lamps and lamp-posts; and (*h*) meters. Additional particulars are given in an advertisement elsewhere, and specifications, &c., may be obtained at the offices of the Consulting Engineer (Mr. Robert Hammond, M.I.E.E.), Ormond House, Great Trinity-lane, London, E.C., after the 17th inst. Tenders must be sent to the Town Clerk (Mr. Geo. Sheffield Blakeway), Guildhall, Gloucester, by Tuesday, Jan. 18 next.

——— The Worthing Town Council invite particulars from persons or firms willing to instal and maintain the electric light in the Borough for a number of years. Particulars from the Town Clerk.

———The Sanitary Committee of the Leicester Corporation invite designs and tenders for motor vehicles for house refuse collection. Proposals to Mr. E. George Mawbey, C.E., Town Hall, Leicester, by Jan. 31.

——— The Electric Lighting Committee of the Canterbury (Kent) Corporation invite tenders for the supply of: (*a*) boiler-house plant, (*b*) engine house plant, (*c*) overhead travelling crane, (*d*) switchboard and instruments, (*e*) accumulators, (*f*) mains, (*g*) public lamps, and (*h*) meters. Tenders to Mr. Henry Fielding, Town Clerk's office, Canterbury, by Dec. 20.

——— The Vestry of St. Pancras (London) invite tenders for the supply and erection of electric lamps, posts, and circuit complete; also fitting and distributing mains. Tenders to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, N.W., by noon, 28th inst.

——— The Corporation of Newport require tenders for a temporary electric lighting plant (to supply current to about 350 16-c.p. lamps) at Wentwood Waterworks. Tenders to the Town Clerk, Town Hall, Newport, Mon., by the 15th inst.

——— The Barking District Council invite tenders for the erection of electricity supply station buildings. Drawings, &c., can be had on application to the surveyor to the Council (Mr. C. J. Dawson, F.R.I.B.A.), Public Offices, Barking. Tenders to the Clerk (Mr. E. H. Lister), Public Offices, Barking, by 5 p.m. of the 21st inst. Further particulars will be found in our advertisement columns.

——— The Canterbury Corporation require tenders for the provision and erection of refuse-destructors to be worked in conjunction with the electricity works about to be established. Tenders to the Town Clerk by the 31st inst.

——— The General Direction of French Posts and Telegraphs invite tenders until the 23rd inst. for the supply of 90 kilometres of paper-insulated cables in five lots. Tenders to the Sous Secrétariat d'Etat des Postes et des Télégraphes, 103, Rue de Grenelle, Paris.

——— Tenders are being invited by the Municipal authorities of Laredo for the concession for the electric lighting of the town. Tenders to El Secretario del Ayuntamiento, Laredo (Santander), Spain, by the 22nd inst.

——— The Municipal authorities of Carabeña invite tenders for the concession for the electric lighting of the town for 15 years. Tenders to El Secretario del Ayuntamiento, Carabaña, Madrid, by 19th inst.

Tenders Accepted.—At the last meeting of the Derby Town Council the contract with Messrs. S. Z. de Ferranti (Limited) for the supply of an engine and dynamo for the electricity works at £7,132. 10s., was approved. Two superheaters have also been ordered from Messrs. Macphail and Simpson at £632.

——— At the last meeting of the Burnley Town Council the tender of the Callender Company was accepted for the supply and laying of cables for the Manchester road extension at £1,686s. 7s.

——— The Sheffield Corporation have accepted the inclusive tender of the British Thomson-Houston Company for the supply of the whole of the electrical equipment of the Nether Edge-Tinsley section of the tramways, at £41,185. 15s. The Corporation hav also let a contract to Mr. R. W. Blackwell for a further supply o copper bonds in connection with the proposed tramway extensions the amount of the tender accepted on Aug. 10 last being increased from £1,404. 8s. 4d. to £3,393. 10s. 2d. The tender of Messrs. Askham Bros. and Wilson, for the supply of the points and crossings for the Nether Edge-Tinsley section, at £2,355 7s., has also been accepted. This is the first section of the tramway to be electrically equipped.

Appointments.—Mr. H. Morton, at present assistant engineer at the Hampstead Vestry Electricity Works, has been appointed Clerk of Works to superintend the erection of the electric lighting plant, &c., at Llandudno, for the District Council.

——— The Eastbourne Town Council have decided to appoint Mr. G. W. Cooper electrical inspector under the terms of the Provisional Order of the Eastbourne Electric Light Company, the appointment of Mr. Wells having been revoked. Mr. Cooper has also been engaged to take control of the Corporation's telephones and fire alarms.

——— Mr. S. Paine, of Lancaster, has been appointed assistant electrical engineer at the electricity station of the Bury (Lancs.) Corporation at a commencing salary of £90.

Vacancy.—There is a berth vacant on Messrs. Drake and Gorham's staff for a draughtsman, as notified in our advertisement columns. The firm's present draughtsman proposes to start business for himself with offices in Victoria-street, which is well described "the home of the small contractor."

Business Notices.—Messrs. Heath, Snoxell and Co. (Limited), of Apollo Ironworks, Blews-street, Birmingham, inform us that they have purchased the electrical engineering business of Messrs. W. H. Heath and Co. of that town. An excellent catalogue of the firm's manufactures is available to the trade.

Liquidations.—There will be meetings of the creditors and contributories in the winding-up of New and Mayne (Limited), at the Westminster Palace Hotel, Victoria-street, London, S.W., on Wednesday next, the contributories' meeting taking place at 1 o'clock, and the creditors' meeting at 2:30, when a scheme will be submitted by Mr. Duncan F. Basden, the liquidator, for forming a new company under the style of "The Engine Patents Development Company (Limited)," or other suitable name, the object of the new Company being the acquisition and undertaking of all or any of the assets and liabilities of New and Mayne (Limited). It is proposed that the unsecured creditors shall receive debentures and debenture stock in the new Company in satisfaction of all claims against New and Mayne (Limited).

Bankruptcy.—Claims against George Thompson, electrical engineer (trading as G. Thompson and Co.), 115, Queen's-road, Brighton, must be in by the 22nd inst. Mr. H. W. Cox, O.R., 4, Pavilion-buildings, Brighton, is trustee.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 1 to Dec. 7, with the ports of destination:—

Argentina—Buenos Ayres, £80; La Plata, £143 (telegraph material); Rosario, £17. *Australasia*—Freemantle, £28; Hobart, £54; Launceston, £595; Lyttleton, £45; Melbourne, £65 (telegraph material); Sydney, £1,883; Wellington, £340 (including £320 telegraph material). *Brazil*—Rio Janeiro, £24; Rio Grande do Sul, £28 (telegraph material). *Canada*—Halifax, N.S., £4,500. *Ceylon*—Colombo, £60. *China*—Shanghai, £236 (including £140 telegraph cable). *Cuba*—Santiago, £15,500 (submarine cable). *Denmark*—Copenhagen, £22. *Egypt*—Alexandria £85 (telegraph apparatus); Port Said, £48. *Germany*—Hamburg, £10. *Gibraltar*, £2,523. *Holland*—Amsterdam, £126; Flushing, £23. *Hong Kong*, £40. *India*—Bombay, £141; Calcutta, £102; Madras, £50. *Italy*—Genoa, £68. *Japan*—Yokohama, £52 (telegraph material). *Mexico*—Santa Cruz, £10. *North Sea*, £1,661 (telegraph cable). *Portugal*—Beira, £295. *Siam*—Bangkok, £39. *Singapore*, £114. *South Africa*—Cape Town, £472; Chinde, £1,060; Delagoa Bay, £273; Durban, £1,128; East London, £12; Port Elizabeth, £32. *Sweden*—Gothenburg, £452; Stockholm, £991 (including £81 telegraph wire). *Uruguay*—Monte Video, £22. Total, £33,449, against £23,295 in the corresponding week last year (Dec. 2 to Dec. 8).

Enclosed Arc Lamps.—We are informed that the Bergmann Co., the General Electric Co., and the Manhattan Co. have all agreed to recognise the Marks patents in America as controlling the enclosed arc lamp business. The Marks English patents were bought some little time back by the Jandus Arc Lamp and Electric Co., who have granted licences to a number of manufacturers. The list, it is stated, will shortly be closed, and proceedings taken against all infringers.

Instrument and General Address Tablets.—The Endolithic Ivory Company, of 61½, Fore-street, E.C., send us samples of small endolithic ivory tablets, which are supplied in considerable quantities to many instrument and apparatus makers in this

country and abroad. The company's goods are well known, and have been before the electrical industry for many years.

A New Commutator Lubricant.—We have received from the Dynamo Brush Co. a sample of a new lubricant for commutator, called "Talcine."

Telephones and Telephone Fittings.—Messrs. Baxendale and Co., of Manchester, send us printed particulars of the "Standard" telephone and telephone fittings. Particulars of the "Beanco" telephone and telephone fittings are also included.

The Engineering Magazine.—The December issue of this magazine contains articles on "National Differences in Labour-Handling Methods," by Hiram S. Maxim; "Shipbuilding as a Productive Industry in Great Britain," by J. McKechnie; "The Importance of Supremacy in the Iron Trade," by J. Stephen Jeans; "The Protection of Shores against Encroachments of the Sea," by E. L. Corthell; "Status of the Water-Tube Boiler in the American Marine," by W. M. McFarland; "The Tall Building from an American Point of View," by A. D. F. Hamlin; "Modern Wharf Improvements and Harbour Facilities," by Foster Crowell; "Cost-keeping Methods in Machine Shop and Foundry," by H. Roland; "The Failure of Legislation to Enforce Railway Competition," by H. T. Newcomb; and "Standards of Practice in Electric-Elevator Installation," by P. R. Moses. The usual review of the World's Technical Press is also given. Copies may be had, price 1s., post free 1s. 3d., at *The Electrician* Office, Salisbury-court, Fleet-street, London.

Railway Diary and Officials' Directory.—We have received the 1898 issue of this useful diary and directory. All interested in railways and railway officials will find much useful information here compressed into a small space.

Agents in France for British Supply Firms.—The British Chamber of Commerce, Paris, issue as a supplement to their monthly circular for December a list of persons open to accept agencies and representations of English houses in France for a large variety of manufactures. The Chamber is desirous of bringing to the knowledge of British manufacturers and exporters the fact that such a list is in existence, and copies can be obtained from Mr. J. G. Colclough, secretary, 25, Boulevard des Italiens, Paris.

Bootle.—An inquiry is being held to-day (Friday) by the Local Government Board into the application of the Town Council to borrow £35,000 for the purpose of establishing electricity supply works.

Bournemouth.—The project for the construction of electric tramways in Bournemouth and district again came before the Town Council on Wednesday, but the previous decision to oppose the scheme was adhered to.

Buenos Ayres.—La Capital Tramways Company, which is the first company to introduce electric traction into Buenos Ayres, notify that their Flores extension (about 9¼ miles in length) and part of their old line, lately equipped on the overhead trolley system, were, with the power-house and equipment, last week officially inspected on behalf of the municipality, and were opened for traffic on the 5th inst.

Burslem.—The Town Council have decided to proceed with their application for a Provisional Order for Burslem. Originally it was intended to include the district of Wolstanton in the area of supply, but, owing to the omission to give the usual notice to the Wolstanton Rural Council, this portion must be dropped for the present year, as the Board of Trade refuse to dispense with the formality.

Buxton.—Prof. Kennedy has been instructed to prepare a report on the electric lighting question for the District Council, who obtained a Provisional Order in 1895. The Buxton District Light and Power Company are applying to Parliament for electric lighting powers, and the Council recently decided to comply with the provisions of their Order, and to establish a municipal supply.

Coatbridge.—Great progress is being made in this district in the employment of electricity as motive power for many of the large works situated in and near Coatbridge. Amongst the firms who have put down extensive electrical plants are the Waverley Ironworks, Coatts Ironworks, Lochrin Ironworks, and Dundyvan Ironworks—all in Coatbridge; Messrs. Hudsons' Boiler Works, the Union Tube Works and the Rochsillock Ironworks—all of Coatdyke; the Woodside Ironworks, Langloan; and 28 arcs and 200 incandescents have been installed at Messrs. Baird's Gartsherrie Ironworks.

Devonport.—The Town Council have decided, on the recommendation of the Tramways Committee, to oppose the application for powers to construct a network of tramways in Devonport, Plymouth, and Stoke.

Dublin.—Mr. C. P. Cotton held a Local Government Board inquiry, on Wednesday, into the Corporation's application to borrow £20,000 for renewing the electric light cables. Mr. Macinerney, Q.C., who appeared for the Corporation, sketched the history of the electricity undertaking, and said that everything went on very well until last year, when several breakdowns in the cables occurred, which were, he was instructed, due to the wearing out of the rubber insulation. In reply to a request for an additional loan, the Local Government Board said they could not sanction a fresh loan for the renewal or replacing of works executed under former loans which were still current, and that they could only grant a fresh loan for works that were altogether new. The total amount spent on the existing cables was £3,300; and these cables would be available to the extent of about £2,000. No portion of the loan now sought would be expended on anything but what was new, and taking into account the loans already granted which had not all been taken up, and also the proposed loan, there would still be borrowing power to the extent of £31,000. The city electrical engineer (Mr. Mark Ruddle), the Town Clerk, and the City Accountant gave evidence in support of the application. Mr. Ruddle stated that the proposed loan was for the execution of new works. The system, in order to keep up with modern requirements, and in order to be worked more economically, must be changed. It was the opinion of their consulting engineer (Prof. A. B. W. Kennedy) and himself that the change would be for the benefit of the citizens, and would cause a considerable saving in working expenses. To keep up the present supply and effect improvements they proposed, instead of putting in new cables, which would be used in the extended area which they contemplated supplying, to use them first to continue the supply to present consumers, and also to improve the system as a kind of duplicate for a time. For engineering reasons they were bound to keep up the supply and use the new cables. When they had the new cables there would be no necessity for continuing the old system, and they would re-lay it in a different way. The real loss on the old cables would be £1,300. They would effect a saving in the generating expenses of the old system of supply, and would put down low-tension distributing mains in addition to the existing mains, and so give a better supply to customers. They proposed to extend the supply as the demand grew. Any repairs to the old cables would be done out of revenue. After the proposed loan the Corporation would still have a borrowing margin of £31,712. The total of the electric lighting loans sanctioned was £64,000, of which £58,000 had been expended. The annual profit was put at £2,025, and of the loans £10,330 had been repaid, while in 1891 and 1892 a sum of £6,000 had been taken from the rates. Mr. Gordon, Q.C., who appeared for some ratepayers, declaimed any hostile attitude to the application. He was there simply to safeguard his clients' interests. The total borrowing power of the Corporation was about £1,400,000, and it now appeared that they were within £31,000 of the end of those powers, which was perilously near. When the Corporation found that they could not get this loan for renewals they adopted an entire change of front. No depreciation fund had been formed. The new loan was wanted practically to cover loss occasioned by depreciation. They proposed to lay down new and powerful cables, but they would not then have adequate means of generating electricity. Some further evidence concluded the inquiry.

At a special meeting of the Corporation, held on Wednesday, Mr. Jones, in moving the adoption of the accounts of the electric lighting department, said the statement did not disclose the discreditable state of things that some anticipated, and as a matter of fact the accounts were satisfactory. Only a sum of £242. 1s. 10d. had to be provided for, and that was after setting aside sufficient to meet sinking fund and interest upon the proposed new loan of £20,000. If the cables were not to be renewed this year they would be £1,700 to the good.

Dudley.—The Council have resolved to oppose the application of the Midland Electric Corporation for Power Distribution for a Provisional Order for this district. Negotiations have been re-opened with the British Electric Traction Company relative to the scheme for the construction of a network of electric tramways and light railways in Dudley and district. The Tramway and Electric Lighting Committee will submit fresh conditions upon which the Company's proposals will be entertained.

Dundee.—At the last meeting of the Town Council a recommendation from the Gas Committee to accept the tender of Messrs. Mackenzie Bros. for the supply of 30 arc lamp pillars, at £315, was referred back, on the motion of Mr. Brownlee, who urged that by the time the work was carried out the winter would be over, and then, owing to the probable introduction of electric traction on tramways, the Town Council would possibly resolve upon something that would necessitate the removal of the lamps. Mr. Ballingall, chairman of the Committee, urged that the pillars could be erected within four weeks, and that they could be strengthened to carry trolley brackets, and even if it should be deemed necessary to remove them at any future time, they could be taken down and erected again at a cost of 25s. each; moreover, the pillars would not be in the way of the electric trams.

Edinburgh.—Mr. William McEwan, M.P., has contributed £115,000 towards the cost of site and the erection of the noble Hall of the University of that city. In all, the sum spent in the McEwan Hall amounts to £368,000. The lighting is to be electrical, the installation being carried out by Messrs. King and Co., Leith, who conducted an elaborate series of experiments before determining upon the scheme which was ultimately adopted. The installation includes from the dome a great central sunlight or electrolier pendant of 20 incandescents of 200-c.p., and 100 150-c.p. and 90 100-c.p., or in all 6,400 c.p. This electrolier weighs 15 cwt., and is raised and lowered by a steel rope and a windlass placed between the ceiling and the outer roof. On the cornice round the top of the Hall there are distributed about 260 lamps, each of 16-c.p., and all concealed from view. These lamps are used to light up the decorations of the dome. In each of the galleries there are 39 lamps of 32 c.p., also concealed behind the pillars and gallery fronts, so that looking around the Hall from the arena one is sensible that it is brilliantly illuminated without having the eye distracted by separate points of light. The total equivalent of lights in the interior is upwards of 13,000 c.p., and there are placed throughout the building lights to the equivalent of a further 300 16-c.p., making a grand total of 1,120 16-c.p. lights. In addition there are six standard pillars at the entrance to the Hall containing four lamps of 25-c p. each, and also the large presentation lamp which Mr. McEwan gave to the town, and for which current is to be supplied by the Corporation.

Electricity in Mining.—According to the *British and South African Export Gazette* high-tension alternating-current electric lighting plant has just been supplied to the Monarch Mine, Rhodesia. An installation has also been erected at Luipaard's Vlei Mine through the local agent of Messrs. Easton, Anderson and Goolden. The equipment includes two 50-unit continuous current dynamos, electric haulers of 35 and 15 H P. respectively, and motors for driving cyanide plant, fitters', and carpenters' shops, &c.

The recently-issued report of the directors of the Sheba Gold Mining Company (Limited) states that owing to the increased price of coal steam power could not be employed. An electrical plant was therefore erected capable of generating sufficient power for 60 stamps, and a second electrical plant capable of generating power for an additional 60 stamps was subsequently put down. Under normal conditions, therefore, electrical power has been provided for working 120 stamps. The existing tram line, which has been from time to time repaired, has been the chief means of Sheba locomotion. The condition of the rolling stock, however, is most undesirable, and the board have decided to adopt the overhead system of traction in place of the present steam locomotives. Part of this electrical plant has already been shipped, and the balance will shortly be completed.

Folkestone.—The question of the construction of electric tramways in Folkestone and the neighbouring towns of Hythe and Sandgate was discussed at a meeting of the Town Council last week. Councillor Baker, who for some time past has taken a prominent part in the discussion of the electric lighting question, moved that the subject be referred to a Committee of the whole Town Council for consideration. Various members, including Alderman Spurgen (one of the largest ratepayers in the town), expressed themselves in favour of the scheme. The opposition to the proposal comes from the Lees district and from the Earl of Radnor (the ground landlord). Councillor Hall, adverting to a petition which had been presented in opposition, said that had he known that such a petition would have been presented he could have presented a counter petition from 11,000 of the principal residents in Folkestone. As the ratepayers in the Hythe and Sandgate districts warmly advocate the construction of the tramways, it may be predicted that the promoters are likely to succeed in getting their Order.

Glasgow.—The Electricity Sub-Committee have now submitted the short leet of six for the position of chief electrical engineer to the Corporation. These are Mr. S. W. Baynes (formerly engineer to the Bradford Corporation, and at present chief engineer of the St. Pancras Vestry's electricity department), Mr. W. A. Chamen (outdoor manager to Messrs. Crompton and Co.), Mr. Munro (of Messrs. Anderson and Munro, Glasgow), Mr. Sidney Sharp, Mr. Stewart (of Clydebank), and Mr. Arthur Wright (chief engineer of the Brighton Corporation's electricity department). The latter asks a salary of £1,200 a year, but the Committee are offering "not less than £800." The gentlemen have been interviewed by the Electricity Committee, and it is proposed to recommend the Council to empower a deputation of three to visit London to make further inquiries into the standing and ability of the candidates. We learn that the leet has now been further reduced to four.

Hammersmith (London).—Although the Vestry's electricity works have been in operation only a few weeks the consulting electrical engineer (Mr. A. H. Preece) has submitted particulars of an extension scheme estimated to cost £25,000. When the proposed extensions have been carried out Mr. Preece estimates that the Vestry will be in a position to meet all demands for current for the next fifteen months. The addition to the plant include three new engines and dynamos, which will increase the capacity of the station to the equivalent of 14,000 8-c.p. lamps.

Hampstead (London).—The Lighting Committee reported at the last meeting of the Vestry that Mr. Thomas Hesketh had resigned his position as assistant engineer at the electricity station, and that they had advertised for his successor.

Hanley.—On the recommendation of the General Purposes Committee the Town Council have decided to oppose the application of the British Electric Traction Company for an Order to construct a light railway between Hanley and Burslem on the ground that the line is not desirable.

"Hazell's Annual for 1898."—This handy volume, which has now firmly established itself in popular favour, grows apace, and now bulks out to about 700 closely-printed pages. Notwithstanding the increase in the bulk of the book, there are still many subjects dealt with by the editors which would improve by amplification. For instance, "Electricity '97" is dismissed in three short columns, and the majority of the subjects briefly mentioned have very little to do with the present year. There is room for improvement also on the score of originality of treatment. Several interesting and useful maps will be found in the new edition.

Hereford.—Mr. Thomas L. Miller has been appointed consulting electrical engineer to the City Council.

King's Norton.—The Rural District Council have authorised the City of Birmingham Tramways Company to employ electric traction on the portion of the Bristol-road route within the Council's district for another 12 months.

Lagos.—A staff of Telegraphists have gone out to Lagos to construct a telegraph line in the Hinterland, of about 350 miles in length. The "Bonny," with the telegraphists on board, took out a large quantity of telegraphic apparatus, material, &c. The expedition is in charge of Lieut. Turner, Royal Engineers.

Leith.—The Town Council have approved the plans for the proposed electricity station. A report has been presented by the Burgh electrical engineer (Mr. W. A. Bryson) on the question of street lighting and the length of distributing mains required throughout the scheduled area. It is proposed to erect in all 68 arcs.

Levenshulme.—The District Council, on Monday, formally approved the agreement for the transfer of the Council's Provisional Order to the Manchester Corporation. The Chairman said they had got, practically, all they wanted, and they had power to purchase the plant in 21 years. The charges for current would be the same as in Manchester.

Leeds.—At the meeting of the Parliamentary Committee on Wednesday the town clerk (Mr. Harrison) and the city accountant (Mr. Derry) presented reports on the legal and financial aspects of the proposed purchase of the undertaking of the Yorkshire House-to-House Electricity Company by the Corporation. The outcome of a lengthy discussion was a recommendation to the Council to authorise the Committee to apply for the necessary Provisional Order to take over the Company's works and undertaking.

London County Council.—At Tuesday's meeting the Council agreed to loan the Vestry of Islington a further sum of £14,250 for electric lighting purposes. It was reported by the Fire Brigades Committee that their attention had been directed to the expediency of lighting part, at least, of the chief brigade stations by electricity, and they recommended that an expenditure not exceeding £1,000 be made on this account. Agreed.

Mangotsfield (Bristol).—The Parish Council have received a proposal from the Bristol Tramways and Carriage Company for lighting Staple Hill electrically. The Company offer to provide 30 lamps, to bear one-third of the expense of installation, and to allow the whole 30 lamps to be arranged on their standards, the lighting authorities undertaking the subsequent service. The matter is being considered by the Lighting Committee.

Norwich.—The Norwich Electricity Supply Company notify that they are in a position to supply, fix and let on hire-purchase electric motors suitable for driving any class of machinery. The Company recently promulgated a free-wiring scheme, and are showing great enterprise in popularising the use of electricity for lighting and power purposes.

Perth.—Mr. W. C. C. Hawtayne has now presented his report on the proposal to establish municipal electricity supply works. The Corporation are advised to commence operations by erecting a station capable of supplying current for private lighting to 10,000 8-c.p. lamps, which, it is estimated, will be required within a comparatively short period. Provision is also made for the erection of 37 arcs of 2,000 c.p. each in the principal thoroughfares. The low-tension continuous-current system of supply is recommended. The total initial capital expenditure is estimated at £25,250, or with

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refuse-destructor, £27,950. The gross revenue is put at £4,800, and the annual net profit at £1,251. A special meeting of the Police Commission was held on Saturday for the purpose of considering the matter; but, after a lengthy and rather acrimonious discussion, the debate was adjourned.

Provisional Order Transfers.—Official notice is given that the Manchester Corporation are about to take transfers of the Levenshulme and Moss Side Electric Lighting Orders (1897). The agreements for the transfers provide for the purchase of the undertakings by the respective Councils on certain terms, but power is reserved to the Manchestsr Corporation in the event of such purchase to continue and maintain works (if any then existing in the districts), and also to supply current in the districts from works either within or without the districts.

Situations Vacant.—We regret to see, in the advertisement columns of last week's *Elektrotechnische Zeitschrift*, the following announcement (in English):—"Wanted, in England, a first-class draughtsman, to design large alternating-current dynamos. State terms and experience." Neither is this the first advertisement of the kind that has appeared in the German technical papers.

Smithfield Club Show.—This show has been held at the Agricultural Hall, London, N., during the week, and is noticeable for an excellent display of engines for various purposes (mainly agricultural), and of agricultural machinery generally. The principal exhibitors were Messrs. Clayton and Shuttleworth, Crossley Bros. (Limited) John Fowler and Co. (Leeds); Mr. E. S. Hindley; Ransomes, Sims and Jefferies; Robey and Co.; and W. H. Willcox and Co. Messrs. Clayton and Shuttleworth have a very attractive and varied collection of their well-known types of engines, of which, by the way, we are informed 31,000 have been turned out at their works. At this stand traction engines form a conspicuous item of the exhibit, and a fine example of high-speed vertical oil engine, which is claimed to combine all the features of the horizontal type of patent safety oil engine manufactured by the firm. Messrs. Crossley Bros. (Limited) show a number of portable and stationary oil engines of small and medium powers. Messrs. John Fowler and Co., Leeds (Limited) have, as usual, a fine show, especially in the traction engine and road locomotive class. Mr. E. S. Hindley shows horizontal, portable and vertical engines of the class with which his name is so closely identified. Hundreds of these engines are in use by agriculturists and the farming classes in all parts of the world. Messrs. Ransomes, Sims and Jefferies are also well represented in the road locomotive, traction, portable, and vertical engine class, and the fine exhibit of this firm attracted general attention. Messrs. Robey and Co. had on show horizontal, compound, vertical and portable engines, and an excellent example of the Robey fixed oil engine. At Stand 193 in the Arcade Gallery Messrs. W. H. Willcox and Co. (Limited), have a fine exhibit of engineers' stores and other goods, the display being of interest to all users of steam power. A good exhibit of high quality belting is here shown. There is, as usual, an entire absence of anything electrical in any of the exhibits, although thousands of visitors who never come to London on any other occasion here foregather, and would, we think, take an interest in, at any rate, the domestic varieties of electrical apparatus.

The Strike.—We give elsewhere official particulars of the position of affairs with regard to the strike in the engineering trades. The break up of the Conference naturally caused considerable excitement in engineering trade circles and especially came as a surprise to the men themselves—we mean those not directly in touch with the leaders on the men's side; by these no surprise was expressed. The position taken up by the men's representatives at the Conference was the natural outcome of the opposition to the concession which it was considered these representatives had made to the demands of the masters in accepting, even temporarily, the terms embodied in the first clause of the masters' proposals. Meanwhile both employers and men appear to support the action of their representatives. Large sums of money have come to hand from various quarters to swell the men's out-of-work funds, and it is stated that the London Trades' Council have issued invitations for a conference of trade unionists in London to consider the dispute generally. It has been suggested that a levy of 3d. per week should be made upon all trades unionists in the United Kingdom, which it is calculated would bring in between £18,000 and £19,000 per week. A ballot is to be taken of all branches of the trades unions affected by the dispute as to the acceptance or rejection of the proposals submitted by the employers to the Conference. These papers are now in the hands of various branches of the Amalgamated Society of Engineers, and the result of the ballot is expected to be known early next week. It is stated that the employers are experiencing but little difficulty in filling up many of the places formerly occupied by the strikers, and that the results obtained from machines worked by the new hands show a greatly increased output against that produced from the same machines when worked by union labour, and this notwithstanding that many of the men now employed come to the work without previous experience.

The "Official Vocabulary."—In the *London Gazette*, of Feb. 23, it was announced that all legitimate words in existing codes would be inserted in the new edition of the "Official Vocabulary" for code telegrams if forwarded to the International Telegraph Bureau, Berne, Switzerland, before March 31. In the *Gazette* of April 13 and July 16 the date was extended to June 30 and Sept. 30, respectively, and the date is now further extended to Dec. 31.

Reading.—We are informed that the Directors of the Reading Electric Supply Company have adopted the recommendation of their managing engineer, Mr. Arthur T. Cooper, and will instal direct-current plant for all future extentions at their generating works, and will lay down, in the near future, a system of 400-volt 3-wire distribution in the central districts. The elementary 100-volt low-tension network now fed by a high-tension alternating system will be sectioned up and gradually transferred to the new distributors, while the alternating plant will be utilised for feeding the outlying residential districts, which have hardly been touched as yet. Mr. Cooper's reasons for marking this change are, firstly, the fact that the centre of Reading can be fed far more economically by a low-tension direct system than a high-tension alternating; secondly, the great superiority of direct over alternating supply from the consumers' point of view. It is proposed to cater for motors, with a very low tariff, and it is hoped that a good demand will be obtained in this direction.

St. George and Hanham Light Railway.—The Light Railway Commissioners have notified that they propose to grant the Order asked for by the Bristol Tramways and Carriage Company for the construction of this line, subject to a purchase clause being inserted.

Sheffield.—As will be seen the City Council on Wednesday accepted tenders for the electrical equipment of the Nether Edge and Tinsley sections of the tramways, and the work of equipping these lines is to be pushed forward with all expedition. The Walkley, Pitsmoor and Ecclesall-roads extensions are also to be carried out forthwith, and tenders are to be invited from the British Thomson-Houston Company, Siemens Bros. and Co., the Electric Construction Company, Dick, Kerr and Co., and Davy Bros., for executing the work to the specification to be prepared by the city surveyor and the resident electrical engineer. The decision in the action brought by the Corporation against the Sheffield Electric Light and Power Company (reported fully elsewhere) is to be considered by the Parliamentary Committee, who are to present a report on the matter.

Shoreditch (London).—A report from Mr. C. Newton Russell (the chief engineer of the electricity department) on the proposal to extend the mains in several additional streets in the district was considered at Tuesday's meeting of the Vestry. Mr. Russell recommends that the East-road and New North-road and the Kingsland-road be lighted from two circuits of 21 arc lamps each. A similar scheme was also recommended for the lighting of Hoxton-street, Hyde-road and Hackney-road. In the case of the first three thoroughfares conduits are already laid on one side of the carriageway. The cost of the extension is estimated at £6,930, and when completed the chief thoroughfares of the parish will be lighted electrically. The applications for current to date represent an equivalent of 18,900 8-c.p. lamps. Owing to this increasing demand the Vestry have had to once more refuse a supply to their neighbours the Bethnal Green Vestry.

Smyrna.—According to a Constantinople correspondent, a syndicate of financiers have applied to the Ottoman Government for a concession for the erection of electricity supply works at Smyrna. The syndicate offer to pay to the municipal authorities 10 per cent. of the income, and to light all public buildings free of cost; to increase the number of street lamps; and to reduce the cost of public lighting to half the present expenditure with gas. The lighting of this important Eastern city has for many years been very bad.

Steamship Lighting.—The new steamer "Cambria," which has been built for the London and North Western Railway Company, and will ply between Holyhead and Dublin, has been fitted for the electric light by the Company under the direction of Mr. F. W. Webb, the Company's mechanical engineer. Electric fans have also been installed. The second-class cruiser "Vindictive" which was launched yesterday (Thursday) afternoon, is also lighted throughout by electricity.

St. Helens.—Dr. Hopkinson has been appointed to prepare a report on the most suitable form of traction for the local tramways.

Staff Dinner.—On Saturday, the 27th ult., the annual staff dinner of the "North-West Provinces" of the National Telephone Company was held at Manchester, under the presidency of Mr. R. H. Claxton, provincial superintendent.

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Stockport.—The Board of Trade have sanctioned the Council's proposed electric lighting scheme. The Local Government Board will shortly hold an inquiry into the application to borrow the necessary money.

Swansea.—The General Purposes Committee are considering a proposal to supply electric current for lighting the new market. The Swansea United Breweries, through the Mayor (Mr. J. A. Thomas), have offered to supply current at 2d. per unit on an agreement for one, two, or three years. From estimates which the Committee have obtained the cost of wiring the market and supplying and erecting 24 arcs of 2,000 c.p. each would be £576. It is probable that the offer will be accepted, and a sub-committee has been appointed to go into details.

The Telephone in Manchester.—The promoters of the scheme for establishing a new telephone service for Manchester and district met on Wednesday, and were presided over by Mr. E. Horkheimer. Promises of support have now (it is said) reached the sum of £60,000. At one time, if we remember rightly, this figure was given as the minimum amount with which the Company could proceed to business, but now it is said that it is not possible to float the company until a much larger amount of financial support is forthcoming. Promises (it was further stated) had been received from syndicates and companies prepared to find all the money needed, but it was felt "that it was not advisable to allow a few persons to have the controlling voice in the company." Mr. W. Thomson, whose remarks we are quoting, said that if they got a licence from the Post Office for a telephone company in Manchester, that company would be a permanent one. They had intended to float a company this month, but were advised to defer this proceeding until the end of January or the beginning of February next year. Mr. Thomson was careful to combat the notion which is held outside Manchester, as well as inside, that it is not well to have two telephone companies in one town, and referred to Stockholm as an example that three companies can work amicably. The most important point, however, was "to have an instrument that would work without losing time, and this would far transcend the monetary gain which would flow from the new telephonic system." Notwithstanding Mr. Thomson's sanguine anticipations there seemed, we thought, a lack of enthusiasm at Wednesday's meeting, and we should not be surprised if, after all, the formation of the New Mutual Telephone Company for Manchester were deferred to a period beyond January or February next.

The Telephone in Norwich.—A number of representative citizens of Norwich are agitating for the Town Council to take up the establishment of a municipal telephone undertaking, in order that Norwich may enjoy the inestimable advantages of a cheap and efficient local telephone service. Ald. G. Green is the spokesman of the telephone reformers in this part of the country. The meeting at which these proposals were made was addressed by Mr. Nicholson, Chairman of the Telephone Subscribers' Committee at Tunbridge Wells, and a committee was appointed to take whatever steps are necessary to give effect to the proposed scheme.

Torquay.—At Tuesday's meeting of the Town Council the consulting electrical engineer (Mr. W. H. Trentham) submitted a report on the progress of the electricity works. He anticipated being able to supply current by Jan. 15.

Weston-super-Mare.—Certain members of the District Council seem determined to do their utmost to resist the proposal to establish electricity supply works in the district. The Council have already passed resolutions on two or three occasions in favour of establishing municipal supply, and the consulting engineer (Mr. W. C. C. Hawtayne) was instructed to proceed with the preparation of plans and specifications. The matter cropped up again at Tuesday's meeting of the Council, and after acrimonious discussion the question was adjourned until the next sitting.

Whitechapel (London).—At Monday's meeting of the District Board of Works it was decided to purchase land adjoining the destructor works at an estimated cost of £5,000 as a site for an electricity supply station. The Board obtained a Provisional Order five years ago.

Withington.—A sub-committee of the District Council has been appointed to ascertain from the Electric Lighting Committee of the Manchester Corporation the terms and conditions upon which they would be willing to supply electric current in Withington.

Worcester.—We are pleased to note that the City Council have reconsidered their recent decision not to increase the salary of the city electrical engineer (Mr. E. T. Ruthven Murray). The matter again came up for discussion at the last meeting of the Council, and, on the recommendation of the Electric Light Committee, it was decided to increase Mr. Murray's salary from £250 to £350 per annum.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents; of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

November 9, 1897.

25,970. W. N. STEWART. Leeds. Improvements in the method, and in or in connection with the means of operating electric railways.

25,998. W. FAIRWEATHER. Glasgow. Improvements in automatic circuit-breakers. (The Crocker-Wheeler Electric Company, United States.)*

25,993. M. P. GATTE. Brussels. Improvements in electric arc lamps.

26,023. C. A. Allison. London. Electrical instrument. (W. C. Banks, United States.)*

26,026. R. G. EVERED. London. Improvements in the covers or domes of the switches of electrical glow lamps, which improvements are also applicable to other electrical switches.

26,040. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) and H. M. HOBART. London. Improvements in the construction of electrical transformers for use in three-wire systems.*

26,057. M. M. BAIR. London. Improvements in or connected with porous cells or receptacles for galvanic batteries.

26,067. F. E. ELMORE. London. Improvements in electrolytical apparatus. (Partly communicated by J. O. S. Elmore, India.)

26,089. D. G. FITZ-GERALD. London. Improvements in terminal and connection screws and contact pieces for electrical purposes.

26,097. R. J. CROWLEY, C. E. MONKHOUSE and A. SMITH. London. Improvements in or relating to galvanic batteries.

26,102. A. KRÜGER. London. An improved process for the production of pliable and elastic bodies by electrolysis.

November 10, 1897.

26,118. E. L. BENJAMIN. London. A conduit and aërial electro-locomotor primarily for laying or drawing-in electric mains or other cables for any service.

26,187. A. F. WOODLEY. London. Improvements in and in the manufacture of filaments for incandescent electric lamps.

26,199. H. H. LAKE. London. Improvements in electric igniting devices for gas burners. (C. P. J. Clement and Hans von Krohn, Belgium.)

November 11, 1897.

26,226. T. P. O. YALE. Stockton-on-Tees. Improvements in the mode of and means for clearing steel wire to receive an electroplated coating.

26,244. T. INGHAM and H. DAVIS. Derby. Improvements in the lighting of miners' safety lamps and the like by electricity.

26,296. A. CAMPBELL. London. Improvements in holders for incandescent electric lamps.

26,306. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) and H. M. HOBART. London. Improvements in switching gear for transformers, reactance coils, storage batteries and the like.*

26,332. H. E. MENIER. London. Improvements in and relating to the jointing of electrical cables. (Date applied for under Patents, &c., Act, 1883, Section 103, May 11, 1897, being date of application in France.)

26,333. J. A. L. DEARLOVE. London. Improvements in and relating to the transmission of telegraphic messages.

26,343. H. S. MAXIM. London. Improved methods of and apparatus for manufacturing filaments of electric lamps.

November 12, 1896.

26,367. H. COONEY. Liverpool. Improvements connected with electrical illumination.

26,373. F. J. TAYLOR. Belfast. A pneumatic brush for dynamos, motors, or any machine for the production or use of electric current by rotary armatures.

26,399. G. K. B. ELPHINSTONE and A. C. HEAP. London. Improvements in electrical measuring instruments.

26,411. G. HENSHAW. London. Improvements in or relating to trolley standards and poles for electric cars.

26,412. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) and H. M. HOBART. London. Improvements in electrical transformers.*

26,448. G. SUTTON. London. An improvement in electric cables.

26,441. C. A. BENNERS. London. Improvements in the preparation of accumulator plates.*

26,455. A. U. ALCOCK. London. Method of and means, or apparatus for, detecting and indicating variations in the condition of circuits traversed by alternating currents, applicable also for the measurement of the inductance, resistance, or capacity of electric apparatus for the transmission of orders, and for other purposes.

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November 13, 1897.

26,468. C. HARRYMAN. Sheffield. An improved memorandum desk for use with telephones, and for other purposes.

26,496. H. DAVIS and L. W. DE GRAVE. Derby. Improvements in water-tight electric fittings.

26,514. A. E. GRENVILLE. London. Improvements in and relating to grids and supports forming part of accumulator plates.*

26,530. J. A. DARGUE, E. GRIFFITHS, and C. H. WRIGHT. Liverpool. Improvements in apparatus for heating buildings and the like by means of hot fluids or electricity.

26,543. F. E. ELMORE. London. Improvements in apparatus for the generation and electrolytic application of electric currents. (Partly by J. O. S. Elmore, India.)

26,640. F. HUGHES. London. Improvements in electrical resistance apparatus.*

26,646. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) and F. HOLDEN. London. Improvements in watt-meters and in means for damping in same and in other apparatus.

26,647. C. O. BASTION and F. M. STAUNTON. London. Improvements in or relating to alternating electric current meters.

26,656. P. F. RIBBE. London. Improvements in and relating to electric accumulator plates.*

26,657. R. W. L. HOLSTEN and THE ELEKTRISCHE BOGENLAMPENFABRIK MAECK and HOLSTEN GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG. Liverpool. An improved device for guiding the carbons in electric arc lamps.*

26,659. R. W. L. HOLSTEN and THE ELEKTRISCHE BOGENLAMPENFABRIK MAECK and HOLSTEN GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG. Liverpool. An improved automatic cut-out or short-circuiting device for electric arc lamps.*

26,660. R. W. L. HOLSTEN and THE ELEKTRISCHE BOGENLAMPENFABRIK MAECK and HOLSTEN GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG. Liverpool. An improved electric arc lamp.*

26,671. A. J. BOUET. London. Improvements in or relating to electrical indicating apparatus for use in hotels, restaurants, workshops and for analogous purposes. (H. Moutardier and L. Boudet, France.)

26,672. P. LESCHINSKY. London. Improvements in or relating to electrically-controlled operating devices for railways.

26,680. A. TRIBELHORN. London. Improvements in electric accumulators or storage batteries.

26,682. W. A. WEBB. London. Improvements in electro-medical and exercising apparatus. (Date applied for under Patents, &c., Act, 1882, Sec. 103, 2nd June, 1897, being date of application in United States.)*

November 16, 1897.

26,694. H. A. FENN and H. T. P. SIMPSON. London. A hot air engine, driven by electrically heated air.

26,709. A. D. MANLOVE. Chesterfield. Improvements in portable electric guns.

26,727. O. J. MENZIES and J. A. BELL. Birmingham. Improvements in electric brakes for cars.*

26,729. W. L. WISE. London. Improvements in alternating current electric motors. (A. J. Churchward, United States.)*

26,732. L. ANDREWS. London. Improvements in or relating to systems of electrical distribution.

26,733. L. ANDREWS. London. Improvements in magnetic cut-out apparatus.

26,734. W. HUGHES. London. The application of one handle in relation to electrical switches.

26,750. W. H. DUNKLEY. Birmingham. Improvements in phonographs.

26,752. E. T. GREENFIELD. London. Improvements in flexible conduits for electrical conductors.

26,762. F. W. FEW. London. An improvement in the bulbs of electric incandescent lamps.

26,781. G. A. PHILLIPS. Birmingham. Certain improvements in electric light switches.

26,803. G. W. SMILEY. London. Improvements in the bulbs or envelopes of electric glow lamps. (F. W. Dunlap, Germany.)

November 17, 1897.

26,827. A. L. DAVIS. London. Improvements in electric arc lamps of the enclosed type.

26,880. G. W. B. CREES, W. L. DURBAN, and J. GORE. London. Improvements in and relating to electrical furnaces specially applicable for the production of calcium carbide.

26,881. G. W. B. CREES, W. L. DURBAN and J. GORE. London. Improvements in and relating to electrical furnaces specially applicable for the production of calcium carbide.

26,918. J. HOPKINSON. London. Improvements in or connected with electrically-driven vehicles.

26,919. O. C. STRECKER and H. H. STRECKER. London. Improvements in or relating to the application of electrode- in electrolytic processes.*

26,921. O. C. STRECKER AND H. H. STRECKER. London. Improved process for preparing insoluble or hardly soluble salts from metallic anodes by electrolysis of aqueous solutions containing two salts.*

26,923. O. C. STRECKER AND H. H. STRECKER. London. Improvements in or relating to the production of protoxides and oxides or of hydro-protoxides and hydroxides from metallic anodes by electrolysis of alkaline salt solutions.*

26,935. A. J. BOULET. London. Improvements in or relating to apparatus for indicating and registering variations of insulation resistance in electric networks and circuits generally. (M. Travailleur, Belgium.)*

November 18, 1897.

26,986. E. DUCRELET. Brussels. Electric trembling interruptor.

27021. C. P. ELIESON and W. S. NAYLOR. London. Improvements in brushes for dynamos and electro-motors.

27022. C. P. ELIESON and W. S. NAYLOR. London. Improvements in accumulator boxes.

November 19, 1897.

27120. T. P. MARTIN. Liverpool. Improvements in or connected with apparatus for electrically illuminating and displaying letters, numerals, devices, and the like for advertising and decorative purposes.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

22,990. ANDREWS. Appliances for the inter-communication of telephones

23,334. CRAIG. Displaying prices and the like in shop windows and other places by electric illumination.

24,776. RAWLINGS and RAWLINGS. Switches for electric currents.

25,541. MAY. Anti-vibration device for gas, electric and other lighting.

28,061. HOLSTEN. Electric current or pressure-regulating device.

28,070. HAWKINS. Electric cables particularly suitable for telephone circuits.

28,158. SIEMENS BROS. and Co. (LIMITED) and NEBEL. Ammeters.

28,347. THEERMAN. Ceiling roses for electrical purposes.

28,511. LUCAS. Manufacture of electric accumulators or secondary batteries.

29,115. KING. Electric storage or secondary batteries.

1897.

1,887. THE BRITISH INCANDESCENT ELECTRIC LAMP COMPANY (LIMITED) and MOUL. Incandescent electric lamps.

6,695. LAKE (Arno and Caramagna). Electric tramways and railways on the sectional conductor systems.

10,439. LEE. Secondary batteries.

14,033. GARTLAND. Electric regulators.

17,099. PIEPER and PIEPER. Rheostats.

20,444. JUNGE (Kraft, Huber and Exner). Telephones.

21,055. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED (Hewlett). Electric cars and surface-contact railways

NEW COMPANIES, STATUTORY RETURNS, &c

CARDIFF AND PENARTH LIGHT RAILWAYS COMPANY (LIMITED).—This Company was registered on Nov. 30, with a capital of £25,000, in £1 shares, to apply for an Order under the Light Railways Act (1896) for power to construct and work a light railway from Penarth to Cardiff, to work the same with electrical or other mechanical power, and to supply electric light and power. The first subscribers (each with one share) are: V. B. D. Cooper, S. P. W. Sellon, C. S. Peach, J. G. B. Elliot, C. J. March, E. Schenk, and H. Heywood.

ELECTRIC STREET CAR MANUFACTURING SYNDICATE (LIMITED).—This Company has been registered with a capital of £25,000, in £1 shares, to enter into agreements with Messrs. Thomas H. and Thomas Parker, for the acquisition of certain patents relating to motor cars and carriages, and the London Electric Omnibus Company (Limited), and to carry on the business of manufacturers of and dealers in motor cars, carriages, and other vehicles, electrical and general engineers, electricians, metal workers, &c. The first subscribers, with one share each, are: Thomas Parker, J.P., M.I.C.E.; Thomas H. Parker, electrical engineer; T. Wardley; S. Craddock, J.P.; M. Fletcher; W. E. Cook, engineer; and E. Parker, electrical engineer. The first Directors are: S. Craddock, Thomas Parker, Edward Lisle, Major Flood-Page, and T. H. Parker (Managing).

R. D. THOMPSON (LIMITED).—This Company was registered on Nov. 30, with a capital of £1,000, in £1 shares, to carry on the business of electric light, telegraph, electrical, mechanical and general engineers, and metal workers.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26⅞d. per oz. (Dec. 9). Consols (2¾ per cent.) 112⅜—112⅞ for money, 113—113⅛ for account; 2½ per cent. 106—106¼ (Dec. 9). Stock Exchange Settling Days: Consols, Jan. 3; Stocks and Shares Continuation Days, Dec. 13 and 28; Ticket Days, Dec. 14 and 29; Pay Days, Dec. 15 and 30; Mining Share Carry-over Days, Dec. 11 and 24.

BABCOCK AND WILCOX (LIMITED).—An extraordinary general meeting of the shareholders of this Company will be held at the Cannon-street Hotel, E.C., on the 14th inst., for the purpose of considering a resolution to increase the capital to £320,000 by the creation of 8,000 new Ordinary shares of £10 each.

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A CANADIAN TRUST.—A Canadian correspondent of the *Financial News* states that negotiations are proceeding between a group of capitalists at Toronto and a large number of electrical and gas-lighting undertakings throughout the Dominion, but especially in the province of Ontario, to amalgamate all these different enterprises under one management, and to so effect considerable economies in the cost of administration. An idea is said to prevail that the whole enterprise will ultimately be offered to English investors.

COMMERCIAL CABLE COMPANY.—This Company have declared a quarterly dividend of 1¾ per cent. and also a bonus of 1 per cent., making 8 per cent. per annum. The transfer books will be closed from the 21st inst. until the 3rd Jan.

COMMERCIAL STEEL COMPANY OF GREAT BRITAIN (LIMITED).—This Company has been formed with a capital of £80,000 in £1 shares, for the purpose of acquiring a licence granted by the Harvey Steel Company of Great Britain, to use certain inventions in the United Kingdom of Great Britain and Ireland. Under the licence the Company is empowered to manufacture, amongst other articles, mining drills, shoes for traction engines, stamps and dies, geared wheels, &c., &c. The Directors include Mr. Robert W. Blackwell and Mr. Philip Dawson. The secretary (pro tem.) and the offices of the Company are Mr. J. J. Macgregor, Broad-street House, New Broad-street, London, E.C. The present issue is for the whole of the capital, and is payable 2s. 6d. on application, 7s. 6d. on allotment, and the balance one month after. The lists opened yesterday (Thursday) and will close for both town and country on or before Monday next. Prospectuses and forms of application can be obtained from the bankers, brokers, solicitors, or secretary of the Company. The full prospectus will be found on another page of the present issue.

COUNTY OF LONDON AND BRUSH PROVISCIAL ELECTRIC LIGHTING COMPANY (LIMITED).—Notice has been given to the existing shareholders in this Company that the Directors have decided to make a further issue of 10,000 Ordinary shares of £10 each, the balance of the authorised Ordinary share capital of the Company. These shares are issued *pro rata* at par to the holders of the existing 30,000 fully paid-up Ordinary shares.

COVENTRY ELECTRIC TRAMWAYS COMPANY (LIMITED).—The Directors of this Company have declared a dividend for the half-year ended Dec. 3 at the rate of 8 per cent. per annum, the same as that paid in the preceding half-year. The contracts for the extensions of the lines have been let, and the whole of the work is to be completed before Oct. 1 next.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment on Jan. 14 of interest of 3s. per share, less income-tax (being at the rate of 6 per cent. per annum), on the Preference shares for the quarter ending Dec. 31, 1897, and the usual interim dividend of 2s. 6d. per share on the Ordinary shares (free of income-tax) in respect of profits for the quarter ended Sept. 30 last. The transfer books will be closed from the 7th to 14th inst. inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend for the quarter ended Sept. 30th, of 2s. 6d. per share, free of income tax, payable on Jan. 15th. The share register will be closed from the 7th to the 14th prox. inclusive. The coupon on the Company's, Five per cent. Australian Government Subsidy Debentures, due on Jan. 1st will be paid on and after that date by Messrs. Barclay and Co., 54, Lombard-street, E.C. Coupons must be left three clear days for examination.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY (LIMITED).—A petition has been presented to the High Court of Justice for the purpose of confirming the special resolution recently passed reducing the capital of the Company from £250,000, in 50,000 Preference and 75,000 Ordinary shares of £2 each, to £162,981, in £50,000 Preference shares of £2 each and 62,981 Ordinary shares of £1 each. The petition will be heard before Mr. Justice Wright on Tuesday.

GUTTA-PERCHA CORPORATION (LIMITED).—The first batch of letters of allotment in the recent issue of this Company has been posted.

GREAT NORTHERN TELEGRAPH COMPANY.—This Company's traffic receipts in November, 1897, amounted to £24,800, and the total receipts between Jan. 1 and Nov. 30 were £252,800, against £261,600 and £286,400 in the corresponding months of 1896 and 1895 respectively.

RAND CENTRAL ELECTRIC WORKS (LIMITED).—Notice is given that the annual ordinary general meeting of the shareholders of this Company will be held at Winchester House, Old Broad-street, London, E.C., on Tuesday next, the 12th inst. The transfer books are closed from the 7th to the 14th inst. inclusive.

SMITHFIELD MARKETS ELECTRIC LIGHT SUPPLY COMPANY (LTD).—Notice is given in our advertisement pages that the prospectus of this Company will be issued early next week. The capital of the Company is £100,000, in £5 shares, and £50,000 Four per Cent. Debenture stock. Subscriptions will be invited at par for £60,000 in 12,000 Ordinary shares, and the whole of the £50,000 Debenture stock. On the Ordinary shares £1 is payable on application, £1. 10s. on allotment, and the balance in one month; and on the Debenture stock 10 per cent. on application, 40 per cent. on allotment, and the balance in one month. The directors include Mr. G. H. Brougham Glasier (chairman of the Charing Cross and Strand Electricity Supply Corporation), Mr. J. Browne-Martin (Director of the Westminster Electric Supply Corporation), and Mr. Ernest Schenk. Mr. V. B. D. Cooper is consulting engineer, and the Secretary and offices are Mr. H. M. Manley, Finsbury House, Blomfield-street, London, E.C. Copies of the prospectus will be obtainable at the offices of the Company, and from the Company's bankers, brokers and solicitors. Reference is made in another portion of our present issue to a novel scheme of charging, and to the special system of discounts which the new company propose to adopt in connection with their electric current supply arrangements. The Company acquire as a going concern the existing station and plant in Charterhouse-street, and attention is directed to the fact that the area of supply is compact, and that the period of supply apart from any day demand represents a nearly all-night load. We understand that out of the 422 shops now constituting the market 175 are already connected. A valuation has been made by Messrs. Fuller, Horsey, Son and Cassell of the plant and buildings, that value of which has been put at £86,666 apart from loose tools, utensils, stock, stores and goodwill. The prospectus will also contain a report from Dr. John Hopkinson on the subject of the supply of electric current to the Cold Storage Company, which has offices and stores in the markets, and Mr. V. D. B. Cooper reports upon the plant, machinery and general equipment of the station to be taken over by the new Company, as from the 29th September last.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION (LIMITED).—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to the further issue of 12,500 Ordinary shares (Nos. 42,342 to 55,341) of the South London Electric Supply Corporation (Limited).

TROLLHATTAN ELECTRISCHE-KRAFT AKTIE BOLAGET.—This Company has been formed at Stockholm, with a capital of 4,500,000 kroner (about £247,500), for the purpose of utilising the Trollhattan waterfalls in the generation of electric current.

UNITED WIRE WORKS (LIMITED).—This Company has been registered in Scotland with a capital of £200,000 in equal divisions of Ordinary and Preference shares of £10 each, to carry on the business of wire drawers, manufacturers, &c. The new Company takes in a number of existing concerns.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Dec. 3 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,002.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half-month ended Nov. 30 is £2,061, against £2,385 in the corresponding period of 1896. The July receipts (estimated at £3,977) realised £3,995.

WESTERN UNION TELEGRAPH COMPANY.—The payment of the usual quarterly dividend of 1¼ per cent. is about to be made. The estimated net revenue of the Company for the December quarter will amount to $1,600,000, the surplus, after allowing for the dividend, will be $158,000, against $164,000.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Aggregate—to date. Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Dec. 4	3,498	+297	...	...	...
Bristol Trams & Carriage	,, 3	2,206	+314	22	58,172	+8,703
City & South London Ry.	,, 5	1,097	+ 45	23	21,880	− 67
Dover Tramways	,, 4	77	...	13	1,501	...
Dublin United (Southern)	,, 3	338	− 61	22	14,286	− 706
Liverpool Overhead Rly.	,, 5	1,286	+217	23	32,582	+4,372
Sheffield Tramways	,, 5	912	+124	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Dec. 1.	Price Wednesday, Dec. 8.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 4. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£18,126	£10	3/0	Central London Ordinary	9¾ 10¼	9¾ 10	3 0 0	June and December	10	..
143,166	10	1/3	Do. (6s paid)	5¾ 6	5¾ 6	3 0 0	,, ,,	..	..
£500,000	Stock	2½	City and South London Railway Con. Ordy.	68 70	68 68	2 15 2	January and July	69¼	68
3,419	£10	5%	Do. 5% Perpetual Preference	15¾ 16	15¾ 16	3 2 6	,, ,,	15	15¾
£ 35,761	Stock	4%	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	139	..
54,000	10	2/3½	Waterloo and City Ordinary	12¾ 13	12¾ 13	2 6 1	June and December	12¾	12¾
87,500	10	3%	Liverpool Overhead Railway Ordinary	11¾ 11¾	11⅞ 11⅞	2 11 11	February & August	..	..
10,000	10	5%	Do. 5% Preference	16 16¼	16 16¼	3 0 7	,, ,,	..	..
137,000	Stock	4%	Do. 4% Debenture	110 112	110 112	3 11 5	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price Dec. 1.		Price Wednesday, Dec. 8.		Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending Dec. 4.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£923,960	Stock	14/0	Anglo-American	58	60	58	60	4 12 6	Feb., May, Aug., Nov.	58½	58
£3,038,020	Stock	23/0	Do. Preferred	104	105	104½	105½	5 9 0	" "	105	104½
£3,038,020	Stock	5/0	Do. Deferred	12½	12¾	12¾	12⅞	—	—	—	—
£137,400	£100	4%	*African Direct Telegraph (Red)	101	105	101	105	3 16 11	January and July	101	—
£25,000	10	—	Amazon Telegraph	5½	6½	5½	6½	—	—	—	—
130,000	10	5/0	Brazilian Submarine	16	16½	16	16½	4 4 10	Mar., June, Oct., Dec.	16⅝	16 1/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	114	118	114	118	4 5 10	June and December	—	—
10,000,000	$100	7%	Commercial Cable Capital Stock	183	188	183	183	4 5 1	Jan., Apr., July, Oct.	—	—
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105	107	105	107	3 14 9	" "	106½	106⅜
16,000	10	8/0	Cuba Submarine	8½	9½	8½	9½	8 8 5	February and August	—	—
6,000	10	10%	Do. Preference 10 per Cent.	18½	19½	18½	19½	5 2 7	" "	—	—
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	4½	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	—	—
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅝	106⅝	103⅝	103⅝	4 4 11	January and July	104	—
60,710	£20	3/0	Direct United States Cable, 1877	10	10½	10	10½	5 14 3	Jan., Apr., July, Oct.	10 7/16	10 3/16
400,000	£10	2/6	Eastern	17	17½	17	17½	3 14 4	" "	17⅜	17 1/16
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18	19	18	19	3 3 8	" "	18⅜	18½
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131	134	130	133	3 0 6	May and November	—	—
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 14 9	February & August	—	—
250,000	10	2/6	Eastern Extension	13½	13¾	13½	13⅝	3 17 9	Jan., Apr., July, Oct.	13⅝	13½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	131	134	131	134	3 0 0	February & August	—	—
£125,700	£100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	100	104	100	104	4 17 4	January and July	—	—
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	100	104	100	104	4 17 4	" "	—	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103	106	103	103	3 15 8	February & August	—	—
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅝	111⅝	108⅝	111⅝	3 12 1	May and November	—	—
180,227	10	1/9	Globe Telegraph and Trust	11½	12	11½	12	3 15 0	Jan., Apr., July, Oct.	11⅞	11 1/16
180,042	10	6%	Do. 6 per Cent. Preference	17½	17¾	17½	18	3 6 8	" "	17⅞	17½
150,000	10	5/0	Great Northern of Copenhagen	26	27	25½	26½	3 15 6	January, April, July	—	—
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	102	105	102	105	4 15 3	March & September	103½	—
17,000	25	12/3	Indo-European	52	55	52	55	4 10 11	May and November	—	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	107	110	107	110	5 9 7	March & September	—	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red) 1942	107	110	107	110	3 13 5	June and December	—	—
11,839	8	4/0	Reuter's	7	8	7½	8½	4 14 1	April and October	—	—
3,381	£100 Cert.	6%	Submarine Cables Trust	136	141	136	141	4 5 1	" "	—	—
15,609	10	6/0	West African Telegraph	4½	5½	4½	5½	5 0 0	—	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 14 4	March & September	—	—
30,000	10	2/0	West Coast of America	¾	1½	¾	1½	—	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	106	103	106	108	3 14 10	June and December	—	—
88,321	10	1/0	West India and Panama	⅝	⅝	½	¾	—	May and November	—	—
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7½	8¼	7½	8½	7 5 5	" "	8½	7⅞
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	5½	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 12 2	January and July	—	—
64,256	15	3/0	Western and Brazilian	9½	10	9½	10	2 19 8	May and November	9⅛	—
33,129	7½	8/0	Do. 5 per Cent. Preferred Ordinary xd	7½	7½	7½	7⅝	3 17 8	" "	7⅜	7½
33,129	7½	1/6	Do. Deferred Ordinary	2½	3	2½	3	—	" "	2⅝	—
£382,230	—	4%	Do. 4 per Cent. Debenture Stock	105	109	103	109	3 14 1	June and December	107½	—
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	103	107	103	107	6 10 10	Feb., May, Aug., Nov.	—	—
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chill Telephone (fully paid)	3	3½	3	3½	5 14 4	August	3	—
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	1/16	—	July	—	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	—	—
484,597	5	3/0	National	6½	6½	6½	6½	4 12 4	February & August	6 7/16	6½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 10 7	" "	—	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14	16	14	16	3 15 0	" "	15½	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6	6½	6	6½	3 16 11	" "	6¼	6 1/16
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104	109	104	109	3 5 0	June and December	108¼	105
171,504	1	0/4	Oriental	1/16	¼	1/16	¼	4 2 4	April and October	—	—
58,000	5	5/0	United River Plate	3½	4¼	3½	4½	5 17 8	July	4⅜	—
£146,733	Stock	6%	* Do. 5 per Cent. Debenture Stock (red.)	102	107	102	107	4 14 4	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	10		11		—	March	—	—
£50,000	5	—	Do. (New Issue) £3. 10s. paid	—		—		—	—	—	—
50,000	£10	14/0	City of London Electric Lighting (fully paid)	26½	27½	26½	27½	2 10 11	February & August	27 1/16	26½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17	18	17	18	3 6 8	January and July	19 1/16	17⅝
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131	134	131	136	3 14 3	June and December	135	133½
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12	13	12½	13½	2 8 2	February & August	13½	12¾
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 6 8	" "	6⅝	6½
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	—	—	January and July	—	—
£36,000	5	2/6	Chelsea Electricity Supply Ordinary	10½	11	10½	11	3 8 2	March	—	—
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	116	113	116	3 14 7	June and December	—	—
£30,000	£10	—	County of London & Brush Prov. Ord. (fully paid)	13½	14	14⅜	15½	—	—	14⅞	13⅞
20,000	£10	6/0	Do. 6% Cumulative Preference	15½	15⅝	15⅛	16	3 15 0	March & September	15⅞	—
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9¼	9½	9⅜	9¾	—	—	9⅜	—
10,000	£5	7%	Do. 7 per Cent. Preference	11	11½	11	11½	3 0 11	March & September	—	—
111,000	£5	..	London Electric Supply Ordinary	2½	2⅝	2⅜	2⅝	—	—	—	—
48,050	£5	..	Do. Preference	5½	6¼	5⅝	6¼	—	—	—	—
49,900	10	5/0	Metropolitan Electric Supply Ordinary	18⅞	19½	19	20	2 15 0	April and October	19½	18 15/16
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	18	19	18½	19½	—	" "	—	—
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119	123	119	123	3 13 6	June and December	—	—
6,452	10	8/0	Notting Hill Electric Ordinary	16½	17½	17½	18½	2 3 3	March	18½	18⅜
275,000	1	—	Rand Electric	1⅜	1½	1⅜	1⅞	—	—	—	—
£125,000	Stock	..	River Plate Elec. Lt. Trct'n, Ltd., 5% 1st Mor. Deb.	93	98	93	98	—	—	—	—
150,000	$100	..	Royal Electric Company of Montreal Shares	148	150	143	150	—	—	—	—
154,000	100	—	* Do. 4½% 1st Mort. Debs.	104	106	104	103	4 5 4	April and October	—	—
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	16½	17½	16½	17½	3 5 9	February & August	17½	17½
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	—	—
£50,000	Stock	—	* Do. 4 per Cent. Debenture Stock (red.	103	106	103	106	3 16 0	June and December	—	—
67,900	5	4/0	Westminster Electric Supply (fully paid)	15	16	16	17	2 19 0	March & September	15⅞	15⅝
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	1/6	Brush Electrical Engineering	1⅝	1⅞	1⅝	2	—	—	1⅞	1 11/16
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	2½	2⅝	2⅝	2⅝	—	—	2 5/16	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	107	111	107	111	4 1 8	February & August	109⅜	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	93	102	101	101	4 8 5	June and December	101	—
10,000	£10	..	British Aluminium Ordinary	—		—		—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference	—		—		—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7	8	7	8	6 5 0	June and December	—	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	108	113	103	113	4 0 6	" "	—	—
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½	1⅝	1½	1⅝	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1⅞	2¼	2	2½	—	—	—	—
£82,850	100	..	* Do. 5% First Mortgage Debentures (red.)	89	94	89	94	5 6 5	January and July	—	—
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3	5 10 0	February & August	2⅛	2 1/16
17,139	5	2/9½	Do. (£5 paid)	4	5	4½	5½	5 0 0	" "	4⅛	4⅛
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101	103	101	103	3 17 8	June and December	—	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅜	2½	2½	2½	4 0 0	February & August	2½	2 1/16
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3⅝	3½	3⅝	4 3 4	August	—	—
91,196	1	10/0	Elmore's Patent Copper Depositing	⅜	½	⅜	½	—	—	—	—
10,000	10	6/0	Henley's Telegraph Works Ordinary	20	21	20	21	4 15 3	February & August	20½	20½
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 12 0	" "	—	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 10	" "	—	—
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	22½	23½	22½	23½	4 6 1	" "	23¼	22⅝
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	103	107	3 14 9	March & September	—	—
$7,350	12	12/0	Telegraph Construction and Maintenance	36	39	36	39	4 12 4	March and July	37½	—
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July	—	—
£22,500	£5	3/6	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	—	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	7	7½	7	7½	4 0 0	" "	7 7/16	7
£100,000	Stock	4½%	Do. 4½% First Mort. Debs. xd	104	106	104	106	4 4 11	May and November	—	—

* In calculating the yield on this security, allowan has been made for accrued interest, but *not* for redemption.

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NOTES.

HAPPY the nation that has no history, though the condition may not be a blissful one for the would-be historian. The Institution of Electrical Engineers is to be congratulated upon having been able to present, at its Annual General Meeting on Thursday week, a report so satisfactory that we are unable to chronicle a single objection to its contents, nor even any serious criticism of the procedure of the Institution and its Council. True, indeed, that certain suggestions were made in regard to the advisability of taking Papers as read, instead of actually reading them; but the friendly proposal, having already been considered and abandoned by the Council, led to no revolutionary change. The feeling of every one present, and the whole tenor of the meeting, seemed to be one of quiet contentedness, that contrasted pleasantly with the heated debates at the Annual General Meetings of not long ago.

THE shadow of a coming event, which, though much regretted, seems unavoidable—viz., the retirement of Mr. WEBB from the secretaryship—induced in all present an expression of warm sympathy with and appreciation of their secretary that must find an echo in every part of the world where there is a member of the Institution. Several spoke of their personal admiration of Mr. WEBB's qualities; and we, in our turn, take pleasure now in testifying to the cordiality that he has always shown towards the technical Press, and the assistance he has ever willingly rendered us in connection with the proceedings of the Institution. We note with gratification the substantial expression of esteem which the Institution has proffered to him in the shape of a pension on his retirement after 20 years' service.

SUCH is the hospitality with which the Institution of Civil Engineers entertains the younger body of engineers in its magnificent house that members of the Institution of Electrical Engineers, when they attend the ordinary meetings, almost fail to realise that they are not in a home of their own. But the annual meeting always has its reminder in the shape of a notice concerning the building fund, to say nothing of the vote of thanks to the "Civils." At the date of the annual meeting in 1896 the building fund amounted to £3,528. 4s. 2d.; it has now swelled to £4,639. 13s. 7d., or rather, that was the figure at the end of September last. Much remains to be added before the Institution can follow the example set by the Institution of Mechanical Engineers and build a house for itself; but at the present rate of increase, and with the hearty co-operation of affluent members, the necessary increment should not take an inordinately long time in arriving.

WE congratulate the recipients of annual Premiums on the successful results of their labours; and although they are too numerous for us to notice them all by name in this column, we hope we may be excused for making special reference to the Extra Premium awarded for his Paper on "The Disturbance of Submarine Cable Working by Electric Tramways," to Mr. A. P. TROTTER. Important increases in the value of the premiums offered by the Institution have been made, and will take effect in the forthcoming session. These are announced in our report of the Annual General Meeting, which will be found in another column.

AN esteemed correspondent points out that in the account which Prof. SLABY has published of his experiments in Germany, where he succeeded in sending signals across about 13 miles of space by wave telegraphy, it is interesting to find that he succeeded in this splendid result without using any single detail that originated with MARCONI. He employed a Righi transmitter, and a coherer of pure nickel filings. He included both transmitter and receiver in earthed conductors, the tops of which were elevated 50ft. or 60ft. into the air, as TESLA suggested. He used a Weston galvanometer as a relay; and as for the choking coils and spark-arresting shunts

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which figure in MARCONI's apparatus as important details, he found them quite unnecessary and removed them from his own. He used a tapper to tap the coherer; but that was described by Dr. LODGE years ago. The most curious thing is hat Prof. SLABY seems to be under the impression that he was using MARCONI's "invention." What he really showed is, that success is not necessarily dependent upon anything that MARCONI has originated.

EXTENSION of letters patent for an invention in the United Kingdom is granted only upon the fulfilment of two conditions, viz., that it is shown that the invention is one of exceptional merit, and that, in the normal term of the patent, the inventor has not obtained an adequate reward. Applications for extension of letters patent are commonly rejected on the score that one, and sometimes both, of these conditions has not been complied with; and it is very rarely indeed that the Judicial Committee of the Privy Council advise Her Majesty to extend a patent.

AN extension of 10 years, however, has recently been recommended for patent No. 5,718[83], relating to Mr. I. A. TIMMINS's ingenious system of electric railway signalling. The merit in this invention is undoubted, and the system has been at work successfully on the Liverpool Overhead Railway and the Swansea Dock Railway for some time past; but Mr. TIMMINS has found that, contrary to popular opinion, a good patent does not necessarily yield a big fortune, for he has been a loser, up to the present time, of about £6,000. We hope that in the ten years of extra time allotted Mr. TIMMINS will not only be able to wipe out that balance on the wrong side, but that he will also reap a substantial reward commensurate with the intrinsic worth of his invention.

RATHER than accept the offer of the National Telephone Company to spend from £30,000 to £40,000 in reconstructing the Huddersfield telephone system and making it as perfect as present experience renders possible, the General Purposes Committee, consisting of the entire Corporation of that city, has adopted the recommendation of the Electric Lighting Committee that the telephone system should be placed under municipal control. The sole inducement would appear to be that Huddersfield, with its well-known passion for municipalisation, wishes to possess the first municipal telephone system, as it already possesses the first tramway system to have been municipalised, and has led the way in other schemes of municipal control of public works. Local government control of telephone systems, however, must not be placed on the same footing as that of baths and washhouses, electric light and water works, or even town tramways. We expect to see such a method of telephone management become a pronounced success only when inland telegraphs and railways shall be managed satisfactorily in a similar way.

WE do not know whether the question of rubber and gutta-percha substitutes is being neglected, or whether those who are working at the problem have met with nothing but ill-success in their endeavours. It is, perhaps, only natural that the manufacturers of gutta-percha and rubber material should view with disapprobation any substitute brought under their notice or put upon the market, for they are in most instances importers as well as manufacturers; and, in any case, their plant has been designed to deal with the genuine material, and would probably have to be modified if a different substance were substituted. This consideration leads to a point which is most frequently overlooked in critically examining products brought forward as substitutes. To produce a material which not only shall have the same electrical and mechanical properties as, say, gutta-percha, but also shall be capable of being applied to wires in exactly the same manner by the same machines and under the same conditions, is evidently a problem of extreme difficulty, if not one that is impossible of solution. Yet it is just this task that is set by the manufacturer, and the experimenter submissively accepts the conditions and aims at fulfilling them.

A SUBSTITUTE for gutta-percha must have some of the same properties of this gum, but in many respects it may be utterly different and yet be admirably suited to insulating submarine cables. It must, it is true, be flexible and mechanically strong at ordinary temperatures, and above all, absolutely waterproof, but it is unnecessary that it should soften at a temperature below boiling point, or, indeed, at any temperature at all, so long as it is suitable for covering wire. There is no reason why the covering should be carried out with the material in a semi-solid state, as in the gutta-percha covering machine, neither is it necessary that it be capable of withstanding exceptionally high electrical pressures. The specific resistance of the substitute might be considerably lower; its specific inductive capacity could not well be higher than that of its rival. In these latter respects, as well as in ease of jointing, there seems even room for considerable improvement over gutta-percha. Even if the processes for manufacturing gutta-percha from the leaves of the plant turn out an unqualified success, the supply of the substance will always remain limited, and will soon prove unequal to the demand, although it may now no longer be used for "artificial fuel," as was the intention in an old patent mentioned by Dr. OBACH in his last lecture. This being the case, there is plenty of room for substitutes, whether "natural" or "artificial." When suitable substitutes have been discovered, let their use by all means be confined, as at present, to the manufacture of golf balls, handles of surgical instruments, and moulds for electrotyping, until experiments in wire-covering have been completed; but the substitutes should not be excluded from this more useful field merely because they have not all the properties—useful and useless—of hardened gutta-percha.

The Society of Engineers.—At the annual general meeting of the Society of Engineers on the 13th inst., Mr. W. Worby Beaumont was elected President in succession to Mr. George Maxwell Lawford.

South-West London Polytechnic Institute.—The next term of this Institute, situate at Manresa-road, Chelsea, S.W., commences on January 4th. Some further particulars of the courses, fees, &c., are given in an advertisement elsewhere.

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Appointment.—Owing to the resignation of Prof. G. Carey Foster at the close of the present session, the Quain Professorship of Physics at University College, Gower-street, will be vacant. Applications should reach the Secretary (Mr. J. M. Horsburgh, M.A.) by March 1st next.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Otranto—Vallona	Oct. 11, 1897 ...	—
Emden—Vigo	Nov. 28, 1897 ...	—
San Thomé—Loanda	Dec. 4, 1897 ..	Dec. 12, 1897
Sitia—Rhodes	Dec. 7, 1897 ...	Dec. 10, 1897
San Thomé—Loanda	Dec. 13, 1897 ...	—

A Correction.—Mr. T. E. Gatehouse requests us to state that, in our report of his evidence in *re* Donnison and others *v.* Beresford (see *The Electrician*, December 10th, p. 237), the words "it was better to put in an insulating metal collar" should have read "it is much better to put in an insulator; metal is a conductor."

The Late Mr. Graves.—The *Times* correspondent at Teheran, under date 15th inst., telegraphs that the British Resident at Bushire has left by the despatch vessel "Lawrence" for the Mekran coast to make investigations into the circumstances of the murder of Mr. Graves, whose biography is sketched by his brother in our "Correspondence" columns this week. The Persian steamer "Persepolis," with Persian troops on board, sailed a week ago. Further particulars show that the outrage was of a most brutal character, the unfortunate man having been hacked to pieces. It is hoped that the murderers will be arrested and duly punished.

Contemporary Electrical Science.—Too late for insertion in his own notes this week, Mr. E. E. Fournier d'Albe writes that he much regrets, in his note on "Platinum Temperature" last week, "having misquoted the name of the author of the valuable Paper in the *Phil. Mag.* It should have been J. D. Hamilton Dickson. He also says he "should have mentioned the formula

$$(R + 20{\cdot}529023)^2 = 0{\cdot}53270015\,(t + 1048{\cdot}4396),$$

which enables anyone to reduce the low-temperature readings in Dewar and Fleming's experiments, as recorded by their thermometer called 'P,' to degrees centigrade."

Obituary.—Mr. Gardiner Greene Hubbard, one of the directors of the Bell Telephone Company, died at Washington on Saturday last, at the age of 76. Mr. Hubbard was President of the National Geographical Society.——The death is announced, at Cape Colony, of Prof. James Holm, late Professor of Physics at the South African College, Cape Town. Prof. Holm was born in Argyllshire in 1869, and had a brilliant career at Glasgow University, passing on to Edinburgh. Subsequently he spent several sessions in private research, under the special direction of Lord Kelvin, in the physical laboratory of the Glasgow University, and also in the electrical engineering workshops. At the completion of his scholarship he was appointed Demonstrator in Physics at the University College, Nottingham, where he remained until appointed to a professorship at the South African College in 1895.

American Engineering in Europe.—Our American contemporaries give abstracts of a communication by a Mr. R. Porter to *The Philadelphia Inquirer*, wherein he congratulates American enterprise on its success in the electrical field in Europe. During the last summer Mr. Porter has been visiting some of the chief English and Continental cities, and he metaphorically rubs his hands at the extensive adoption of American electric railway plant. Not content with this success of American manufactures, he says: "As a rule, I met in charge of these works either our own countrymen, or foreign engineers who had spent years in the United States in our great electrical establishments . . . There are great opportunities for us, not only in England, but all over the world, for the new century will inaugurate the age of electricity, and the nation of its birth and first utilisation should rightly hold first place in all appertaining thereto."

A Peculiar Trolley Accident.—A peculiar accident recently occurred on one of the Brooklyn electric lines. A car was being switched from the east bound to the west bound track, and in jolting over the switches the trolley pole slipped from the wire. In his efforts to replace the trolley the conductor gave it an extra hard pull, which resulted in separating some of the span wires from their fastenings. The trolley wire thus left without support sagged, and the consequent strain upon the other span wires resulted in tearing them down for a distance of 2½ miles. The trolley wire was not broken, but as it lay upon the ground it emitted a shower of sparks, which caused some consternation to those who happened to be in the vicinity, but no personal injury was done. It took three hours to replace the trolley wire and restore order out of the entanglement. An accident of this nature is of unusual occurrence; indeed, we do not recall ever hearing of one of the kind. It emphasises the importance, however, of having strong supports.

Telephone Rates in France.—On representations made by the General Councils, Chambers of Commerce, and other bodies to the Administration of Posts and Telegraphs with a view to obtaining a reduction of the telephone tariff, a number of modifications in the charges in vogue in the smaller towns in France have been made. Telephone subscribers in towns of less than 60,000 inhabitants have now the right of choosing a contract rate or a rate of payment per conversation. The former class of subscribers may communicate with any other local subscriber without extra charge, the latter on paying 15c. per three minutes' conversation. Telephonic areas directly connected to the same centre by lines not exceeding 15 miles in length constitute these local districts, and the annual charges are based on the population of the various districts. If two district centres are not more than 15 miles apart, a subscriber may have free communication with subscribers in both districts by paying the annual subscription in force in the larger district and a supplementary annual charge of £4.

United States Duty on Electric-Light Carbons.—When the Dingley Tariff Bill went into effect last July its provisions with reference to the importation of electric-light carbons into the United States called for a duty of 90 cents per 100 carbons, no limitation being made as to size. As a result of the vague phraseology of this section dealers argued that they could increase the length of the carbons imported, and after importation could cut them into proper lengths for use. On the other hand, the Treasury officials claimed that the duty should be based upon the length of the carbons as used in lamps. The matter was referred to the Customs authorities at Washington, and in a recent decision on the subject it is held that the duty should apply to the standard lengths of carbons—that is, the sizes actually used in lamps, and not on the increased lengths. The importers had brought into the country carbons 32in. long, which were afterwards cut into three carbons of the commercial length. They were thus enabled to obtain three carbons in place of one. Attention was called to the vagueness of the language of the Section at the time the Bill was being considered in Congress, but without any effect, and the differences of opinion just settled were the natural result of this uncertainty.

A New Prepayment Meter.—A new form of penny-in-the-slot electric meter, the invention of Mr. W. Watson, is being brought out by the Automatic Electric Meter Syndicate, and is on trial at several electric supply stations. The principle upon which the apparatus is based is that of an electrically-controlled clock. On the insertion of a penny, a pawl is released permitting the clock to be wound up and a second clockwork movement to be turned back a certain fixed amount. The same motion of the handle switches the current on, the current passing through a pair of solenoids on its way to the lamps, but until these solenoids are excited the clock does not go. The escapement of the second clockwork movement referred to above is acted on by the first clock through an arm whose travel is varied by the current flowing through the solenoids. This is effected by slots and notches cut in the moving arm so that the variations occur in steps corresponding to 1, 2, 3 . . . 12 lamps. The switch, which is controlled by a spring, is released mechanically as soon as the second clock has returned to its initial position. The meter can be regulated to give from six to eight 8 c.p. lamp hours for each penny, and if desired as many as 12 penn'orths can be prepaid at a time. Although containing a considerable amount of clock-

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work the price of the meter is low, but prolonged trial alone can show whether the instrument is or is not likely to keep in order.

Automatic Sun-Blinds.—What we believe to be the latest development in automatics is a sun-blind recently introduced by a Berlin firm. As soon as the sun shines on the room or window to be protected the blind lets itself down, and when the sun "goes in" the blind draws itself up again. Two glass bulbs are connected by a U-tube partially filled with mercury. A platinum wire melted into the glass makes contact with the mercury at the bend of the tube, and there are also platinum contact-wires brought into the sides of the tube, one of which is in contact with the mercury only when it stands level on the two sides, and the other only when the mercury in one side of the tube rises. One of the bulbs contains only air, the other is filled with black wool. When no sun is out the air in the two bulbs occupies the same volume, and the mercury stands at equal heights in both legs of the tube; but when the sun is shining, the bulb with the black wool absorbs the sun's rays, and causes the mercury to rise in the opposite side of the tube. This closes the circuit of a motor which lets down the blind, an automatic switch switching off the current as soon as the blind gets to the end of its range, and reversing the connections of the motor so that it is ready to wind up the blind as soon as the other contact in the tube is made. When the blind reaches the top the current is again switched off, and the connections are reversed at the switch.

Changing Live Insulators at High Pressure.—The following interesting description of the method of changing the insulators on a live 10,000-volt circuit appears in the *Electrical Engineer* of New York. Mr. Jackson, of the Peninsular Light and Power Company, Michigan, thus describes his procedure:—

"The method I use in changing the insulators upon the 10,000-volt circuit is extremely simple, but at the same time quite safe, if due precautions are taken to have the apparatus dry. We use a 30ft. ladder in two parts so that it can be made of the proper length to catch the cross-arm. At the upper end a small board is put on, having a hole in it of the right size to fit on the end of the cross-arm. For the ladder to stand upon we have a platform 30in. by 30in. square, having a lower part which has a pin with insulator at each corner, and an upper part which fits upon the insulators in the lower part. This upper part has two recesses for the feet of the ladder to fit in. When the ladder is in place someone goes up and screws a small hand-vice upon the cross-arm. The hand-vise is of iron, and has a piece of copper wire soldered to it. This wire is touched to the line wire upon which the broken insulator is located, and if everything shows all right, is wrapped around same. A three-foot stick boiled in paraffin is used in first touching the wires together. When the grounding wire is properly on the man goes to work with bare hands and changes the insulators; then the grounding wire is taken off and the clamp removed. With a plant such as we have it is an absolute necessity to be able to change the insulators at any time. The only time we can shut down without causing our customers trouble is between 3 and 4 p.m. on Sundays, and a bad insulator cannot be left from Monday till Sunday; at least should not. We have not found it necessary to take the voltage off any portion of the system for two months and 14 days."

The New York Underground Rapid Transit Project.—On several occasions in the past we have referred to the various difficulties met with in the endeavours to secure a system of underground rapid transit in New York city, which is sorely needed. There now seems to be a ray of hope of carrying the project to a successful issue. Last summer Commissioners were appointed by Court to decide as to the practicability and advisability of the construction of the proposed underground rapid transit road. After due deliberation the Commissioners, on November 8th, rendered their decision. They ultimately decided that there was great need for this system as proposed, and no serious objection to it; that it will not cost more than the estimated $35,000,000; that it will be possible for the city to issue the necessary bonds without approaching the constitutional limit of indebtedness; that it will be possible to construct the road and have it in operation within four years' time; and, finally, that the road should be constructed and operated, as proposed. The decision is so strongly in favour of the project that it is thought that the court, to which the matter has been referred, will report favourably upon it. If the committee's report is confirmed, the next step in the enterprise will be the letting of the contracts. The contract provides for the construction of the entire system and its operation by the contractors for a long term of years, the whole system reverting to the city's ownership at the end of the period o operation. A strong company has been organised to bid for the contracts, and it is expected that active work will be under way in the course of a few months.

Gutta-Percha.—Dr. Obach's third and last Cantor lecture, delivered at the Society of Arts last Monday, was chiefly devoted to a consideration of the mechanical and electrical properties of gutta-percha. He emphasised the important effect of the proportion of resins contained in the finished material on its tensile strength, hardness, elasticity and softening temperature, illustrating this with tables of figures, diagrams and experiments. The choice of the latter was most happy, for it is no easy matter to devise suitable experiments to relieve the tedium of a two hours' lecture teeming with numerical data and names. By the majority of the audience figures and names are not appreciated, and those to whom they do appeal are not satisfied with one or two extracts quickly read out from interesting tables out of their sight on the lecturer's desk. The experiment which seemed to gratify the audience most was the rough tests of some model gutta-percha boats in a model polar sea. Each boat was in turn taken from among the icebergs and struck with a wooden mallet. The one made of resinous gutta-percha was shivered to atoms, while those in which the resins were present only in very small proportions withstood the test perfectly. A useful rough test of the proportion of resins is to treat the material with ether or petroleum spirit, and then measure the specific gravity of the spirit with a hydrometer. This method, of course, only gives approximate results, but where an accuracy of a few per cent. is all that is required it may well be used in preference to the more laborious methods of analysis. It is noteworthy that the specific gravity of the material itself is no true indication of its quality, Soondie gutta-percha having a lower specific gravity than "genuine," and that of white and mixed gutta-percha being again higher. The extraction of the resins appears but slightly to improve the electrical properties. The uses and applications of gutta-percha were next enumerated, the only important ones being for electrical purposes, golf balls and the handles of surgical instruments. The process of covering wire with gutta-percha was very briefly dealt with. The electrical and hydraulic tests to which the wire is subjected were mentioned, and figures were given as to the number of miles of gutta-percha-covered wire laid in various parts of the globe, and the number of tons of gutta-percha it represented. The property possessed by gutta-percha and balata of absorbing oxygen when subjected to the sun's rays was next considered, and curves were given showing how this property varied in the different classes of the material. Finally two artificial substitutes were mentioned, Mourlot's "Gutta Française," which is extracted from the bark of the birch tree, and "Velvril," a more recent production. The latter is, we understood, formed from collodion cotton and castor or linseed oil. Dr. Obach left the inference to be drawn that he did not think much of either of these compositions. A long list of the persons to whom Dr. Obach was indebted for assistance terminated the lecture, and was evidence, as Mr. Alexander Siemens pointed out in proposing a vote of thanks, of the pains which the lecturer himself must have taken in the collection of information from so many authoritative sources.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, December 17th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Papers to be read: (1) "The Elastic Properties of Steel Wire," by Archer Keigwin; (2) "The Elasticity of Portland Cement," by W. L. Brown.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting in the Rooms of the Chemical Society, Burlington House, W. Continuation of discussion on Mr. L. Epstein's Paper, "Accumulator Traction on Rails and Ordinary Roads."

TUESDAY, December 21st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read and discussed: "A New Transmission Dynamometer," by Prof. W. E. Dalby.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

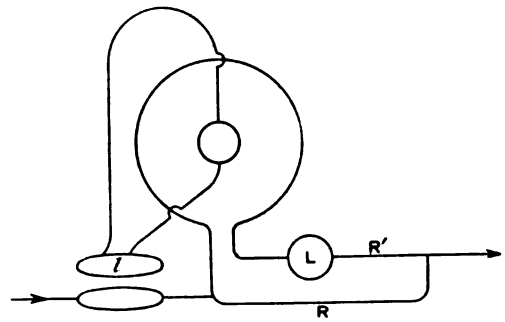
Theory of Zeeman Effect.—J. Larmor develops a theoretical analysis of Zeeman's phenomenon of a somewhat general character, which may help to throw light on the nature of the electric vibrations in the molecule. Starting from the supposition of a single ion of mass, M, describing an elliptic orbit under the attraction of a fixed centre proportional to the distance therefrom, he shows that the original period a will be triplicated into one equal to a, and two others equal to $a \pm eH/2Mc^2$, where H is the field and c the velocity of radiation. The same rule applies whatever be the number of revolving ions in the molecule, and however they are attracted to each other or attracted to fixed centres on the axis, provided the charges of the ions are proportional to their masses and all of the same sign. The character of the radiation from such a vibrator is independent of the orientation of its orbit with respect to the magnetic field. With a large number of such vibrators, oriented indifferently, every spectral line seen in a direction at right angles to the magnetic field would be split up into three lines, each of the same breadth as the original, the middle one plane polarised at right angles to the magnetic field, the other ones in the direction of the field. As the aggregate light must be unpolarised, the intensity of the middle line would be twice that of either of the outer ones. But viewed along the field the middle line would disappear, as the exciting vibration would be end-on to the observer. The other lines would be circularly polarised, in directions determined by the sign of the electron, as pointed out by Zeeman. If only negative ions are free to move, as has been supposed, and if the charges of these negative ions are proportional to their masses, the differences of frequency between magnetic doublets and the outside lines of magnetic triplets in the spectrum should be the same for all lines. Moreover, they should be the same in different spectra. This hypothesis can therefore be definitely put to the test.

[Larmor, *Phil. Mag.*, December, 1897.]

Solution and Dissociation.—According to W. Sutherland, the reasons usually assigned for the remarkable fact that the laws of the osmotic pressure of a solute in a solvent are the same as if the solvent were annihilated and the solute left as a perfect gas, are quite inadequate, because they would apply to any selected lot of the molecules of the solvent, and therefore to all the molecules, *i.e.*, to the liquid state. The simplest conception of the structure of a membrane dividing off a sugar solution is that of a mesh, amidst the threads of which the water molecules are packed in such a manner as to give way before one another almost as in ordinary water, while the sugar molecules are held back by the mesh. Thus the mesh forms a solid or quasi-solid framework, through which water can pass with high viscous resistance, while the sugar molecule is absolutely blocked. Now, if the framework turns back the sugar molecules, it must take the force of their blows and shield the water molecules from them. From the pure water side of the membrane, therefore, the water molecules entangled in it receive more blows, *i.e.*, an excess of pressure, which leads to the passage of water towards the sugar solution, and is thus eventually balanced by a hydrostatic pressure, which is called the osmotic pressure. At the free surface of the solution both water molecules and sugar molecules escape, but the latter are more easily entangled with each other, and "condense" back into the liquid. Dissociation as understood by Ostwald offers no difficulty here. Dissociated Na and Cl ions escaping from the liquid recombine with avidity to form NaCl, which then returns to the solution. The very marked dissociating power of water is associated with its general exceptional character; if water were not exceptional, it ought to be a somewhat difficultly liquefiable gas, whereas its high molecular force constrains it to liquefy and so produce a dense aggregation of swiftly moving molecules; that these should tear apart the atoms of salts with their known electrical contrast is a strange but fruitful discovery in physical chemistry.

[Sutherland, *Phil. Mag.*, December, 1897.]

Measurements with Alternating Currents.—An important Paper has been published by H. A. Rowland on the measurement of inductances, capacities, and resistances by means of alternating currents. The number of methods described is 24, mostly new ones. The latter depend upon adjusting two currents to a phase difference of 90deg., by passing one current through the fixed and the other through the suspended coil of an electrodynamometer. By this means a heavy current can be passed through the fixed coils, and a minute current through the movable coil, thus multiplying the sensitiveness possibly 1,000 times over the zero current method. Many of the methods become very simple on using mutual inductances made of wires twisted together and wound into coils. In this way the self-inductances of the coils are all practically equal, and the mutual inductances of pairs of coils also equal. Hence, it is only necessary to measure the minute difference of these two to reduce the constants of the coil to one constant, and yet by proper connections the inductances can be varied in many ratios. Three wires is a good number to use. However, the electrostatic induction between the wires must be carefully allowed for or corrected if much greater accuracy than 1 per cent. is desired. Relative results are more accurate than absolute ones, as the period of an alternate current is difficult to determine, and its wave form may depart from a true sine curve, or be complicated by harmonics. The various methods are formulated and illustrated by diagrams. No. 12 is interesting as allowing of the determination of the ratio of two inductances to within 0·01 per cent. The approximate formula is $L:l::R+R':r$, and the arrangement is shown in the diagram. The main



error to guard against whenever larger inductances or resistances are included, arises from twisting the wires leading to these. The electrostatic action of the leads, or the twisted wire coils of an ordinary resistance box, may cause errors of several per cent. Using short small wire leads far apart, the error becomes very small.

[Rowland, *Am. Journal of Science*, December, 1897.]

Photo-electric Properties of Salts.—J. Elster and E. Geitel pointed out some time ago that salts coloured by the influence of cathode rays show certain photo electric properties, losing a negative charge quicker when brightly illuminated than when kept in the dark. The same remarks apply to colourless fluorspar, which acquires a deep violet colour. The same colours may be produced by heating these substances in potassium or sodium vapour, with the difference that the colouring penetrates all through the substance, instead of being confined to the surface, as it is when produced by cathode rays. Some such chemically prepared substances, including yellow rock-salt, violet sylvine and blue potassium bromide were tested for photo-electric properties and found to be distinctly sensitive. It is therefore certain that, for instance, violet sylvine has the same photo-electric properties whether the substance is coloured in its natural state or by exposure to cathode rays, or by exposure to potassium vapour. This result would naturally lead to the theory, already enunciated by Wiedemann and Schmidt, that the colouring consists of metallic potassium. The observations recently made by Abegg, who could discover no trace of reducing action or alkaline reaction of the coloured substance, would tell against this theory, unless we can suppose that the amount of colouring matter is exceedingly small.

[Elster and Geitel, *Wied. Ann.*, No. 12, 1897.]

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THE MAGNETIC SHIELDING OF CONDUCTORS OF ELECTRICITY.

BY PROF. ERNEST WILSON.

The experiments herein described suggested themselves to the author when engaged on the subject of the transmission of force by a rotating magnetic field to an armature carrying conductors threaded through holes punched out in a circle near the surface.* The object is to get a practical demonstration of the disturbances to be dealt with under different conditions. The method employs a ballistic galvanometer for the determination of changes of magnetic induction within secondary circuits placed in different positions on or near the test piece A (Figs. 1 and 2). An electromagnet having a laminated core, and between the poles of which the test piece is placed, is supplied with magnetising currents from a set of 56 storage cells, a considerable non-inductive resistance being interposed in the circuit in order that the reaction of the magnet when reversal of current takes place may be quickly overcome, since at the moment of reversal when the current is zero the whole electromotive force is applied to the magnet itself. Also the laminations diminish induced electric currents in the iron, so that their effect on their tendency to maintain the induction in its then state is rendered small, the net result being that the changes of induction are effected in a time small when compared to the periodic time of the ballistic galvanometer, namely, about ten seconds. Fig. 1 is an end view and Fig. 2 a side view of the magnet with test piece in position. The magnet coil M consists of

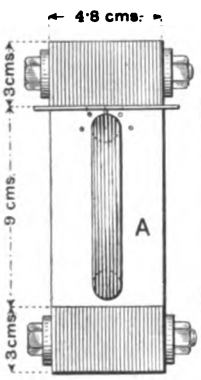

Fig. 1.

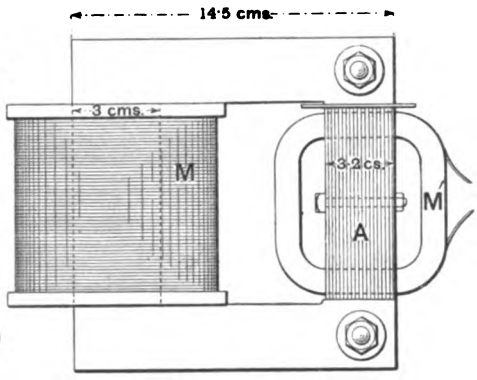

Fig. 2.

600 turns of No. 18 B.W.G, copper wire, and the cross magnetising coil M′ has 14 turns of the same size of wire. For the sake of clearness the upper portion of the test piece A is shown to larger scale in Fig. 3. The space between the pole-piece and test piece is determined by means of a piece of hard wood *a b*, having a thickness of 0·15cm. It has three saw cuts across its surface, parallel with the tunnel in the test piece, into which exploring coils 1 and 1′ are wound. Just inside the iron two small holes $\frac{1}{32}$in. diameter are drilled, and exploring coils wound through these and along the air-gap; 2′ is nearer the surface than 2. Deeper in the iron coils 3 3′ are wound round through small holes in the iron and the near surface of the tunnel.

Fig. 4 gives a diagram of connections in which R, R′ are adjustable non-inductive resistances; M, M′ are the magnetising and cross magnetising coils; C, C′ are current meters; S, S′ are reversing switches. The switches are placed close together and can be simultaneously reversed; and further by reversing them in the same or opposite directions simultaneously the two effects in each exploring coil can be observed without disturbing the arrangement of the secondary circuits. The coils 1, 2, 1′ 2′ in the air space and just inside the iron consist of fine silk covered copper wire each having two turns. Nos. 3, 3′, have one turn each of silk-covered copper wire. By means of mercury cups in a block of paraffin each of the exploring coils 1, 2, 3, and 1′, 2′, 3′, can be connected to the ballistic galvanometer through extra resistance if necessary.

* See *The Electrician*, Vol. XXXVII., p. 565.

The method of observing the results given in Tables I. and II. is as follows:—For each exploring coil in turn kicks on the ballistic galvanometer are observed; D by reversing only the magnetising current in M, the current in M′ being zero; D_1 by simultaneously reversing S, S′ in the same direction with current in M′; and D_2 by simultaneously reversing S, S′ in opposite directions. A number of kicks were observed in each case to make sure that the effects are properly repeated, and an average taken. In any one experiment on an exploring coil the extra resistance in the ballistic galvanometer circuit was constant, so that the observed deflections are proportional to the change of induction, and can be compared. Two sets of complete figures are given in Tables I. and II.

Table I.

Exploring coil.	Mag. current in M = 0·42 amps, M′ = 0	Average induction per sq. cm. B in C.G.S. units.	Mag. current in M = 0·42 amps, M′ = 8·64			
	Observed deflection D.		Observed deflection D_1, S, S′ reversed in same direction.	Observed deflection D_2, S, S′ reversed in opposite direction.	Mean observed deflection $\frac{D_1+D_2}{2}$.	Half-difference $\frac{D_1-D_2}{2}$ expressed as a percentage of D.
1	346	1,851	448	266	357	26·3
2	252	1,491	312	164	237	29·4
3	293	4,040	463	119	291	57·8
1′	335	1,771	246	426	336	26·9
2′	362	1,786	222	501	361	38·4
3′	313	3,544	133	495	314	57·8

Table II.

Exploring coil.	Mag. current in M = 2·18 amps, M′ = 0·0	Average induction per sq. cm. B in C.G.S. units.	Magnetising current in M = 2·18 amps, M′ = 8·64			
	Observed deflection D.		Observed deflection D_1, S, S′ reversed in same direction.	Observed deflection D_2, S, S′ reversed in opposite direction.	Mean observed deflection $\frac{D_1+D_2}{2}$.	Half-difference $\frac{D_1-D_2}{2}$ expressed as a percentage of D.
1	494	7,198	513	467	490	4·66
2	291	4,730	283	287	285	0·7
3	316	13,920	335	286	310	7·6
1′	503	7,171	472	523	497	4·97
2′	471	6,345	446	480	463	3·6
3′	342	12,400	318	364	341	6·73

The current in the cross-magnetising coil M′ is the same in Tables I. and II., and its effect upon the induction is very marked in Table I. when the magnetising-current turns due to M are such that the induction per square centimetre B is comparatively small. In Table II. the same current turns in M′ produce smaller effect upon the distribution. In both cases the effects upon coils 3, 3′ are most marked. With regard to coils 1, 1′, 2, 2′ the effects are reversed in the two tables. In Table I. coils 2, 2′ are more affected than 1, 1′, whilst in Table II. coils 2, 2′ are less affected than 1, 1′. It is to be observed in Table I. that the agreement in coil 2 between the mean of D_1, D_2, and D is not so good as in Table II., and a second series of experiments show the same result. The areas of these exploring coils have been estimated as accurately as possible, but the error may be somewhat considerable. This does not affect the deductions obtained from the observed kicks.

Suppose the loop M′ to be rotating with an armature core between the poles of an electromagnet, then if I be the maximum induction through the loop in C.G.S. units, and t the time of a half revolution in seconds, $\frac{2I10^{-8}}{t}$ is the average electromotive force per turn in volts induced in the loop. The average current in one turn of the loop will be this electromotive force divided by its ohmic resistance. The average force on the armature at the radius of the conductor can then be deduced on the ordinary theory. It varies as the square of this electromotive force, and is inversely proportional to the resistance of the loop and the frequency of the induction in the armature. Knowing the actual speed of rotation the rate at which the armature does work follows. The effect of current in the armature conductors upon the induction in the armature is therefore of great importance. It will be found that the cross-magnetising force due to M′ is what may be

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realised in practice; it is equivalent to about $8{\cdot}7 \times 10^{-5}$ volts per centimetre linear of conductor.

In Dr. H. du Bois' admirable treatise on "The Magnetic Circuit," the subject of change of direction of lines of induction at the surface between a ferro-magnetic substance and air is well set forth. The law assumed to govern the change of direction asserts that the ratio of the tangents of the angles made by the two directions at the surface with the normal is equal to the ratio of the permeabilities of the two media. In Fig. 5 if A, B is the trace of the bounding surface between, say, a piece of iron and air, then by the law $\tan \alpha' = \mu \tan \alpha$, where μ is the permeability of the iron, air being taken as unity.

The author has been interested in the recent discussion in *The Electrician* as to the way in which force is exerted upon

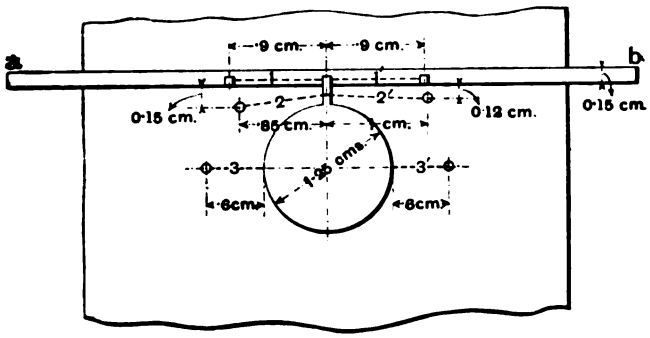

Fig. 3.

an armature producing torque, as in the case of buried conductors. That such force is the outcome of disturbance due to the currents in such buried conductors cannot be doubted. The above experiments do not pretend to throw any light upon the way in which force is transmitted, but they have raised one or two points which may have interest. I allude more especially to the best induction densities (B) to be adopted in the design of motors or generators employing buried, or partially buried, conductors in the armature. In practice one has two distinct cases to be dealt with (1) the case of an ordinary direct current motor or generator, the armature rotating, say, between two magnet poles (2), the case of an armature of an alternate current induction motor. In the former the fre-

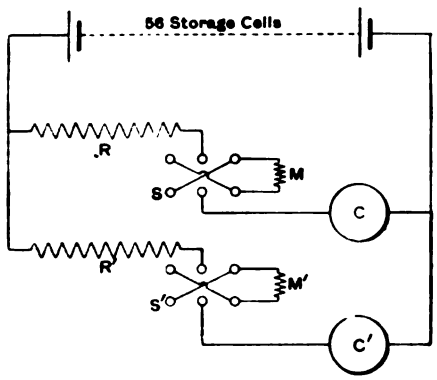

Fig. 4.

quency of the magnetic induction in the armature is the speed of its rotation if the poles be fixed. Take a speed of 1,000 revolutions per minute; then the frequency is 17 nearly. In the latter case, if the frequency of the impressed field be, say, 100, and the difference of the frequencies of impressed field and armature be 1 per cent., then the frequency of magnetic induction in the armature is 1 per second (the actual speed of the armature depending upon the number of effective poles), such frequency depending upon the load for given conditions. So far as the armature is concerned dissipation of energy due to magnetic hysteresis and eddy currents might be smaller in the induction motor. On the other hand, the primary circuit of this motor experiences the full frequency of supply.

The dissipation of energy by magnetic hysteresis in an armature core rotating in a uniform magnetic field* rises as the induction per square centimetre (B) rises, the curve not widely differing from that ordinarily obtained by reversal of magnetism as in a transformer core, until B is about 15,000 in soft iron, and after this dissipation diminishes, with further increase of B, the frequency being the same. This effect may partially go on in teeth of armature cores, and if this be so it would explain why these teeth might work with advantage when highly magnetised in generators and direct-current motors.

In the working of induction motors and starting with the armature running light, that is, when it is very nearly in synchronism with the rotary field, the torque gradually rises as the load is increased until it reaches a maximum. A further increase brings about diminished torque, and instability sets in. In traction work it is especially important that the average torque is well within the maximum, and it has been pointed out by Mr. C. E. L. Brown† that since the torque depends upon the current in the armature conductors and the magnetic field a change from star to mesh grouping will increase the field for the same potential difference and greater reserve power be obtained. This necessarily implies that the normal fields are comparatively weak, and on account of dissipation of energy in the stationary part of the motor, it is wise to limit the field. This being the case in induction motors, it is well to ask at what induction density should the motor work under light load. If the tangential pull on the armature be some function of the angle α in Fig. 5 it would seem that working into a condition of increased permeability

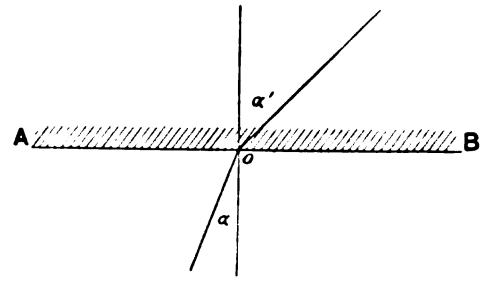

Fig. 5.

might be best. Take an induction curve for a representative sample of transformer iron: for B = 2,000, μ = 1,900; for B = 6,000, μ = 2,800; for B = 12,000, μ = 1,700. If B is, say, 3,000 or 4,000 when the motor runs unloaded the increase of current in the primary coils and the disturbance due to increase of current in armature will increase the permeability on one side of the conductor and in the pole-piece, so that increase of torque might arise from two causes, namely, increased induction and increased inclination. If the initial value for B = 6,000, then increased induction will be obtained with diminished permeability. How far this may have practical importance if it exists the author is not prepared to say, but it is interesting to trace on the above assumptions the effect of variation of permeability upon torque, and an interesting experiment would be to pivot the test piece A (Figs. 1 and 2) and measure the proportional increase of force at a certain radius in the two cases.

I wish to thank Messrs. Simpson, Greenbank and Davey, Student Demonstrators in the Siemens Laboratory, King's College, London, for the help they have given me in connection with this article.

BOOKS RECEIVED.

"Whittaker's Mechanical Engineer's Pocket-Book." By Philip R. Björling. (London: Whittaker and Co. Price 5s.)

"Kalender für Elektrotechniker." By F. Uppenborn. (Munich: R. Oldenbourg. Price 5 marks.)

"Electrical Traction." By Prof. Ernest Wilson. (London: Edward Arnold.) Price 5s.

* See F. G. Baily, *Phil. Trans.*, R. S. Vol. 187 A 1896 p. 715.

† See *Proc.* Inst. Electrical Engineers, Vol. XXVI., p. 425, also "Electrical Traction," by the Author, p. 169.

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A SIMPLE METHOD OF STARTING ALTERNATING SINGLE-PHASE INDUCTION MOTORS.*

BY PROF. RICCARDO ARNO.

All single-phase alternating induction motors, as now constructed, require to be started as rotary field motors. For this purpose the inductor part is wound with two separate circuits; the supply current circulates through the main winding during the regular run, while the other is intended only to carry, in the starting period, an auxiliary current displaced in phase with respect to the principal one.† We propose herewith to describe a simple method of starting, which permits of accomplishing the operation with the help of the main alternating-current only. This result is obtained by—

1. Inserting, during the first moment of starting, a resistance of a proper value in the circuit of the armature.
2. Impressing on the rotary part of the machine a very small initial velocity, by the sense of which the direction of the run is determined.
3. Reducing the additional resistance down to zero gradually as the maximum speed which corresponds to it is attained.

It was ascertained‡ by the author that the starting resistance to be introduced in the armature is such as to make the virtual value of the current in the main circuit nearly double of the value attained under the same load, while the motor is running. This is also the condition satisfied when starting the motor by the usual methods. Practical experience has proved that such an impulse as is communicated by giving a pull to the belt or rotating the armature by one quarter-turn —accordingly to whether the motor starts under no load or a very small load—is sufficient to start the motor. Hence the method proposed is not only very simple, but practical, and suited also for motors of large powers. The results obtained are easily explained if we consider the single-phase motor as a differential rotary field motor, and deduce its properties directly from those of polyphase motors.§

Let $\mathbf{B}$ stand as well for the induction in the rotary field as for one-half the maximum value of induction in the alternating field; n the frequency of both fields; S, r and L respectively the surface, the resistance, and the inductance of each of the N elementary sections of the armature; m the number of revolutions per second. Then the torque acting on the armature of the polyphase motor is given by

$$K = \pi N \mathbf{B}^2 S^2 \frac{r(n-m)}{r^2 + 4\pi^2 L^2 (n-m)},$$

while the corresponding torque on the single phase motor is¶

$$K' = \pi N \mathbf{B}^2 S^2 \left[\frac{n-m}{r^2 + 4\pi^2 L^2 (n-m)^2} - \frac{n+m}{r^2 + 4\pi^2 L^2 (n+m)^2} \right].$$

In Fig. 1 a curve is plotted with the values of m as abscissæ (to the left of O_1), and the values of K as ordinates; the curve consists of two branches, symmetrical with respect to O_1, and only one of which is represented in the figure. Both branches are asymptotical to O_1x, and have a maximum ordinate in M; this is $\frac{K = N\mathbf{B}^2S^2}{4L}$ and corresponds, for the branch herewith considered, to a speed $m = n - \frac{1}{2\pi}\frac{r}{L}$. The curve has at O a point of inflection, and its inclinations there amount to $\frac{\pi N \mathbf{B}^2 S^2}{r}$. It follows that, by increasing r, m diminishes, while K remains always the same; thus the point M is shifted along a line parallel to Ox from left to right, and approaches at first the axis O_1Y' (*see* Fig. 2) until it reaches it (Fig. 3) and goes beyond afterwards (Fig. 4). At the same time the inclination of the curve in O being inversely proportional to r, diminishes correspondingly. This is shown by Figs. 2, 3 and 4, in the three cases, which are especially interesting, of r slightly less than, or equal to or larger than $2\pi nL$. The curves constructed represent the torque K on the polyphase motor as a function of m. From these we may deduce the curves which correspondingly represent the torque K′ of the single-phase motor. This is done by drawing, with

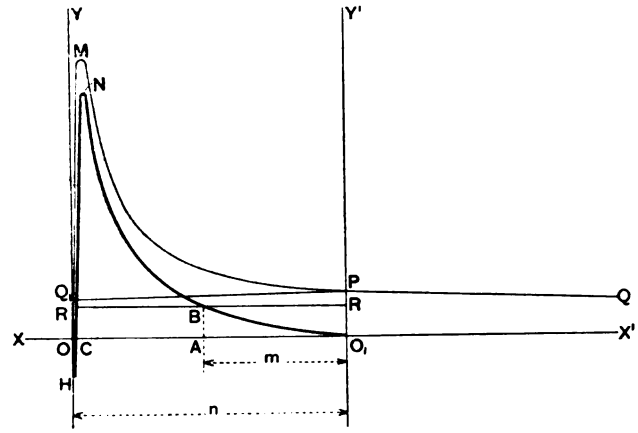

FIG. 1.

respect to Oy' the symmetrical line to the portion PQ of the line constructed, and taking the differences of the ordinates for same values of abscissæ. The lines O_1NCH (Figs. 1, 2, 3) and O_1N_1NH (Fig. 4) thus obtained clearly show the various properties of the single-phase induction motors in the four cases which we have considered.

When the velocity m increases from zero up to O_1C (Figs. 1, 2, 3) the torque K′ varies from zero up to a positive maximum and down to zero again. It takes a negative value when m is larger than OC. However, if the resistance inserted in the armature is such as to make $r > 2\pi nL$ (Fig. 4), then whatever the value of the speed may be, K′ is always negative. In all these cases the machine cannot be operated as a motor.

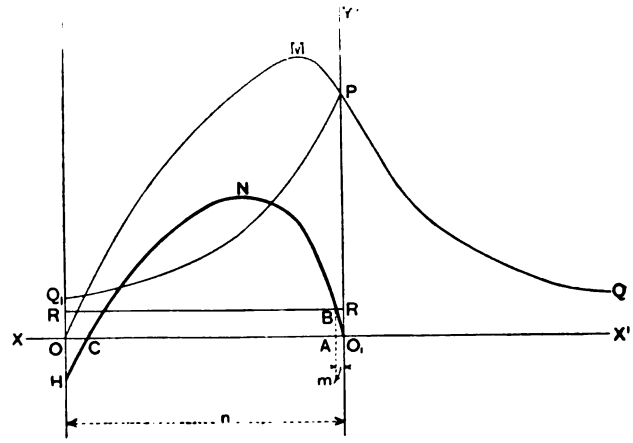

FIG. 2.

Taking $r < 2\pi nL$ (Figs. 1, 2 and 3) it is to be observed that when r is small (Fig. 1) OC is slightly inferior to n, and the maximum value of K_1' slightly inferior to the maximum value of K; when r is comparatively large (Figs. 2 and 3) the differences between O_1C and n, and the difference between the maximum K_1' and the maximum K are larger; they increase both as r increases until $r = 2\pi nL$ (Fig. 3), after which the motor is stopped. Now let the ordinate of the horizontal line RR represent the resisting torque to be overcome; this line meets the curve in B. In order to start the motor it is necessary to reach a speed higher than that corresponding to the abscissa of B. The value of this starting speed for a given

* A communication read before the Associazione Elettrotecnica Italiano, at Turin, September 22, 1897. (We are indebted to Signor Giovanni Giorgi for the translation of this valuable Paper.—ED. *E.*)

† Patents are applied for.

‡ The experiments were carried out on an induction motor of 3, 5 H.P., constructed by Messrs. Brown, Boveri and Cie; the frequency was 40, the voltage 100, and the speed 1,250 revolutions per minute.

§ Galileo Ferraris, "Un metodo per la trattazione dei vettori rotanti od alternanti ed una applicazione di esso ai motori elettrici a correnti alternanti." Memorie della R. Accademia delle Scienze di Torino, Serie II., Tom. XLIV.

¶ J. Sahulka, "Theorie der Tomson's chen Brown's chen Motoren für gewöhnlichen Wechselstrom," *Elektrotechnische Zeitschrift*, July 7, 1893, p. 391. Galileo Ferraris, op. cit.

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torque may be very small when R is slightly less than $2\pi nL$, while it is always comparatively large in all other cases. The condition of r inferior, but by very little inferior, to $2\pi nL$ is, then, the proper one to be satisfied, in order that a quite feeble initial speed impressed on the rotary part of the machine may set up starting under the sole action of the alternating current.

The case of $r = 2\pi nL$ corresponds to the best starting conditions of the polyphase motors, as for $m = 0$ the value of K is a maximum. We may thus say that the additional starting resistance to be inserted in the armature winding of the single-phase motor is little less than the starting resistance of the polyphase motor. It has been already observed, and it results from the figures, that $2\pi nL$ is the

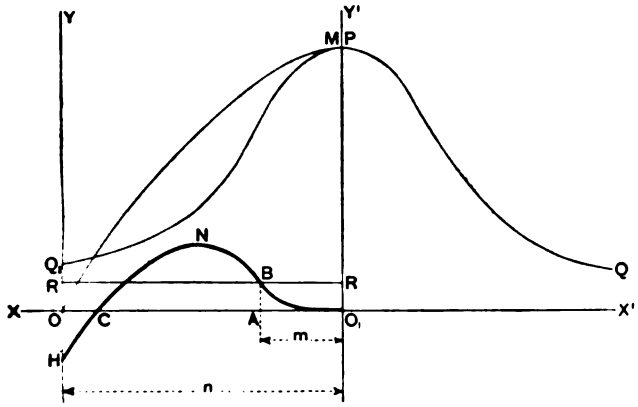

Fig. 3.

maximum value of r, above which, for certain values of the speed, the torque is negative; hence, another rule to fix the proper value of the starting resistance of the alternate induction motor is to take it slightly inferior to the maximum value above which the working of the machine is no longer possible.

As noted in the former Paper,* the first experiments on the proposed method were carried out by the author on a 3·5 H.P. Brown motor, installed in the electrical laboratory of the Museo Industriale in Turin. The results obtained being favourable, in order to properly judge of the technical importance of the method, further trials were necessary. It was possible for the author to accomplish a new line of experi-

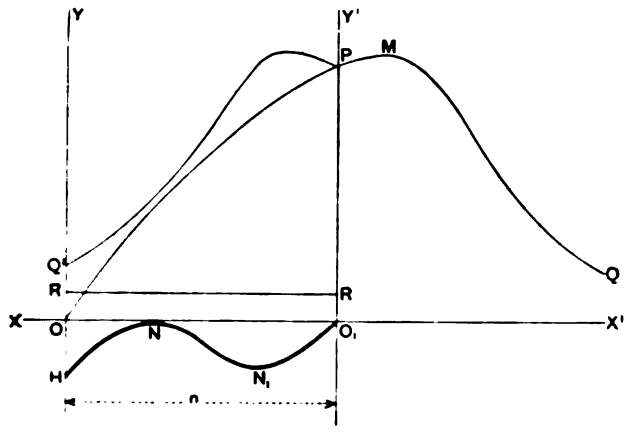

Fig. 4.

ments owing to the special kindness of Mr. C. Sutermeister, the proprietor of the electrical works of Intra; of Mr. A. Croppi, technical manager of same, and Mr. G. Merizzi, the manager of the electrical works of Sondrio, who took great interest in the new method. The author is glad herewith to express to these gentlemen his sincerest thanks. The three motors, distributed on the single alternating distribution of Intra, were constructed by Messrs. Brown, Boveri and Co.; they work, respectively, at the speed of about 600, 800 and 400 revolutions per minute, developing 12, 25 and 110 H.P. The ordinary Brown method, which consists in generating a phase difference in two inductor windings by the help of an electrolyte, had been resorted to up to now in order to start these motors under the load merely of the belt and the loose pulley. The first two motors, of 12 and 25 H.P., are low-pressure (110 volt), the third one high-pressure (3,000 volt); the frequency of the alternate circuit was 42.

Having started these motors by the new method, under the load due merely to the belt and the loose pulley, not only were the results formerly obtained perfectly verified, but also a new remarkable result was obtained, viz., in correspondence with the starting resistance inserted in each elementary winding of the armature the virtual value of the alternating current in the inductor circuit, during the first moments of the initial period, was nearly the same as that absorbed under the same conditions of load during the regular run of the motor. This condition is by far more advantageous than the one obtained when starting the motors by the artificial generation of a rotary field. For these reasons it has been decided to adopt the new method under licence of the author for starting the motors installed in the electric plant of Intra, thus affording an opportunity to practically show that the method offers not only greater simplicity and economy than those employed up to now, but is also far more advantageous in other respects.

* From the commencement of this paragraph to the end of the article the translation relates to a second communication made by Prof. Arno to the same Society, at Milan, October 24, 1897.—Ed. *E.*

LEYTON GAS ENGINE ELECTRIC SUPPLY STATION.*

BY PROF. HENRY ROBINSON, M.I.C.E., M.I.E.E.

When in 1895 I advised the Leyton Urban District Council to adopt gas-producing plant and gas engines at a proposed electricity installation, which I subsequently carried out for them, I was of opinion that the somewhat unsuccessful results that had hitherto attended the exclusive employment of gas engines for driving dynamos in electric lighting central stations was due to causes which could be avoided. The successful working of the Leyton Station since its opening in September, 1896, has proved that my anticipations were correct, as will be seen by the results of tests that I made last month (October) of the plant after a year's working. It may be mentioned that the supply of electricity to the Leyton district is on the continuous current three-wire system, with 300 volts across the outer conductors, or 150 volts on each side of the middle conductor. The plant at the central station consists of the following:—Three Dowson gas generators, made by the Dowson Economic Gas and Power Company (Limited), of 39, Old Queen-street, Westminster, two of which are intended to serve 110 B.H.P. each, and the third is lined with thicker walls to reduce the furnace to serve about 85 B.H.P. The lining can, however, be altered at any future time to make all three generators alike.

Three sets of gas coolers, scrubbers, &c.

One gas holder, 20ft. in diameter and 10ft. high.

Four "Premier" gas engines, made by Wells Bros., of Sandiacre, near Nottingham, each driving by belting a 35-kilowatt dynamo, made by the Electric Construction Company (Limited).

Two batteries of 85 storage cells, arranged on the three-wire system. The cells are of the "Tudor" type, made by Mr. A. B. Pescatore, of Manchester, and have a capacity of 880 ampere-hours.

Three motor transformers for balancing the pressure on the two sides of the three-wire system.

The battery charging arrangements are designed with a view to charging off the 300-volt mains, so that the dynamos may be used for direct supply simultaneously with charging, and also to enable the pressure-steadying influence of the batteries to be felt at all times on the mains (although it is not always needed). This is effected by cutting out 40 cells from the 170, thus leaving 130 to be charged across the 300 volt mains, including a number of regulating cells, which may be cut out towards the end of the charge. A cable connection divides the 130 cells into two sets of 65, and the group of 40 cells, together with a resistance, is placed in parallel with either of the sets of 65 cells, and is shifted from one set to the other at regular intervals during the charge, and the resistance is so regulated as to ensure a uniform charge to all the 170 cells. The introduction of the resistance in series with the group of 40 cells involves some loss in charging, which is approximately equivalent to charging (65 −40) twenty-five extra cells, or 195 cells instead of 170. Taking into account the effect of cutting out the regulating cells towards the end of the charge, it represents more like 190 cells in place of 170, or say, 12 per cent. excess charge. If, therefore, the efficiency of the batteries

* Abstract of a Report to the Leyton Urban District Council.

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is, say, 70 per cent. in ordinary work, this special system of charging would reduce it to about 63 per cent. The advantages resulting from this arrangement, however, far outweigh the loss incurred by the small extra coal consumption, but inasmuch as a large part of the output at Leyton takes place at present from the batteries, it might be thought without this explanation that the figures which are hereafter given show an excessive difference between the current generated and the current sold. As the demand increases the proportion drawn from the batteries will decrease, and therefore the fuel consumption per unit sold will approximate more nearly to the consumption per unit generated, without regard to any improved efficiency which would naturally follow on an increased load.

In October, 1896, some tests were made with the first two engines and producers that were then working, but which have been added to since. At that time the conditions were rather different to those which now obtain. The engines were run at 160 revolutions per minute, with about 52 explosions per minute (out of a possible 80), and drove two dynamos in parallel, generating about 25 kilowatts each. A test at that time lasted 5 hours 35min., the output was 280 Board of Trade units generated, and the fuel consumption was as follows :—

Anthracite coal	448lb.	=1·597lb. per unit.
Coke	52 „	=0·186 „ „
Totals	500 „	=1·783 „ „

This represented a cost of 0·22d. per unit for fuel without taking into account any standby losses. No reliable figures, however, as to working costs were available when that test was made. In March of this year, during a discussion at the Institution of Civil Engineers on gas-producer plant, I was able to give the results of working at Leyton in the previous month of February, when the output was 5,660 Board of Trade units sold, and the coal consumption was only 3·92lb. per unit sold. I then expressed the opinion that the fuel consumption would fall to less than 3½lb., and this has already been fulfilled, for in September the figures were as follows :—

Coal per unit sold	3·28lb.,	costing	0·3608d.
Coke „ „	0·161lb.	„	0·0112d.
Total	3·441lb.	„	0·372d.

The corresponding figures per unit generated were—

Coal	2·24lb.
Coke	·11lb.
Total	2·35lb.

I am indebted to Mr. H. Collings Bishop, the resident electrical engineer of the Council, for data as to the working during the year. Table No. I. gives a summary of the coal consumption and output for each month of this year. The units used at the central station for lighting and other purposes and not metered, and the current required for running the balancing transformers is also accountable for part of the difference between the units generated and the units sold, which in the early stages of working comes out exceptionally high. The records of the cost of fuel during the period given in Table I. show that it was only two-thirds of a penny per unit sold. Although this is very satisfactory, the fuel cost will be even less when the winter months are included. The figures for October, 1897, were somewhat abnormal, owing to an electrical exhibition being held at the Town Hall, for which current was supplied free of charge. The coal per unit sold, therefore, comes out considerably more than in September, but would not have done so in the ordinary course of events. The prospects of further improvement are still considerable, and may be indicated under different heads, although all are more or less connected with the increase in demand.

The steam boiler is capable of blowing the generators to double the power as yet used ; the extra fuel required, being very small, can be obtained from the siftings of the ashes that are raked out of the generators. The consumption of coke will, therefore, remain practically constant until double the present output is reached, when the amount required per unit sold will probably not exceed $\frac{1}{10}$th of a pound.

The increased demand will reduce the time during which the generators stand idle, and the standby loss will therefore be less. The generators will also work at full load for a longer period, and, inasmuch as the efficiency at full load is very much better than at lighter loads, there will be a distinct saving on that account, as well as from running the engines at full load for longer periods supplying direct, and thereby reducing the proportion supplied from the batteries.

Tests made on October 26th and 27th, 1897.—On October 26th the test was carried out with one gas generator supplying gas to two engines driving dynamos at approximately the full load for which the latter were designed. The dynamos were coupled in parallel, and were employed to charge the storage batteries as well as to serve the day load on the mains. The coal used was anthracite, as supplied under contract to the Leyton Urban District Council for ordinary working at 20s. 6d. per ton delivered at the works. The run was quite under normal conditions of working, and goes on every day of the week with very slight variations. The coal for consumption was weighed out in buckets, and the time of stoking noted. The level of the coal in the generator was noted at the beginning and end of the run, and at intervals throughout. The level of the gasholder was also observed at intervals, but was not allowed to fluctuate largely. One of the engines was fitted with indicator gear, and several diagrams were taken every hour. The electrical output was noted by a Kelvin voltmeter and by the ordinary switchboard ampere meters. The readings of the ampere meters were confirmed by the readings of recording watt-meters in the dynamo circuits. The extent to which gas-driven dynamos give and take the current from each other when running in parallel is of course much larger than with steam-driven plant, and, as the load decreases (and reduces the number of explosions per minute), the fluctuation becomes greater. It is a noteworthy fact that during the tests and in ordinary work the dynamos ran with practically no sparking, even when four machines were put in parallel at two-thirds of the full load. The second test (on October 27th) was carried out under these conditions, and very little rheostat regulation was necessary to ensure a fairly equally distribution of the load ; the recording instruments gave 87, 101, 105 and 109 units respectively, as the outputs of the four machines during a five hours' run.

The heat value of the gas was tested by Mr. Dowson's representative by means of a calorimeter at intervals throughout the trials, and the mean results are given in Table II. The gas tested was taken from the inlet main of the gas holder, where all variations in quality would be noted. The heat values given are calculated at 60°F., the average temperature of the gas in the holder. The latent heat of the steam produced in combustion is included. The results of the two tests are set out in Table II., and also plotted in Figs. 2 and 3. The second test was made with two gas generators working at about two-thirds of their full capacity and serving four engines, working at about two-thirds of their full load.

To keep one engine running at full speed with no electrical load involves a consumption of 24·4lb. of coal per hour, or about ½lb. per hour for each "full load" electrical horse-power, and the increased consumption as the electrical load is added amounts to 0·571b. per hour per electrical horse-power. At full load, there-

Table I.—*Monthly Data as to Fuel Consumption and Electrical Output during* 1897.

——	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
Total units generated	8,892	9,417	13,464	11,588	10,630	8,552	9,319	10,744	12,573	17,893
„ „ sold (private lighting)	2,512	2,215	3,154	2,109	1,500	1,196	1,349	1,642	3,228	5,230
„ „ sold (street lighting)	2,393	3,445	4,844	4,645	3,892	3,146	3,247	4,349	5,383	6,332
„ „ sold	4,905	5,660	7,998	6,754	5,392	4,342	4,596	5,991	8,611	11,562
„ „ not sold*	3,987	3,757	5,466	4,834	4,238	4,210	4,713	4,743	3,962	6,331
Total pounds of coal consumed	22,311	22,237	31,543	29,359	26,600	21,737	22,650	27,030	28,256	42,970
„ „ „ coke „	1,202	1,220	1,164	1,239	1,377	1,100	1,024	1,182	1,384	1,301
Maximum current in amperes at 300 volts	130	198	175	180	176	150	162	215	270	370
Ignition gas used (cubic feet)	1,700	2,600	3,950	2,770	2,900	1,700	2,130	3,570	3,000	4,000
Coal per units generated in pounds	2·55	2·36	2·34	2·535	2·50	2·54	2·43	2·51	2·24	2·40
Coke „ „ „ „ „	0·135	0·129	0·086	0·107	0·129	0·129	0·11	0·11	0·11	0·073
Coal „ „ sold „ „	4·55	3·92	3·94	4·33	4·93*	5·000	4·93	4·51	3·28	3·72
Coke „ „ „ „ „	0·246	0·215	0·146	0·222	0·255	0·254	0·223	0·198	0·161	0·11
Ignition gas per unit sold in cubic feet	0·191	0·46	0·493	0·411	0·538	0·392	0·463	0·595	0·349	0·346

* N.B.—The units not sold include much unmetered current such as that used at the central station, and by the motor transformers, as well as the loss in the batteries and in distribution.

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Table II.—*Results of Tests, 1897.*

Date.	Oct. 26. Two engines at full load and one generator.	Oct. 27. Four engines and two generators at ⅔rds full load.
Number of engines at work	2	4
„ gas generators at work	1	2
Duration of test	5 hours	5 hours
Average consumption of coal per hour in lbs.	98·5	151·2
„ „ coke „ „	14·4	17·2
Electrical output in B.T. units—		
Engine No. 1	—	87
„ No. 2	156	101
„ No. 3	—	105
„ No. 4	163	109
Total output in B.T. units	319	402
Average per hour	63·8	80·4
„ I.H.P. of engine No. 4	59·5	43·5
„ E.H.P. of dynamo No. 4	43·7	29·2
Efficiency = E.H.P. / I.H.P.	0·734	0·67
Total I.H.P.	116·4	160·4
„ E.H.P.	85·5	107·6
Assumed B.H.P. (taking it as a mean between the E.H.P. and I.H.P.)	100·95	134·0
Coal consumption per I.H.P. per hour in lbs.	0·846	0·942
„ „ „ B.H.P. „ „	0·975	1·128
„ „ „ E.H.P. „ „	1·152	1·405
„ „ „ B.T. unit generated	1·543	1·88
Coke „ „ „ „	0·225	0·214
Total fuel „ „ „ „	1·768	2·094
Gas consumption per I.H.P. per hour	—	80 cubic ft.
Calorific value of 1 cubic ft. of gas in British Thermal units	153	156

fore, the consumption will be 1·07lb. per electrical horse-power per hour. The light-load consumption may appear excessive compared with the light-load consumption of steam by steam engines, but it should be borne in mind that these figures apply to the combination of gas engines with gas producers, and not to engines alone.

It is sometimes urged that gas engines require more oil than steam engines, but the results at Leyton prove that this is not the case. The first year's working only involved an expenditure of 0·03d. per unit sold for waste, oil and water. All other engine-room stores (such as incandescent lamp renewals, arc lamp carbons, &c.) were covered by 0·045d. per unit sold. There are very few steam engine stations which can show lower figures, even on a much larger scale of working.

The starting arrangements on the engines consist of a hand-pump to force a charge of gas and air into the combustion chamber, and a winch handle with pinion engaging in teeth on the flywheel rim to turn the crank into starting position. The plan works remarkably well. On October 27th the four engines were all started and run up to full speed by one man in 4min. Then, after an interval of 9min. to get the gasholder into the position most suitable for the test, the dynamos were all switched on in another 4min. On another occasion an engine was started within 5min. of the lighting of the ignition burner. During ordinary work the standby engine is, of course, always ready, with the ignition tube heated up.

It should be explained that the coal consumption given in Table I. is the actual quantity weighed and put into the generators. Some of the coal received has to be sifted, as the dust cannot be used in the generator. The total amount of coal paid for is therefore slightly in excess of the figures given. The siftings are available for other purposes, but only at a reduced value. The consumption of coke per unit generated, as given in the table, is very much less than that used in the trial runs. The reason for this is that in ordinary working the siftings from the ashes raked out from the generators are used in the boiler furnaces, and represent a very substantial saving in coke, whereas on the trial runs the fuel used for the boilers was all coke.

On October 27th the amount of ash and clinker raked out of the generator in the morning was 231lb., out of which 136lb. was fit for use in the boiler furnace. The quantity of coal put into the generator to make up the fire to the normal level after clinkering, and to prepare for starting work, was 214lb. There was a delay of some 15min. or 20min. before starting the engines, during which the gas had to be blown off. It appears, therefore, that the amount of coal required to make up the losses in one generator (capable of serving 110 brake-H.P.) after a day's run of about 10 hours at nearly full load is about 2cwt., and the ash siftings available for the boiler amount to over 1cwt. These figures, of course, only apply to the particular kind of coal used in this trial, but the 2cwt. is, I believe, higher than usual with more expensive coals.

With higher-priced coals the amount of clinker and ash would be less, and therefore the making-up quantity would also be less; but, on the other hand, the siftings to go to the boiler would be less, and therefore the coke consumption would be greater. It is doubtful whether any substantial improvement would result from employing more expensive coal. The anthracite used in 1896, and up to July 22nd this year, was different from that now in use and cost more, but the results show no perceptible difference in favour of either.

So far as I am aware, such information as is contained in this report has not been previously obtained or published, and therefore it will be of interest to those who are concerned in deciding as to the relative merits of gas and steam plants. The cost of fuel per unit sold being only ⅔rds of a penny is very satisfactory for a period which does not include the months of November and December, and considering the large difference between the amount of current generated and the amount sold, the proportion of which will, however, be steadily reduced as the load increases.

ELECTRIC LIFTS AND CRANES.*

DISCUSSION.

(*Concluded from page 227.*)

Mr. W. H. PREECE, C.B., Vice-President, said he had early seen that electricity, if it possessed any merits, had the merit that it was particularly adapted for application to the very simple mechanical operation of lifting weights to a certain height. As soon as he had had the chance he had applied electricity to working lifts. The great merit of electricity was that it could be applied where it was wanted, that it could be used when, and only when, it was required; there was no waste in the meantime, and it could be stored quite as well as hydraulic power. He had, at the Post-Office at Leeds, three lifts worked by electricity. One was a short lift, only used for lifting parcel baskets, bags, mails, &c. It made 300 trips a day, and its height was only 12ft. 2in. The other two lifts had a run of 52ft. He had made careful and accurate experiments upon those lifts upon the same system as that adopted by the author. In the table on p. 258 would be found the load, the travel, the time, the power, the energy, and the cost of working. Those engineers who loved the horse-power, and did not understand the watt, would find both in that table, so that both the old and the modern engineer could gratify their feelings in regard to the unit which each used and understood. In Leeds the cost of working each lift was almost exactly £7 per annum, and there were three lifts working there at a total cost for twelve months of £22. 14s. 8d. He had also sent out to the Cape of Good Hope two lifts for use in the General Post Office there. They had been very carefully measured and tested, and their total efficiency worked out at about 40 per cent. In other words, the electric motors worked with an efficiency of over 80 per cent., and the gearing of the lifts themselves had rather a lower efficiency. At the General Post Office in London there were several hydraulic lifts, which were very largely used. Their average load amounted to six persons per trip, and the average number of trips was 238 loaded trips, the total number of trips being much more; 4,560 gallons of water per day were used, being received from the London Hydraulic Company. One was a ram lift, and another a suspended lift, similar to that suggested by Mr. Walker. The ram lift cost £125. 10s. per annum, and the suspended lift £94 per annum. The height of the lifts was 84ft. in the General Post Office, as against 51ft at Leeds; and the average load in the General Post Office was higher than the average load at the Post Office in Leeds. The mean cost per lift for equal loads and equal heights worked out, for the hydraulic lifts £35 a year, and for electric lifts £7 a year; so that, from actual experience, the cost of working an electric lift against a hydraulic lift was in the instance given as 1 to 5. The electric power was developed on the premises. With regard to speed, Mr. Ellington had suggested that the electric lift was slow. The average speed very nearly approached 2ft. per second in the electric lifts. A rate of 300ft. per minute was not comfortable travelling; 2ft. per second was fairly comfortable, and he believed the average was rather below 1ft. per second; so that with regard to speed he did not think any comparison could be drawn, since they were equal. In regard to staff, it was only the difference between a skilled mechanic and a skilled electrician; his experience was that a skilled electrician required less training than a skilled mechanician. With regard to storage, he would say that whatever could be done with a hydraulic accumulator could be done with an electric accumulator. He knew many places where nearly two-thirds of the work of the electric-lighting station was performed by energy stored in accumulators. Many people thought of electric accumulators of to-day as accumulators which existed 10 or 12 years ago, but he could assure them that the electric accumulator of the present day was as different from the electric accumulator of the past, as the water accumulator of to-day was compared with the rough machinery used in the last century. He thought the Table showed that electricity as a motive power applied to lifts and cranes was not to be brushed aside with old-fashioned notions.

* Paper read by Mr. Ravenshaw at the Institution of Civil Engineers.

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Tests of the Electric Lifts at the Post Office, Leeds.

	Lift No. 1.*						Lift No. 2.†						Lift No. 3.†					
No. of Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
E.M.F. constant, 105 volts. Direction	up	down	up	down	up	down	up	down	up	down	up	down	up	down	up	down	up	down
Load ....lb.	0	0	448	448	896	896	0	0	448	448	896	896	0	0	448	448	896	896
Travel ....ft.	12	12	12	12	12	12	51	51	51	51	51	51	52	52	52	52	52	52
Time per trip ...sec.	19	19	17	17	19	17	37	39	38	38	40	35	38	41	38	38	40	38
Maximum cur. amps.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Average current ....amps.	3	15	13	10	21	5	10	28	15	17	28	8	3	27	15	17	26	5
Duration of current ....secs.	19	19	17	17	19	17	37	39	38	38	40	35	38	41	38	38	40	38
Energy per trip ...watt-hours	1·66	8·31	6·44	4·95	11·63	2·47	10·7	31·8	16·61	18·6	32·6	8·1	3·3	32·2	16·61	18·6	30·3	5·5
Cost per single trip at 1½d. per unit	·0025	·0125	·0096	·0074	·0174	·0037	·0160	·0477	·0249	·0279	·0489	·0121	·0049	·0483	·0249	·0279	·0454	·0082
Cost per double trip at 1½d. per unit	0·01495		0·0170		0·0211		0·0637		0·0528		0·0610		0·0532		0·0528		0·0536	
Average current from meter reading....amps.	3	15	13	10	21	5	10	28	15	17	28	8	3	27	15	17	26	5
Average speed....ft. per min.	37·9	37·9	42·3	42·3	37·9	42·3	82·7	78·4	80·5	80·5	76·5	87·4	82·1	76·1	82·1	82·1	78·0	82·1

* Platform, 5ft. 8in. by 7ft. 6in., constructed to carry 15cwt. Balance weight = cage plus 4cwt.
† Cage, 2ft. 10in. by 3ft. 6in., constructed to carry 8cwt. Balance weight = cage plus 4cwt.

Mr. RAVENSHAW, in reply, considered the efficiencies given in the Paper for the electric cranes were low rather than high. He had known electrical cranes which had given higher efficiencies, but the case in point was a special one. It was a large crane, and power was lost in the gearing. The loss in the electrical part was 10 per cent. at full load, and in the gearing about 40 per cent. There was a very heavy chain barrel, and a large weight of chain down the vertical girder which had to be balanced by a heavy hook. In the crane mentioned there was a switch (Fig. 6), by which the motor could be started very gently. He had not advocated either the three-motors or the single motor. He thought the three-motors in many cases could be used with great advantage; but there was the disadvantage that it was possible to apply an inordinately large current, which responded very rapidly, and caused damage. The instruments were all carefully calibrated after the tests, and the results were the average of a great number of readings. He had not advocated electrical over hydraulic lifts, because he was certain that hydraulics would not entirely give place to electricity. A hydraulic lift was certainly very simple, especially when there was a single ram. Mr. Ellington complained that the lift he had ridden in in Berlin did not start immediately, that it lagged and hesitated. Possibly it was a lift made by a German firm, and of which he had recently seen the mechanism. It had an escapement gear, and passengers had to wait till the escapement ran half-way down before the lift would start. He believed the escapement did not reach the bottom at all. With regard to jerking, he had himself gone up and down a hydraulic lift which had caused him great concern. It sometimes went very fast and sometimes very slow; sometimes it could not be stopped, then it was suddenly reversed, and there was a great jerk. He had spoken to the makers on the subject, and they said that it was the fault of the man who worked the lift. A new man was then employed, and the jerking did not now take place. This showed that care had to be taken in working hydraulic apparatus. He had ridden in many English electric lifts, and as a rule, they worked very steadily. The rope could be pulled right down to the bottom, and it started smoothly. As to the small number of working parts, the electric lift gear (Figs. 1—3) showed only two working parts, namely, an armature and worm-wheel. In the lift gear shown there was a second guide-wheel, but many lifts had not that. In the jigger lift there were more than two working parts. As to being able to apply a large amount of power, that was done every day in the case of electric railways. He did not think there was any difficulty in that respect, with heavy flywheels and automatic expansion gear, especially with the accumulators now being used. With regard to the cost of transmitting power by electricity, generating plant for electricity cost about 25 per cent. more than for hydraulics, the engines and boilers required being the same. Where overhead wires could be used the cost of the electrical conductors was much less than that of hydraulic pipes, but where underground conductors were used the cost was about the same. The increased cost of electric motors and gear was about 25 per cent. greater where a short travel was required, but for hauling-engines, where a rotary motion was necessary, he did not think there was much difference. He had experience of a great many plants on both systems, and had based his figures on practice. As to repairs, electricity had a great advantage over hydraulics, as it was not affected by frost. He had fitted hydraulic cranes with electric wires to heat the pipes and cylinders to prevent freezing, and had effected a saving of nearly £100 a year in repairs per crane in consequence. With properly-constructed electric motors the repairs and maintenance did not exceed 5 per cent. per annum. As to cost of working, in a typical plant where the power was transmitted over an area of, say, one square mile, the losses were approximately as follows:—In dynamos 8 per cent., in cables 8 per cent., in motors 10 per cent. under varying loads, or a total loss of 24 per cent. The engines could be taken to deliver power to the dynamos at a cost of £8 per brake-horse-power per annum, so that the power would cost £10·5 per brake-horse-power per annum at the motor-shaft. Electric motors were remarkably well suited for travelling cranes, and could be arranged so simply that they could be very easily adapted to existing machines. This application was an extremely important one, and a large number of square shaft and rope-driven cranes had been adapted to work by electricity in the last few years

CORRESPONDENCE.

Mr. JOHN A. F. ASPINALL remarked that in the erecting shop at Horwich good illustrations were afforded of the advantages of driving overhead cranes with electric motors instead of ropes. There were twenty 30-ton cranes in this shop, driven in pairs, with a single rope 1⅝in. in diameter, 600ft. long, weighing 3½ cwt., and running at a speed of 3,880ft. per minute. Each of the 10 ropes, with their pulleys, absorbed 15·5 H.P. The energy required to lift a 46-ton engine with two cranes was only 16·4 H.P., including internal friction. The ropes had been dispensed with, and a single motor fitted to each crane with most advantageous results. Another application of electricity to lifting work was shown by an arrangement he had had introduced in the Victoria (Manchester) Station of the Lancashire and Yorkshire Railway for the transmission of parcels from point to point. The arrangement was unique, and, he believed, the first of its kind. It had been running for two years, and lifted baskets containing 8 cwt. of parcels, and, when high enough, ran with them at about eight miles an hour. It covered about 100 miles a week, lifted about 500 or 600 baskets of parcels, and had consumed, on an average, 45 B.T. units of electricity in the same time. The current was taken from the electric-lighting circuit, and passed from one rail through the machine, returning through to the second rail.

Mr. H. S. COTTON noticed that the author advocated a gear with a quick pitch for the worm. With a worm of sufficiently flat pitch to make the gear self-holding there was at any rate a loss by friction of about 50 per cent. of the energy required to work the lift, but even in hand-power goods lifts self-holding gear was almost always employed, notwithstanding this loss, on account of the gain in safety and simplicity. It appeared a retrograde step to permit in an electric lift the holding of the cage in position at the various floors to be dependent on a brake brought into action by an extraneous machine, viz., a spring or a falling weight. In a hydraulic

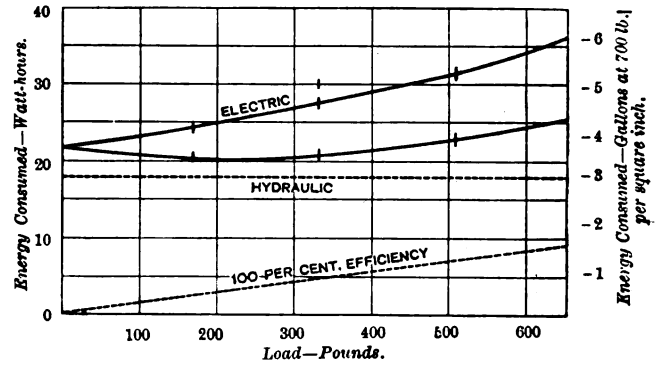

FIG. 11.

lift, whether of the suspended or direct-acting type, the position of the cage was directly controlled by the admission or release of the water, and when the power was shut off, the cage was locked in position by the water in the working cylinder. In comparing the working of hydraulic and electric lifts the pressure of the water power available was important. Many lifts were worked from the domestic supply mains, and these were sometimes miscalled hydraulic lifts, though the pressure available was seldom as much as $\frac{1}{10}$ of the ordinary hydraulic pressure of 700lb. per sq. in. With low-pressure water the supply pipes and lifting machinery were bulky and expensive, and, unless large reserve tanks were specially provided, the domestic supply was rarely sufficiently constant in pressure to give an efficient result. When water at a pressure of 700lb. per square inch was available, it was regularly adopted as the most suitable power for lifts and cranes; he was not aware of any instance of a lift formerly worked by hydraulic power at this pressure from the public mains having been replaced by an electrically-driven lift. The curves in Fig. 11 indicated energy consumed in watt-hours, and the equivalent in gallons of water at

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a pressure of 700lb. per square inch. The lower inclined straight line showed the energy required to raise different loads to a height of 36ft. 6in., assuming an apparatus with an efficiency of 100 per cent. The horizontal straight line showed the energy, viz., 3 gallons, the equivalent of 18 watt-hours, consumed by a simple hydraulic suspended lift in raising the load to the full height at a speed of, say, 180ft. per minute. The flat curved line next above the horizontal line was the upper curve given for the electric lift in Fig. 4 of the Paper, and showed the energy consumed at different loads when the cage was taken up and down again with the same load; in the actual work of a lift such circumstances occurred very rarely. The upper curve showed the energy expended by the electric lift when different loads were taken up and the cage was brought down empty. This curve with no load showed 20 per cent. more energy consumed than by the simple hydraulic lift at full load; and when the electric lift was working at its highest efficiency of 25 per cent., as shown on the diagram, the consumption of energy was double that of the hydraulic lift. The results for the consumption of energy by an electric lift given by the author were apparently for working the cage up and down without stopping at any intermediate floors. This did not prevail in practice, and the cage would sometimes be stopped at each floor, and on the average at certainly more than one floor for each trip. With a hydraulic lift, the consumption of power was not increased, however frequently the cage was stopped, the energy being always consumed in proportion to the height travelled. The results for an electric lift given by the author in columns 5 and 15, Appendix I., showed the energy consumed to be relatively considerably higher with a shorter travel, viz., 8·3 watt-hours, with a travel of 24ft. 9in., and 11·12 watt-hours, with a travel of 36ft. 6in. Assuming, apart from the power consumed in starting and stopping the cage, the energy used to be proportional to the height travelled, these results showed that, when the cage and load were balanced, it required 2·2 watt-hours of energy to start and stop the cage once on the up journey. The increased consumption, amounting to 8 per cent., due to one additional stop on the journey with a load of 336lb., was marked at 1. At higher loads, with the cage stopping at the intermediate floors, the consumption of energy by the electric lift would presumably be largely increased.

Mr. E. KILBURN SCOTT remarked that in modern practice the objection to the end-thrust in single worm-gear, representing, as it did about 20 per cent. of a total of 30 per cent. lost in friction, was overcome by employing duplex worms on the motor shaft, one right-handed and the other left-handed. The two worm-wheel shafts were meshed together, and thus each worm only took half the load, and consequently its life was much prolonged. Again, besides there being a total absence of end-thrust,

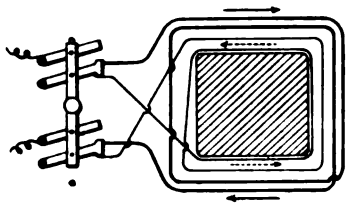

Fig. 12.

experience would appear to show that the actual friction of the worms themselves was less than with a single worm and worm-wheel. An efficient ball or roller-thrust bearing was expensive; and it should also be remembered that it was detrimental to use any but the best lubricants. All the earlier lift-motors were reversed by reversing the direction of current through the armature, but the Otis and other types of lift were now generally fitted with field control—the current in the field-magnet coils being reversed at each journey up or down. For eliminating permanent magnetism, and at the same time reducing sparking, "reverse coils," consisting of several windings placed alongside the field-coils, Fig. 12, were used with the Eickemeyer motors on the Otis lifts, and were thrown into circuit each time the field circuit was cut off. On throwing over the switch shown in the figure, the current due to the field-magnets losing their magnetism had a path open to it in the opposite direction round the field magnet (as shown by the arrows), and the arrangement was therefore very effective in reducing residual magnetism, and so facilitating the working of "field-controlled" motors. He thought that in the automatic throttling rheostat, as used in electric lifts, there was something wanting—at any rate for the higher speed passenger service of, say, 250ft. per minute, especially when considered from the point of view of its useful working life. When it was remembered that a high-speed passenger-lift must gradually start and travel, and then gradually stop again in moving from one story to the next in, say, 4sec. to 5sec., it would be seen that the automatic action had to be very quick. On this account also the *vis-viva* of the armature and gear must be as low as possible, and it was probably this fact more than any other which had proved the small squat Eickemeyer motor to be so eminently suitable for the work.

Electricity had an advantage over hydraulic power in that it was very easy to conduct the electric power into the car; but so far as he was aware, this had only been taken advantage of for the purpose of putting switches and regulating devices on the car; the pilot motor regulation which Mr. Sprague used on his screw lifts being a case in point. In view of these facts, he had designed an arrangement in which full advantage was taken of the flexibility of the electric system, whilst at the same time realising high-speed service, exact stopping at the floors and maximum safety. The arrangement consisted of two steel spindles screwed along their whole length with a double thread of about 3in. pitch; they were firmly held from revolving at both ends of the car-race, and passed through the corners of the cage as shown in Figs. 13. An electric motor was attached to the lower side of the car, which was supplied with current either by means of hanging cables or by slippers pressing against copper strips fixed to the side of the car-race. The motor drove two pairs of skew-wheels, arranged right-hand and left-hand, thus effectively getting rid of end-thrust. The driven wheels (Fig. 14), to a larger scale, formed the nuts to the screws, being split so that they could be readily replaced. The friction between the nut and the screw might be reduced by having steel balls between their respective threads, as in the Sprague lift, but owing to the very quick pitch of the thread he did not think this was required, and, as would be seen, a conical roller or ball-bearing was interposed between the cage and the nut. In descending with a heavy load, the motor might be used as a very efficient brake by being short-circuited on itself or being temporarily turned into a generator, in the same way as on some of the electrically worked mountain railways in Switzerland; and thus in a building where there were several lifts, they might be made to help one another. There were some disadvantages in the arrangement, but on the other hand there was the great advantage that the car-attendant had the power directly at his feet, and could at any time see exactly how the motor, switches, &c., were working. Great safety and exact stoppage at floors were also secured, and the arrangement was self-contained, as no starting-rope with its sheaves (or its more complicated equivalent, the pilot-motor) was required. In order that the extra weight carried by the cage might be as small as possible, he had designed a motor for the work which had its magnetic circuit made entirely of laminated iron; the frame and the two bearings being made of an aluminium alloy, which, whilst being almost as strong as cast-iron, was only about one-third its weight. The same method could be worked out

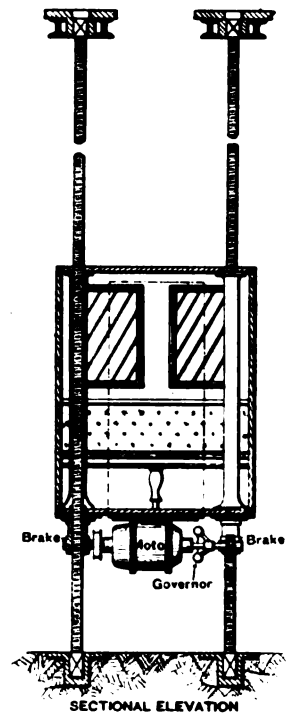

Fig. 13.

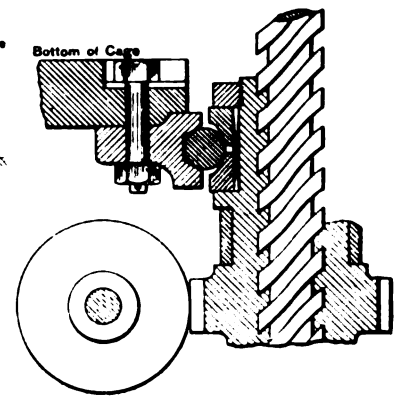

Fig. 14.

with a rack at the side of the car-race, or the motor might be fitted with a winding drum, and haul itself up and down. These did not give the safety of two screws, but in any case there seemed to be no valid reason why the beautiful flexibility of electricity should not be taken full advantage of by placing the motor on the car itself.

Mr. R. LETHBRIDGE TAPSCOTT observed that electrical transmission rendered available a single source of energy for the various requirements of extensive works, which formerly involved the use of gas for lighting, steam to drive the shafting for working the numerous machines, and to drive the pumps for obtaining the pressure necessary to work hydraulic presses. The question now arose whether the hydraulic pressure could be usefully replaced by the electric current, or by an electric motor used to work the accumulator. The working of the travelling crane had now been perfected, but there remained for improvement the haulage of the trucks and trolleys through the works, without overhead wires. When these could be replaced by some simple arrangement it would be possible to convey the power by easily disposed cables, free from the objection to running shafting, and possibly with greater economy of the initial steam-engine power. He assumed that the author was describing the lifting of the heaviest weight yet attempted by electrical power and with the fewest electrical machines; it would appear, however, that by having only one motor, three sets of gearing and two minor electrical appliances were necessary. He therefore asked whether, in addition to the dynamo supplying the power, three independent motors, one for lifting the weight,

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another for travelling the crane, and the third for traversing the weight, would not be more economical and render unnecessary all the gearing, besides enabling the coupling of the hoisting-drum direct to the motor. The rotation of the drum would then be the same as the rotation of its motor, and the power from the motor receiving the current from the supply-station would be treated so as to rotate the motor carrying the hoisting-drum slowly; and by the introduction of suitable magnets the current would then be used as a brake. The author, however, appeared to have satisfied himself by experiment that the gearing was preferable to the multiplication of electrical appliances, while acknowledging that the switching on and off of a current was such a simple process; besides, there was the case of locking with the current by the use of magnets, which appeared so simple that he was disposed to think that the gearing might eventually be dispensed with in such machines.

Mr. R. H. THORPE said that motors connected with winding machinery had to start their loads from rest, and accelerate them smoothly and as quickly as possible without using large power from the supply circuit. In order to fulfil these conditions a shunt motor with a few series turns was not enough, since the starting and accelerating current under such conditions would be nearly double the running current for maximum load. To fulfil the conditions without drawing heavily on the mains required a motor giving a starting torque at least double the running torque, such a requirement could not well be filled with such a small motor as the author proposed, even if the motor only occasionally did maximum work. It was well known that properly-constructed worm gear gave a very good efficiency, where the pitch was made quick enough, as it naturally would be with high-speed elevators, running at speeds of over 200ft. per minute. The arrangement of rope transmission stated to be used by Messrs. Easton and Anderson, similar to that used by cable tramways, was not as well adapted to lifts as a fixed rope on the drum, since the automatic devices for stopping the car at the top and bottom must be more complicated, and therefore, for every-day use, were not as reliable. No mention was made in the Paper of a very interesting system of controlling lifts which gave ideal results in respect to starting and stopping. In this system the motor received its power from a special generator. The armatures of the generator and motor were connected, the motor field was constantly excited from an independent source, the generator field being controlled by a switch in the car. The generator armature was kept revolving at a constant speed, so that the power supplied from it was under control of a car-switch worked by the attendant. The whole operation was therefore electrical, and no mechanical brake was used, and, consequently, all jars were avoided. Even at the highest speeds the car started and stopped without vibration. The drawback was the extra generator, and consequent cost and additional space required. The starting device designed by the author required, as explained by him, only so much resistance as was needed to allow the maximum current to start the motor with the maximum load. This was permissible for small duties and motors designed with large starting torque. For heavy-duty lifts such an arrangement was objectionable, since it was not permissible on supply circuits of moderate size to use the maximum current for maximum loads every time a motor was started; yet where a centrifugal governor reduced the resistance it became necessary to allow for every load the maximum current, since no resistance could be cut out unless the motor had first started its load. Where the author employed a solenoid with a shunt winding connected with the armature terminals, unless this magnet was very powerful it might refuse to work when the contacts became rough; and, on the other hand, his method of working was uncertain, since it was not impossible that the brush, after having cut out all resistance, would not drop back to the starting position when the motor stopped, the operation depending upon gravity alone.

Mr. F. W. WEBB remarked that the travelling cranes in the Crewe Works, some 53 in number, had been constructed for rope or cord driving, and, generally speaking, the results had been satisfactory, although loss in power was inherent to the system. He had early felt convinced that electric power might be applied with many advantages; it was not, however, until the latter end of 1889 that a somewhat serious accident occurred to a workman due to the breaking of a cord running at a speed of about 5,000ft. per minute, which induced him to substitute experimentally electric power for the cord in one of the cranes. The new system had been put to work in the early part of 1890 with such encouraging results that he had since applied it to nine others, and he anticipated that in the course of a few years all the cranes at Crewe would be electrically driven. Of the 10 cranes altered two had each a lifting capacity of four tons, three of 10 tons, one of 15 tons, and four of 30 tons. The motors, switches, and other electric apparatus, which were constructed at Crewe, were all of one type, but varied in dimensions to suit the varying powers required. The armatures were of the Gramme type with Paccinotti teeth. The field-magnets were of the Manchester type, and were cast in mild steel specially made for the purpose at Crewe. An independent motor was provided for each of the three movements of the crane. In the case of the lifting and long traversing movements the motors were of the same size, but for the cross traversing movement a smaller motor was provided. The magnets were energised three in series from a circuit which was never broken, the current in this circuit being about one ampere and the pressure 120 volts. The movements of the motors, which were reversible, were controlled by switches actuated by three short levers placed immediately in front of the crane attendant. In their normal position these levers stood upright, and they were pushed from him or pulled towards him in accordance with the direction he wished the movement to be made; and in each case the current on the first movement of the switch passed through a variable resistance formed from the scrap charcoal-iron left after forming the armature plates. This resistance was wholly cut out when the lever was pulled over. The switch contacts were of carbon, the short ends of arc-lamp carbons being used for the purpose, and the same carbon was used for the motor brushes, which had a fixed position in relation to the commutator. All motors were constructed to run at a maximum speed of 1,500 revolutions per minute, a worm and worm-wheel transmitting the movement to the crab gearing. In the case of the 30-ton cranes used in the erecting shops for lifting locomotives, the load was lifted at a speed of 2ft. 6in. per minute at an expenditure of 70 amperes at 120 volts. The long travelling was performed at a speed of 100ft. per minute with an expenditure of 60 amperes at 120 volts, and the cross traverse at a speed of 50ft. per minute with an expenditure of 30 amperes at 120 volts. In the case of light weights the speed of lifting was 10ft. per minute. In the case of the 15-ton crane, which had been provided in connection with a boiler-riveting plant, the crane was 50ft. above the floor-level, and all its movements were controlled by switches on the ground, a magnetic brake being provided on the armature shaft to arrest the motion as soon as a rivet-hole had been brought into place for the closing of the rivet. The cost of repairs had so far been very small; no renewal of commutators had been necessary, but they had to be lightly skimmed up in the lathe about once in twelve months. The carbon switches and brushes had to be renewed once in six months, and as this applied to cranes which were very heavily worked, the result was considered satisfactory. He took the opportunity of acknowledging the services of Mr. A. M. Thompson, M.Inst.C.E., his chief assistant in charge of the electrical and signalling departments, under whose supervision the work referred to had been carried out.

Mr. RAVENSHAW, in reply to the correspondence, thought the remarks of Mr. Aspinall and Mr. Webb bore out his experience that it was comparatively easy to apply electricity to an existing travelling crane. Electric transmission appeared to be specially suitable for this work, the energy being transmitted through fixed conductors, instead of by ropes or square shafts running at a high speed. He considered the use of a slow-pitched worm, the only advantage of which was the holding power due to its low efficiency, entirely wrong, and he had experienced no difficulty with the use of magnetic brakes. He was afraid the arrangement of vertical screws suggested by Mr. Scott would be very expensive and have a low efficiency. There was no difficulty in winding an ordinary motor of good design to give a good starting torque with a small current without further complication in the switching arrangements. He preferred magnetic to mechanical brakes, and when they were well designed and were controlled by a double-pole switch there was no danger of their refusing to act.

ANNUAL GENERAL MEETING OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the annual general meeting of the Institution of Electrical Engineers on Thursday, the 9th inst., the annual report of the Council and the statement of accounts and balance-sheet for the year ended September 30, 1897, were adopted. The following resolution, moved by the President, seconded by Major S. Flood Page, and supported by Prof. S. P. Thompson (Vice-President), Mr. Langdon, Prof. Perry, and Mr. Mordey, was unanimously carried:—

> "That in further recognition of his valuable services to the Institution during the past 20 years, a pension of £300 per annum be allowed to Mr. F. H. Webb on his retirement from the office of Secretary."

Votes of thanks were unanimously accorded to the Institution of Civil Engineers, the local honorary secretaries, the honorary treasurer (Prof. Ayrton), the honorary auditors (Mr. F. C. Danvers and Mr. A. Stroh), the honorary solicitors (Messrs. Wilson, Bristow and Carpmael).

The President announced that the scrutineers reported that the gentlemen named in the list published in *The Electrician*, November 12th, p. 67, had been duly elected as President, Council, and officers for the year 1898.

Report of the Council.

Elections and Transfers.—The total of the additions to the Register during the year has been 216, comprising 3 foreign members, 17 members, 120 associates and 76 students, and 53 candidates have been approved for ballot next month. 24 associates have been transferred to the class of members, and 82 students to the class of associates.

Deaths and Resignations.—The losses sustained by the Institution during the year through death amount to 22, viz.: 2 honorary members (Mr. Jacob Brett and Dr. Von Stephan); 2 foreign members (Dr. W. P. Brix and G. Verier); 6 members (John Aylmer, W. S. Graff Baker, W. H. Blakeney, W. W. Cargill, H. C. Forde, and W. Moir); 10 associates (J. Auchinachie, F. V. Andersen, L. H. Chase, Paul Dimier, Capt. A. B. Hawes, F. Lilley, E. Oldroyd, A. Pond, G. H. Thornton and T. B. Webber); and 2 students (Edward Ray and C. Yatman).

Special allusion has previously been made to Mr. Jacob Brett, whose name must always be remembered as that of one of the very earliest pioneers in telegraphy, as one of the founders of submarine telegraphy; to Dr. von Stephan, who in his position of Postmaster-General of Germany, did so much for telegraphic science; and to Mr. John Aylmer, one of the most zealous and indefatigable of the Institution's local honorary secretaries. Mr. H. C. Forde was one of the original members and a former member

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of Council; his name was very prominently connected with submarine telegraphy, and his death was deeply deplored by all who knew him.

Two foreign members, two members, twenty associates and six students have resigned during the year.

Papers.—In addition to the very interesting Inaugural Address of the President, the following Papers have been read during the year.

Date.	Title.	Author.
1897.		
Jan. 28.	"Electrically Interlocking the Block and Mechanical Signals on Railways."	F. T. Hollins (member).
Feb. 25.	"The Relative Size, Weight, and Price of Dynamo Electrical Machines."	E. Wilson (member).
Mar. 11.	"On some Repairs to the South American Company's Cable off Cape Verde in 1893 & 1895."	H. Benest (associate).
April 8.	"Some Recent Developments in Electric Traction Appliances."	A. K. Baylor.
April 22.	"The Generation of Electrical Energy for Tramways."	J. S. Raworth (member).
May 13.	"The Disturbance of Submarine Cable Working by Electric Tramways."	A. P. Trotter (member).
May 27.	"Dynamos"	W. M. Mordey (member).
Nov. 11.	"Accumulator Traction on Rails and Ordinary Roads."	L. Epstein (member).

Annual Premiums.—In respect of Papers read during the Session 1896-97 the Council make the following awards, viz.: the "Institution Premium," value £10, to Mr. W. M. Mordey (member) for his Paper, entitled "Dynamoes"; the "Paris Electrical Exhibition Premium," value £5, to Mr. John Gavey (member) for his Paper on "The Telephone Trunk Line System in Great Britain"; the "Fahie Premium," value £5, to Mr. Benest (associate) for his Paper on "Some Repairs to the South American Company's Cable off Cape Verde in 1893 and 1895." They also award an extra premium of £5 to Mr. A. P. Trotter (member) for his Paper on "The Disturbance of Submarine Cable Working by Electric Tramways."

The Students' Premium, value £3. 3s., they award to Mr. P. S. Sheardown, for his Paper entitled "Notes on Electric Tramway Traction," and they further award two extra premiums of £2. 2s. each to Mr. F. Johnston for his Paper on "Accumulators," and Messrs. R. M. Sayers and S. S. Grant for their Paper on "The Working of Long Submarine Cables."

The Council desire to remind members of the increase which they have decided to make in the number and values of the annual premiums commencing with the Session 1897-98, viz:—

The "Institution Premium" to be increased from £10 to £25
The "Paris Electrical Exhibition Premium" to be increased from ..... 5 to 10
The "Fahie Premium" to be increased from ..... 5 to 10

Two additional premiums for original communications, not read, but accepted for publication in the *Journal* of the Insitution, viz., one of £10 and one of £5.

For Papers by students, read at the students' meetings:—

One premium of £10.
Two premiums of £5 each.

The Willans Premium.—Looking to the fact that the award of this premium is, according to the Trust, to be made triennially, your Council, by whom the first award is to be made, have considered themselves justified in selecting for such award any one of the Papers on the subject specified in the trust deed which have been communicated to the Institution since December, 1894, the date of the trust being January, 1895, and they accordingly award the premium, the value of which they have increased to £25, to Mr. Mark Robinson (member) for his Paper entitled "On the Recent Development of the Single-Acting High-Speed Engine for Central Station Work," read May 9, 1895.

Salomons Scholarship.—Ths Council have awarded a Salomons scholarship of £50 to Mr. Edward Ernest Tasker, a student of the Technical College, Finsbury.

Students' Class.—The Council are glad to be able to report that the improvement in the merits of the Papers read at the students' meetings, to which they alluded last year, was sustained during the past Session. Visits to the following places were arranged for the students by the secretary during the year, viz.: the works of the Electric Welding Company, the works of the India Rubber, Gutta-Percha and Telegraph Works Company, the works of Willans and Robinson, the stations of the City and South London Railway, the Central Electric Lighting Station, Islington, and the electric lighting works of the Great Eastern Railway.

The Council have pleasure in acknowledging the facilities thus kindly afforded to the students of visiting works of so much interest to them.

Wiring Rules.—The new wiring rules, as finally approved by the Council, were issued at the end of July last. The revision of the former rules was carried out by the Technical Committee, comprising the whole of the Council and some other members, whose experience was such as to render their advice and assistance of special value. The Committee and its sub-committee held many meetings, and obtained, both by personal interviews and by correspondence, very valuable information and opinions, not only from municipal engineers and the engineers of electric lighting and power stations, but from the leading manufacturers of cables and apparatus. The rules, consequently, are based upon the experience and knowledge of representatives of all classes in the electrical profession and the electrical industry, and can scarcely fail, therefore, to be of material service to all who are engaged or interested in the employment of electric energy for lighting, heating, or motive power, &c. Although in certain respects somewhat more detailed than the old rules, they are not intended to take the place of specifications drawn up by consulting engineers, or to be regarded as other than an enunciation of the general principles which should be observed in the wiring for the supply of electrical energy.

Annual Dinner.—The annual dinner was held this year at the Hotel Cecil on November 24th, and the number of members present was larger than usual.

Annual Conversazione.—The Conversazione this year was, by permission of the trustees of the British Museum, held in the Galleries of the National History Museum, South Kensington, and was very numerously attended. Much of the success of the entertainment was due to the temporary installation of the electric light for the occasion by the Kensington and Knightsbridge Electric Lighting Company, who, at the request of the Council, kindly undertook to carry out the work at a minimum of cost to the Institution. Your Council are glad of this opportunity of acknowledging their indebtedness to their colleague Mr. H. W. Miller, the engineer to the Company, for the great amount of trouble taken by him personally in respect of the work which had to be carried out under considerable difficulties.

Building Fund.—The amount standing to the credit of this account at the date of the last annual general meeting was £3,528. 4s. 2d. This year the Council, in pursuance of the desire unanimously expressed by the members that the fund should be augmented from time to time, as far as the finances will permit, have transferred to it from the general fund a further sum of £1,000 out of the surpluses of 1895 and 1896, which sum, together with dividends and income tax recovered, brings the total amount standing to the credit of the fund on Sept. 30th last up to £4,639. 13s. 7d., of which £63. 15s. 11d. remains to be invested.

Annual Accounts and Financial Position.—The statement of accounts and balance sheet for the year ending Sept. 30, 1897, shows that the financial position of the Institution continues sound and satisfactory, the excess of the receipts over expenditure during the year being £1,080. 11s. A further amount of £185. 1s. 9d. has been invested on account of life compositions, leaving at the date up to which the accounts were made a balance of £131. 6s. 5d., which has since been also invested. The Council have the satisfaction of reporting that the amount already received in respect of subscriptions outstanding on Sept. 30, 1896, exceeds the estimate made in the last annual report, viz., £532. The estimated realisable amount of subscriptions outstanding on Sept. 30, 1897, is £555, and some of this is taken into account in the balance sheet now presented.

The Secretaryship.—On March 25th last your President announced that Mr. Webb desired to retire in February next from the office of Secretary, which he will then have held for a period of 20 years. The applications received in response to the advertisement inserted in the technical journals for a successor to Mr. Webb were 48 in number, and were very carefully considered by a Committee specially appointed by the Council, and certain of the candidates, whose qualifications appeared to best meet the requirements, were personally interviewed by the Committee in the first place, and subsequently by the Council, who finally selected Mr. Walter George McMillan, F.I.C., F.C.S., late lecturer on metallurgy at Mason College, Birmingham. Although Mr. McMillan will not actually take office until February 12th, his engagement commenced on October 1st, so that he might have ample time to make himself acquainted with the duties of his office. The Council feel that they would be failing in their duty were they to omit to place on record their high appreciation of Mr. Webb's services to the Institution during the best years of his life. While they respect his single-mindedness, his high personal character, and those qualities which have made every member a friend, they deeply deplore the loss of his services.

Meetings of Scientific Societies.—In this issue of *The Electrician*, and in future issues, the announcements of meetings of scientific societies, &c., will be found at the bottom of the last column of Notes.

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The Electrician.

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ELECTROMAGNETIC THEORY, VOL. II.—By Oliver Heaviside. The second volume of this important work is in an advanced stage, and will be ready shortly.

ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.—By J. Elton Young. This work will be issued early in 1898. Some extracts from the book have already appeared in *The Electrician*, from which it will be seen that the latest practice in Electrical Testing for Telegraph work has been treated by the Author.

THE ELECTRIC ARC.—By Mrs. Ayrton. This work will shortly be published, and will contain an historical sketch of the early experiments on the electric arc, as well as the important results of recent research.

PRACTICAL TELEPHONY.—By Dane Sinclair and F. C. Raphael.

SECONDARY BATTERIES.—By E. J. Wade. Fully illustrated. The Author in this work will deal briefly with the theory and fully with the chemistry, design, construction and manufacture of secondary batteries or accumulators.

PRIMARY BATTERIES.—A work on this subject will shortly be published, bringing the theory and practice of the Primary Battery up to date. The book will be fully illustrated.

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"THE ELECTRICIAN" WIREMAN'S POCKET-BOOK.—"The Electrician" Company will shortly publish a valuable pocket-book for the use of those engaged in wiring work, both external and internal.

CHRISTMAS WEEK NOTICE.

In Christmas week "The Electrician" will be published on Friday, as usual, but Contributions, Correspondence, News Items and Advertisements should reach the Publishing Offices not later than midday Wednesday, December 22nd.

GAS-ENGINE ELECTRIC SUPPLY STATIONS.

Internal combustion engines have been adopted in many electric supply stations at home and abroad in preference to steam plant. We have frequently noticed this practice, and have criticised it from different points of view; and descriptions of several gas-engine stations have appeared in *The Electrician* from time to time. In our issue this week will be found two articles intimately connected with the subject. One of these is a descriptive account of a successful little gas-power electric light plant, at Leicester, which is worked by the Midland Railway Company for lighting their railway station and yards. Through the courtesy of Mr. W. Langdon, the chief of the electrical department, we are enabled to put our readers in possession of facts, regarding the working of a gas-power station, that must go a long way towards the settlement of the vexed question as to the suitability of gas engines for electric-power stations. The other article is an abstract of a report from Prof. Henry Robinson, dealing with the interesting little gas-engine electric supply station owned by the Leyton Urban District Council. Prof. Robinson boldly assumed considerable responsibility when he advised the Leyton Council to adopt gas power, at a time when the failure or scanty success of this form of engineering experiment in other quarters was obviously tending to discredit it in the eyes of a great many leading central station engineers. But Prof. Robinson had the courage of his convictions; and he felt, what we have often expressed as our own view of the matter, that—to quote from his recent report—"the somewhat unsuccessful results that had hitherto attended the exclusive employment of gas-engines for driving dynamos in electric lighting central stations was due to causes which could be avoided." It must be peculiarly gratifying to Prof. Robinson to be able now, as he reviews the condition of the Leyton station, to feel that already to a great extent his faith in the

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gas-engine has been justified, and that there is so much promise of improved working in the near future.

Primarily, the consideration which suggested and ultimately led to the adoption of the gas-engine in an electric-generating station was the enormously higher possible and realised efficiencies of the internal combustion engine, as compared with the boiler and steam engine. It is not too much to say that upon this one fact of the superior fuel economy engineers chiefly based their expectation of success with gas-engine stations. Riper experience has shown that this consideration alone, important though it be, is not sufficient to satisfy the practical and commercial conditions of the problem. The earlier experiments in gas power for electric generating stations were comparative failures, because sufficient attention was not paid to the many chances of defective working to which gas engines were liable—defects that required but careful attention and forethought in order to remove them. A plant that worked under conditions in which almost the only item standing to its credit was a superior economy of fuel was speedily, as it was indeed inevitably, found to be severely handicapped. Yet it was soon made manifest that the chief defects exhibited were incidental rather than inherent; and, gradually gaining experience in a novel form of central station work, engineers came to recognise that the plant should be designed and laid down with special regard to the class of work it was intended to perform. If this course should now seem so obvious that its non-adoption in the first instance was ridiculous, the story of Columbus and the egg may serve to remind us that what may appear obvious after an event will often seem difficult or even impossible before the event has occurred.

It may be instructive to indicate what appears to be the prospect, for the immediate future, of gas-driven electric generating plant; the assumption being, of course, that no radical improvement in gas engine practice will be introduced which might place the practice on a different footing. Hitherto gas-engine electric power stations have been classed among supply concerns of low or moderate size, and we know of no instance where gas power has been exclusively used in stations of the first magnitude. There is a reason for this, quite apart from the mere fact that an experiment would naturally be tried at first on a comparatively small scale. We think that the modern gas engine has amply justified its existence in stations of small capacity; Belfast, Leicester, and Leyton furnish instances that strongly support this contention. By comparison with steam-driven stations of the same size and output, all the examples of well-designed and intelligently-worked gas engine supply stations show the superiority of gas power over steam upon this scale of working. But about really large stations it is a different story; we do not think the gas engine, as at present designed, shows any commercial advantage over steam power for concerns of this size. The time may and probably will come when the gas engine will compete with the largest stationary steam engine built for driving a dynamo; but at present there are several serious drawbacks. Large gas engines are more economical than small gas engines in nothing like the same proportion in which a large steam engine is less wasteful of steam than a small one; and the practical limits of size and power are much lower for the gas engine than for its more common rival. To equip a large central station with gas engines would necessitate many more engine and dynamo sets than if steam power were to be adopted; and, though it is not improbable that the cost of fuel in such a case would be lower for gas than for steam power, yet the difference which might exist would be enormously over-balanced by the excess in many other items of cost, such as labour, repairs, oil, &c., that the use of gas engines would involve. It is our conviction, therefore, that the gas engine furnishes a convenient and commercially economical motor for small supply stations favourably situated, but that its adoption in larger stations must await future developments of the gas engine itself before it can be made a success.

ELECTROMAGNETIC THEORY.—CI.*

BY OLIVER HEAVISIDE.

(*Continued from page 477, Vol. XXXIX.*)

§ 410. Another way of getting solutions of the characteristic equation of V or C should not be passed over, having interesting connections with the preceding methods. The characteristic of $V\epsilon^{\rho t}$ being

$$v^2\Delta^2(V\epsilon^{\rho t}) = (p^2 - \sigma^2)(V\epsilon^{\rho t}), \tag{1}$$

by (5), (6), § 378, we formerly used the form of solution

$$V\epsilon^{\rho t} = \epsilon^{sx}A + \epsilon^{-sx}B, \tag{2}$$

where A and B are time functions, and s is the operator $v^{-1}(p^2 - \sigma^2)^{\frac{1}{2}}$. But write (1) in the form

$$(v^2\Delta^2 + \sigma^2)(V\epsilon^{\rho t}) = p^2(V\epsilon^{\rho t}), \tag{3}$$

and we see that another form of solution is

$$V\epsilon^{\rho t} = \cosh \nu t \,.\, A + \frac{\sinh \nu t}{\nu}B, \tag{4}$$

where A and B are now x functions, and

$$\nu = (v^2\Delta^2 + \sigma^2)^{\frac{1}{2}}. \tag{5}$$

The form (4) is suitable for the derivation of the results due to given initial states. Thus, given that $V = V_0$ and $C = C_0$ at the moment $t = 0$. These data serve to determine A and B, and therefore V and C, with the assistance of (5), (6) § 378. The results are

$$V = \epsilon^{-\rho t}\left\{\left(\cosh + \frac{\sigma}{\nu}\sinh\right)\nu t \,.\, V_0 - \frac{\sinh \nu t}{\nu}\frac{\nabla}{S}C_0\right\}, \tag{6}$$

$$C = \epsilon^{-\rho t}\left\{\left(\cosh - \frac{\sigma}{\nu}\sinh\right)\nu t \,.\, C_0 - \frac{\sinh \nu t}{\nu}\frac{\nabla}{L}V_0\right\}. \tag{7}$$

Notice that the second of these is derivable from the first by interchanging V and C, V_0 and C_0, R and K, L and S. If one solution has been worked out, another having a different physical meaning is immediately derivable by the interchanges mentioned. Also notice that the functions of νt are even functions; that is, by (5), they are functions of Δ^2. So the V due to V_0 is derivable by even differentiations with respect to x, whilst the V due to C_0 is derivable by odd differentiations. We have here the means of constructing any number of solutions, provided V_0 and C_0 are given continuous functions of x, so that the operations can be carried out by ordinary rules.

For example, if $V_0 = Ax$. Then $\Delta^2 x = 0$, so it is the same as taking $\nu = \sigma$. The result is

$$V = \epsilon^{-\rho t}\epsilon^{\sigma t}Ax = Ax\,\epsilon^{-Kt/S}. \tag{8}$$

Here V subsides by leakage, but without change of type. The corresponding current is

$$C = -\frac{A}{L\sigma}\epsilon^{-\rho t}\sinh \sigma t = \frac{A}{2L\sigma}\left(\epsilon^{-Rt/L} - \epsilon^{-Kt/S}\right). \tag{9}$$

The current is the same everywhere, and is negative, whether σ be positive or negative.

Similarly, if $C_0 = Bx$, we obtain

$$C = Bx\,\epsilon^{-Rt/L}, \qquad V = \frac{B}{2S\sigma}\left(\epsilon^{-Rt/L} - \epsilon^{-Kt/S}\right) \tag{10}$$

It is now V that is negative for any value of σ.

If we combine the two initial states, and make $B = A/Lx$, then $V_0 = LxC_0$ initially, a positive wave, and

$$V = Ax\,\epsilon^{-Kt/S} + \frac{Ax}{2\sigma}\left(\epsilon^{-Rt/L} - \epsilon^{-Kt/S}\right) \tag{11}$$

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is the resulting V. When $\sigma = 0$, we reduce to

$$V = LvC = A(x - vt)\epsilon^{-\rho t}, \quad (12)$$

representing a positive wave.

Similarly, the results due to $V_0 = Ax^2$, Ax^3, &c., may be developed. They are much more complicated. Passing on to a complete power series, the simplest is $V_0 = A\epsilon^{hx}$. Here the potence of Δ is h, so the results are

$$V = \epsilon^{-\rho t}\left(\cosh \nu t + \frac{\sigma}{\nu}\operatorname{shin} \nu t\right)A\epsilon^{hx}, \quad (13)$$

$$LvC = -A\epsilon^{-\rho t}\operatorname{shin} \nu t\, h\epsilon^{hx}, \quad (14)$$

where ν means the positive constant $(v^2h^2 + \sigma^2)^{\frac{1}{2}}$, by (5).

More important than the last case is the simply periodic. If V_0 and C_0 are simply periodic functions of x, say of $\sin mx$ and $\cos mx$, the potence of Δ^2 is $-m^2$, and (6), (7) represent the solutions explicitly, provided ν has the constant value $(\sigma^2 - m^2v^2)^{\frac{1}{2}}$. Or, if $\lambda = (m^2v^2 - \sigma^2)^{\frac{1}{2}}$, which may be more convenient, then

$$V = \epsilon^{-\rho}\left\{\left(\cos + \frac{\sigma}{\lambda}\sin\right)\lambda t.\ V_0 - \frac{\sin \lambda t}{\lambda}\frac{\Delta}{S}C_0\right\} \quad (15)$$

$$C = \epsilon^{-\rho t}\left\{\left(\cos - \frac{\sigma}{\lambda}\sin\right)\lambda t.\ C_0 - \frac{\sin \lambda t}{\lambda}\frac{\Delta}{L}V_0\right\} \quad (16)$$

are the simply periodic solutions. They may also be regarded as the general solutions, provided $-\lambda^2 = v^2\Delta^2 + \sigma^2$ defines λ.

A curious case is $\lambda = 0$, or $m = \sigma/v$. This we had before, § 379. There is no change of type as the time advances.

§ 411. All the above solutions labour under the defect that they are not practical in this respect, that the initial states extend continuously over the whole range of x. Moreover, if V_0 is represented by x, x^2, x^3, &c., it increases infinitely as we pass away from the origin. Even $V_0 = \epsilon^{hx}$ becomes infinite on one side. And although the simply periodic solution has no infinities it does not vanish at infinity. A more practical sort of initial state would be $V_0 = A\epsilon^{-hx^2}$, vanishing at infinity on both sides, and by an expedient admitting of concentration at the origin. But the working out of this case is rather elaborate.

Now since (7), (8) are the general operational solutions they are true for any V_0 and C_0, discontinuous as well as continuous. It is by the consideration of states which are initially discontinuous that we should obtain practical solutions showing the genesis and progression of waves. So we have to find how to algebrise (7), (8) for discontinuous V_0 or C_0. There are two ways. One is to convert the general solutions to Fourier integrals, and then evaluate them. The other way is to find a transformation of the general operational solutions which will allow of their direct algebrisation. The direct way was the first way I attacked this problem. My second way was a similar process applied to an impressed force. The third way was the indirect process of going viâ Fourier integrals, corroborating the results got by the previous ways.

Here first do the integrals, to get it over. It is readily proved in works on plane trigonometry that

$$\pm 1 = \frac{4}{\pi}\left(\sin\frac{\pi x}{l} + \tfrac{1}{3}\sin\frac{3\pi x}{l} + \tfrac{1}{5}\sin\frac{5\pi x}{l} + \ldots\right), \quad (17)$$

being $+1$ when x is between 0 and l and -1 when between 0 and $-l$. So there is a jump at the origin. This is important. Make l infinite. Denote the coefficient of x in any sine term by m, then the step dm is $2\pi/l$, so (17) is converted to

$$\pm 1 = \frac{2}{\pi}\int_0^x \frac{\sin mx}{m}dm, \quad (18)$$

being $+1$ when x is $+$ and -1 when x is $-$. The jump is 2 at the origin. Next differentiate to x. The result is (dividing by 2),

$$\Delta 1 = \frac{1}{\pi}\int_0^x \cos mx\, dm, \quad (19)$$

i.e., an impulsive function of total 1, condensed at the origin. This is the effective meaning for physical purposes. So

$$\frac{f(y)dy}{\pi}\int_0^x \cos m(x - y)\,dm, \quad (20)$$

represents zero, except at $x = y$, where the total is $f(y)dy$. Finally,

$$f(x) = \frac{1}{\pi}\int_{-\infty}^{\infty} f(y)dy\int_0^x \cos m(x - y)\,dm, \quad (21)$$

by integrating (20) from $y = -\infty$ to $+\infty$.

The above is a short cut to Fourier's theorem. But it is (19) or (20) we want here. Go back to (6), (7), and let the initial state be V_0dy at the point $x = y$. Then

$$V = \epsilon^{-\rho t}(p + \sigma)\frac{\operatorname{shin} \nu t}{\nu}\frac{V_0dy}{\pi}\int_0^\infty \cos m(x - y)\,dm. \quad (22)$$

In this form the ν operator can act on the discontinuous operand by direct differentiations applied to the cosine function. The potence of Δ^2 is $-m^2$, and the result is

$$V = \epsilon^{-\rho t}\frac{V_0dy}{\pi}\int_0^\infty \frac{\sin \lambda t}{\lambda}\cos m(x - y)\,dm. \quad (23)$$

The corresponding C is

$$C = \epsilon^{-\rho t}\frac{V_0dy}{\pi}\int_0^\infty \frac{m}{L}\frac{\sin \lambda t}{\lambda}\sin m(x - y)\,dm, \quad (24)$$

by doing the same work for the part of (7) depending on V_0. These being the V and C arising from V_0dy at the point $'y = x$ integration from $y = -\infty$ to $+\infty$ will give V and C due to any initial distributions V_0, C_0. So the general solutions (6), (7) are equivalently expressed by

$$V = \frac{\epsilon^{-\rho t}}{\pi}\int_0^x\int_{-\infty}^{\infty}\left\{V_0(p + \sigma) - C_0\frac{\Delta}{S}\right\}\frac{\operatorname{shin} \nu t}{\nu}\cos m(x - y)\,dm\,dy, \quad (25)$$

$$C = \frac{\epsilon^{-\rho t}}{\pi}\int_0^x\int_{-x}^{\infty}\left\{C_0(p - \sigma) - V_0\frac{\Delta}{L}\right\}\frac{\operatorname{shin} \nu t}{\nu}\cos m(x - y)\,dm\,dy, \quad (26)$$

where $\nu = (\sigma^2 - m^2v^2)^{\frac{1}{2}}$, and V_0, C_0 are expressed as functions of y.

§ 412. We can evaluate these integrals in any case in which V and C have been determined, say by the operational solutions (6), (7). For example, we know the results due to $V_0 =$ constant, or x, ϵ^{hx}, &c. But these special evaluations do not help us to evaluate for a discontinuity. Say V_0 is constant on the left, and zero on the right side of the origin. The full realisation then depends upon evaluating this integral, which is the fundamental one,

$$u = \frac{2}{\pi}\int_0^\infty \frac{\sin \lambda t}{\lambda}\cos mx\,dm, \quad (27)$$

where $\lambda = (m^2v^2 - \sigma^2)^{\frac{1}{2}}$. When this is done we can easily derive the V and C due to elements of V_0 and C_0 anywhere. Before solving (27), however, and without knowing the result, we can get some information out of (23), (24).

Thus, let us find the space-integral of V due to V_0dy at the origin. We have

$$\frac{V}{V_0dy} = \frac{\epsilon^{-\rho t}}{\pi}\int_0^\infty \cos mx\left(\cosh + \frac{\sigma}{\nu}\operatorname{shin}\right)\nu t.\,dm, \quad (28)$$

and therefore

$$\frac{\int_0^x V dx}{V_0dy} = \frac{\epsilon^{-\rho t}}{\pi}\int_0^\infty \frac{\sin mx}{m}\left(\cosh + \frac{\sigma}{\nu}\operatorname{shin}\right)\nu t.\,dm. \quad (29)$$

This can be evaluated when $x = \infty$. Look back to equation (18). When x is made infinitely great, the effective meaning is that the 1 is concentrated at the origin of m. It is the only place where the infinitely rapid oscillations do not effectively cancel. So put $m = 0$ in the t function. We make $\nu = \sigma$, and get

$$\frac{\int_0^\infty V\,dx}{V_0dy} = \frac{\epsilon^{-\rho t}}{\pi}\frac{\pi}{2}\epsilon^{\sigma t} = \tfrac{1}{2}\epsilon^{-Kt/S}. \quad (30)$$

That is, a charge initially at one spot subsides in amount according to $\epsilon^{-Kt/S}$, however it may be redistributed, which we are not supposed to know. The $\frac{1}{2}$ factor shows that half the charge only goes to the right.

Exactly similarly, if the initial state is C_0dy, we have

$$\frac{\int_0^x C dx}{C_0dy} = \frac{\epsilon^{-\rho t}}{\pi}\frac{\pi}{2}\epsilon^{-\sigma t} = \tfrac{1}{2}\epsilon^{-Rt/L}. \quad (31)$$

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That the total charge subsides according to $\epsilon^{-Kt/S}$, and the total momentum according to $\epsilon^{-Rt/L}$, may be proved in an elementary manner through the properties of the distortionless circuit.

Since there is no V beyond $x=vt$, we may give x in (29) any value exceeding vt, and still have the result (30), and therefore

$$\epsilon^{\sigma t}=\frac{2}{\pi}\int_0^x\frac{\sin mx}{m}\left(\cosh+\frac{\sigma}{\nu}\sinh\right)\nu t\,.\,dm, \qquad (32)$$

if $x>vt$. But if x is less than vt, the value of this integral is a function of x in general. Except when x is just under vt. We then exclude the head of the disturbance, namely, the wave going to the right, of amount $\frac{1}{2}V_0dy\,\epsilon^{-\rho t}$. Deduct this from $\int_0^x V dx$ in (30), therefore. This means that the value of the right number of (32) is $\epsilon^{\sigma t}-1$, when x is just under vt. When x is actually vt, take the mean, and say $\epsilon^{\sigma t}-\frac{1}{2}$. See (41), (42), § 398, for another arrival at these results.

§ 413. Next we may find the time-integral of C at any point. First, we may prove by ordinary integrations that

$$\int_0^t\epsilon^{-\rho t}\frac{\sin\lambda t}{\lambda}dt=\left[-\epsilon^{-\rho t}\frac{\cos\lambda t+(\rho/\lambda)\sin\lambda t}{v^2(m^2+RK)}\right]_0^t, \qquad (33)$$

$$\int_0^t\epsilon^{-\rho t}\left\{\cos\lambda t-\frac{\sigma}{\lambda}\sin\lambda t\right\}dt$$

$$=\left[\epsilon^{-\rho t}\frac{-2b\cos\lambda t+(m^2v^2+2b\sigma)\lambda^{-1}\sin\lambda t}{v^2(m^2+RK)}\right]_0^t, \qquad (34)$$

where $b=K/2S$. Therefore, if initially we have V_0dy and C_0dy at the origin, we obtain, by (24) for the result due to V_0, and by the companion to (23) for the result due to C_0,

$$\int_0^\infty Cdt=\frac{dy}{\pi}\int_0^\infty\frac{KS^{-1}LC_0\cos mx+V_0m\sin mx}{v^2(m^2+RK)}dm. \qquad (35)$$

This is a well-known form of integral. It makes

$$\int_0^\infty Cdt=dy\left\{\tfrac{1}{2}LC_0\left(\frac{K}{R}\right)^{\frac{1}{2}}+\tfrac{1}{2}SV_0\right\}\epsilon^{-x\sqrt{RK}}, \qquad (36)$$

showing separately how much is due to V_0 and how much to C_0. The latter vanishes when there is no leakage, and which is more striking, increases indefinitely with K at the origin; whereas the former is greatest when $K=0$ and least (zero) when $K=\infty$.

If $V_0=LvC_0$, so that we start with a positive wave to the right and $Q=SV_0dy$ is the initial charge, then the last formula makes

$$\int_0^\infty Cdt=\tfrac{1}{2}Q\left\{1+\left(\frac{KL}{RS}\right)^{\frac{1}{2}}\right\}\epsilon^{-x\sqrt{RK}}. \qquad (37)$$

All the charge goes to the right when $L/R=K/S$, and never returns. But we get only $\frac{1}{2}Q$ when there is no leakage. Though all of Q goes to the right at first, $\frac{1}{2}Q$ comes back again. It is the resistance that causes this. When K/S exceeds R/L, the time integral of the current exceeds Q. This is abnormal, because R/L is always greater than K/S practically. But in the application to electromagnetic waves in general, both cases may have to be considered.

§ 414. Next, we have to evaluate the integral u, equation (27), before progress can be made to complete knowledge by the Fourier integral method. We may expand the function $(\sin\lambda t)/\lambda$ in a series in various ways. For example, the expansion (166), § 375, may be employed, with special meanings of the symbols, to find $\epsilon^{\nu t}/\nu$, and $\epsilon^{-\nu t}/\nu$, and therefore $(\sin\lambda t)/\lambda$. We may then, if we can, effect the integration concerned in u term by term. Or other expansions may be employed in the same manner. But such work is very complicated, and, without guidance, might not be satisfactory. There is, however, a short cut whereby the complications due to using a full algebraical expansion of $(\sin\lambda t)/\lambda$ may be avoided.

Thus, λ is a function of σ^2. So, by Taylor's Theorem,

$$f(\sigma^2)=f(o)+\sigma^2f'(o)+\frac{\sigma^4}{\underline{2}}f''(o)+\ldots. \qquad (38)$$

But it may easily be proved by differentiating $\epsilon^{\nu t}/\nu$ that

$$\frac{d^2}{dtd\sigma^2}\frac{\epsilon^{\nu t}}{\nu}=\tfrac{1}{2}t\frac{\epsilon^{\nu t}}{\nu}. \qquad (39)$$

Therefore

$$\frac{d}{d\sigma^2}\frac{\epsilon^{\nu t}}{\nu}=\int\tfrac{1}{2}t\frac{\epsilon^{\nu t}}{\nu}dt. \qquad (40)$$

The operators $d/d\sigma^2$ and $\frac{1}{2}p^{-1}t$ are therefore equivalent, and we may employ the changed operator to obtain the expansion of $\epsilon^{\nu t}/\nu$ by integrations to t instead of differentiations to σ^2. The same is true of the function $\lambda^{-1}\sin\lambda t$. Thus,

$$\frac{\sin\lambda t}{\lambda}=\left(1+\tfrac{1}{2}\sigma^2p^{-1}t+\frac{(\frac{1}{2}\sigma^2p^{-1}t)^2}{\underline{2}}+\ldots\right)\frac{\sin mvt}{mv}, \qquad (41)$$

because $\sigma=0$ reduces λ to mv. Or, to avoid misunderstanding of the meaning of $p^{-1}t$,

$$\frac{\sin\lambda t}{\lambda}=\frac{\sin mvt}{mv}+\tfrac{1}{2}\sigma^2\int_0^t t\frac{\sin mvt}{mv}dt+\frac{(\frac{1}{2}\sigma^2)^2}{2}\int_0^t tdt\int_0^t t\frac{\sin mvt}{mv}dt$$

$$+\ldots. \qquad (42)$$

That this gives a correct expansion of the function concerned may be verified by comparison with the formula (166), § 375, already referred to. The process here indicated, in fact, provides an alternative method of finding the expansion of $\epsilon^{\nu t}/\nu$, and the connected functions. But the point at present is *not* to employ the developed expansion, but the operator which develops if out of $(\sin mvt)/mv$. Thus, by (27) and (41),

$$u=\left(1+\tfrac{1}{2}\sigma^2p^{-1}t+\frac{(\frac{1}{2}\sigma^2p^{-1}t)^2}{2}+\ldots\right)\frac{2}{\pi}\int_0^\infty\cos mx\frac{\sin mvt}{mv}dm \qquad (43)$$

by shifting the operator outside the sign of integration to m.

Now, since

$$\cos mx\sin mvt=\tfrac{1}{2}\sin m(vt+x)+\tfrac{1}{2}\sin m(vt-x),$$

we can see, by comparison with (18) above, that the value of the integral in the last equation multiplied by $2/\pi$ is v^{-1} when $vt>x$, and zero when $vt<x$. Therefore

$$u=\frac{1}{v}\left(1+\tfrac{1}{2}\sigma^2p^{-1}t+\frac{(\frac{1}{2}\sigma^2p^{-1}t)^2}{\underline{2}}+\ldots\right)(0\text{ or }1). \qquad (44)$$

That the operand is 0 when $t<x/v$ has the result that if we use the operand 1 only, the limits of integration must be from x/v to t instead of from 0 to t. So.

$$u=\frac{1}{v}\left\{1+\tfrac{1}{2}\sigma^2\int_{x/v}^t t\,dt+\frac{(\frac{1}{2}\sigma^2)^2}{\underline{2}}\int_{x/v}^t tdt\int_{x/v}^t t\,dt+\ldots\right\}. \qquad (45)$$

The first term in the brackets is 1; the second is

$$\tfrac{1}{2}\sigma^2\left[\tfrac{1}{2}t^2\right]_{x/v}^t=\tfrac{1}{2}\cdot\tfrac{1}{2}\sigma^2(t^2-x^2/v^2); \qquad (46)$$

the third is

$$\tfrac{1}{2}\frac{(\frac{1}{2}\sigma^2)^2}{\underline{2}}\int_{x/v}^t t(t^2-x^2/v^2)dt=\tfrac{1}{8}\frac{(\frac{1}{2}\sigma^2)^2}{\underline{2}}(t^2-x^2/v^2)^2; \qquad (47)$$

the fourth

$$\tfrac{1}{8}\frac{(\frac{1}{2}\sigma^2)^3}{\underline{3}}\int_{x/v}^t t(t^2-x^2/v^2)^3dt=\tfrac{1}{48}\frac{(\frac{1}{2}\sigma^2)^3}{\underline{3}}(t^2-x^2/v^2)^3; \qquad (48)$$

and so on, the process being to multiply any term by t and then integrate to obtain the next term. We can see at a glance now what the complete formula is. It is

$$u=\frac{2}{\pi}\int_0^\infty\cos mx\frac{\sin\lambda t}{\lambda}dm=\frac{1}{v}I_0[\sigma(t^2-x^2/v^2)^{\frac{1}{2}}]. \qquad (49)$$

provided $t>x/v$. And $u=0$, if $t<x/v$.

Compare with (33), § 398, where this result was arrived at in another way. Having got it out of the Fourier integral, we can now if we like proceed to obtain the formulæ for the waves of V and C due to V_0dy and C_0dy. They agree fully with the previous results, as in § 371 for instance, and so need not be repeated here.

§ 415. The following generalisation of the result is of importance in some other electromagnetic problems, and may therefore be conveniently put here for future reference. Using the notation for Bessel functions explained towards the end of the last chapter, we have

$$J_0[(n^2/v^2-m^2)^{\frac{1}{2}}r]=\frac{2}{\pi}\int_0^\infty\frac{\cos m\lambda\sin nv^{-1}(r^2+\lambda^2)^{\frac{1}{2}}}{(r^2+\lambda^2)^{\frac{1}{2}}}d\lambda, \qquad (50)$$

$$G_0[(n^2/v^2-m^2)^{\frac{1}{2}}r]=\frac{2}{\pi}\int_0^\infty\frac{\cos m\lambda\cos nv^{-1}(r^2+\lambda^2)^{\frac{1}{2}}}{(r^2+\lambda^2)^{\frac{1}{2}}}d\lambda, \qquad (51)$$

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provided $n/v > m$. The first of these is equivalent to (49). The second is its companion, concerning the other Bessel function. But if $n/v < m$, then the value of the integral in (50) is zero instead of $J_0(\ldots)$; and instead of $G_0(\ldots)$ on the left side of (51) we must write

$$K_0[(m^2 - n^2/v^2)^{\frac{1}{2}}r]. \qquad (52)$$

Also, whether m be greater or less than n/v, we have this result:—

$$K_0[m^2 - n^2/v^2))^{\frac{1}{2}}r] \sin nt = \frac{1}{\pi}\int_{-\infty}^{\infty} \cos m\lambda \frac{\sin n\,[t - v^{-1}(r^2 + \lambda^2)^{\frac{1}{2}}]}{(r^2 + \lambda^2)^{\frac{1}{2}}} d\lambda \qquad (53)$$

This formula includes the preceding.

(To be continued.)

THE LEICESTER GAS POWER ELECTRIC LIGHTING STATION OF THE MIDLAND RAILWAY.

Having had a desire to place our readers in possession of accurate and well authenticated data that might enable them to form a more sound opinion as to the merits of gas power for electric supply stations, and knowing that one of the most successful of the few gas engine stations in this country was that owned by the Midland Railway Company at Leicester, we sought from Mr. W. Langdon, the telegraph superintendent of that Company, and were fortunate in receiving from him, the particulars as to equipment and working of the Leicester station which are embodied in this article. We take this opportunity to express our thanks to Mr. Langdon, as well as to Mr. Goodchild, the resident engineer.

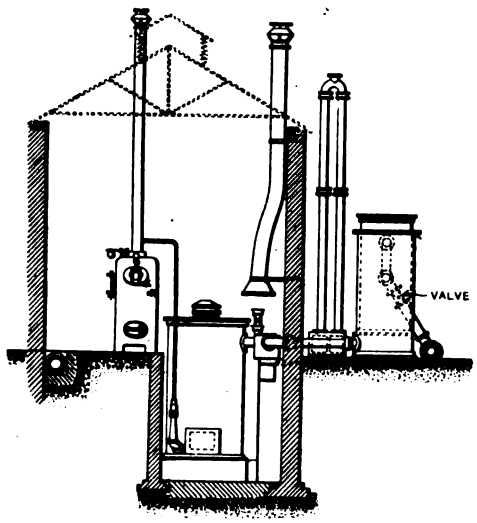

FIG. 1—Transverse Section of Dowson Gas Generator House at Leicester (Midland Railway) Gas Power Station.

The reason which induced the Midland Railway Company, in 1894, to employ gas power instead of steam was that the space available for the generating plant was somewhat inadequate for steam. The laying down of a steam plant in the space at their disposal would have proved inconvenient in many ways. Another site could have been selected, but this would have been inconvenient owing to the greater distance at which the generating station, under those circumstances, would have been placed from the work required of it. Another reason was that gas had been previously discussed, and there was a desire in the mind of the engineer, Mr. Langdon, to test its economy and advantages as against steam. Certain difficulties which presented themselves in respect of the adoption of a steam plant clinched the matter and gas was determined upon.

The gas generating machinery (Figs. 1 and 2) consists of two Dowson gas generators, each capable of generating gas, with coke as fuel, for 100 B.H.P., or, with anthracite "peas" as fuel, for 120 H.P. Each generator is 8ft. 9in. high, and 4ft. 8in. in diameter. There are two boilers, one being held in reserve, each boiler being capable of supplying two generators. For each generator a cooler, hydraulic box, coke scrubber, and sawdust scrubber, are provided. The gas holder is 16ft. diameter by 10ft. deep, and has a capacity of about 2,000 cubic feet.

A general view of the station, showing the gas holder and coolers outside the buildings, is given in Fig. 3. The machinery room (Fig. 4) is equipped with a number of Crossley gas engines, belted to continuous current dynamos for arc and glow lighting. Four of the engines are each capable of developing 90 I.H.P. when running with coal gas at 200 revolutions per minute, there being a supply of this fuel available for occasional use. These engines have a stroke of 21in. and cylinders of 16in. diameter. Two smaller engines, having the same length of stroke, but cylinders of only 11½in. diameter, will develop 50 B.H.P. with coal gas, or 40 B.H.P. with Dowson gas, when running at 200 revolutions per minute. All these engines are of Messrs. Crossley Bros.' (Limited) special high-speed electric light type, and are horizontal engines working on the "Otto" cycle. The valves are of the mushroom type, and the ignition is effected by means of heated tubes. Porcelain and various metal tubes have been used, but, we believe, a preference has been found for ignition tubes of the first-named material.

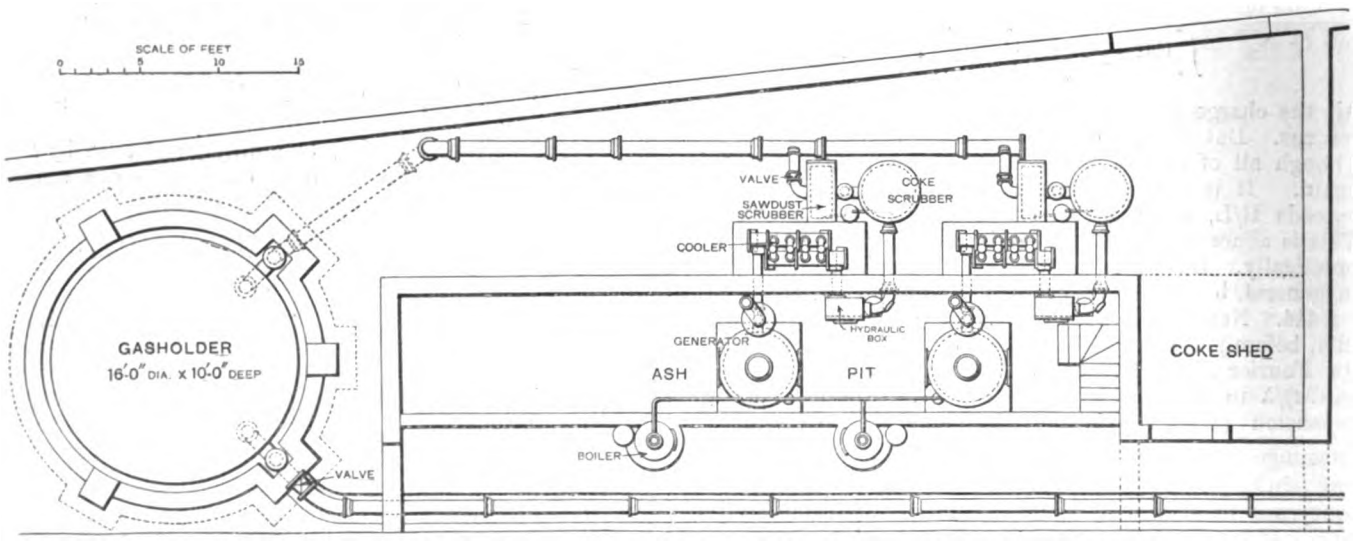

FIG. 2—Plan of Dowson Gas Generator Plant at Leicester (Midland Railway) Gas Power Station.

One difficulty met with in the gas engines—a difficulty which is perhaps the more marked when employed in connection with electrical machinery—has been that of the ignition tubes. At Leicester for some time past, as already said, porcelain ignition tubes have been employed. A spring adjustment is used in connection with them, and by the

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elasticity which this affords, the bulging of the tube is as a rule avoided. Where a rigid cap is employed the expansion of the tube under the influence of the heat causes the walls of the tube to bulge out about midway, or the tube to bend and crack.

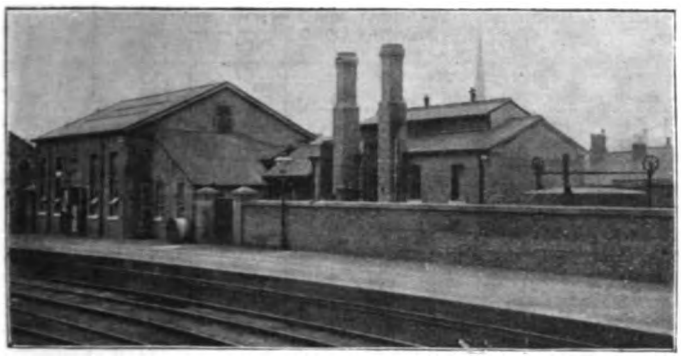

FIG. 3.—General View of the Gas Power Electric Light Station of the Midland Railway Company, at Leicester.

Three of the 90 H.P. engines are employed to drive three 60-light Brush arc machines, for series arc lighting at 10 amperes. The fourth large engine drives a Mordey-Victoria 110-volt continuous current machine for incandescence lighting. The two small engines are belted to two Siemens 110-volt dynamos, rated at 15 kilowatts each, these also being used for incandescence lighting. In addition to these generators there is a Mavor and Coulson compensator, with Sayers' winding, which is run on the low-pressure circuit, and is found to give great satisfaction in working.

A number of the arc lamps for the sheds and yards lighting are ordinary series Brush and Thomson-Houston lamps. There are also a number of Brush-Vienna lamps run two-in-series on the 110-volt constant potential mains. Besides the arc lighting of the yards, sheds, passenger station, &c., there is a considerable load of glow lamps, these lamps being distributed about the offices and other apartments within the passenger station. Although the several loads on the 110-volt and series machines are independent, so far as the dynamos and engines are concerned, they are combined as regards the gas generators. The character of the several and combined loads will be found, for irregularity and trying conditions, to compare with those of ordinary supply stations. Figs. 5 and 6 are reproduced from a number of typical load curves, taken at this station at the dates indicated. We understand that they are thoroughly representative load diagrams.

Repairs for this station and lighting circuits have not been by any means heavy. Some expense has, however, been incurred in consequence of it having been necessary, owing to the manner in which the engines were first laid down, to lift them, and attend to the beds and replace them. One or two short sections of cable have also called for renewal, owing to development of faults, the cause of which has not been quite evident. The engines are carefully overhauled after each run; or, when the lighting is required to be continuous, as is sometimes the case, day and night, during the existence of fogs, they are overhauled when opportunity affords.

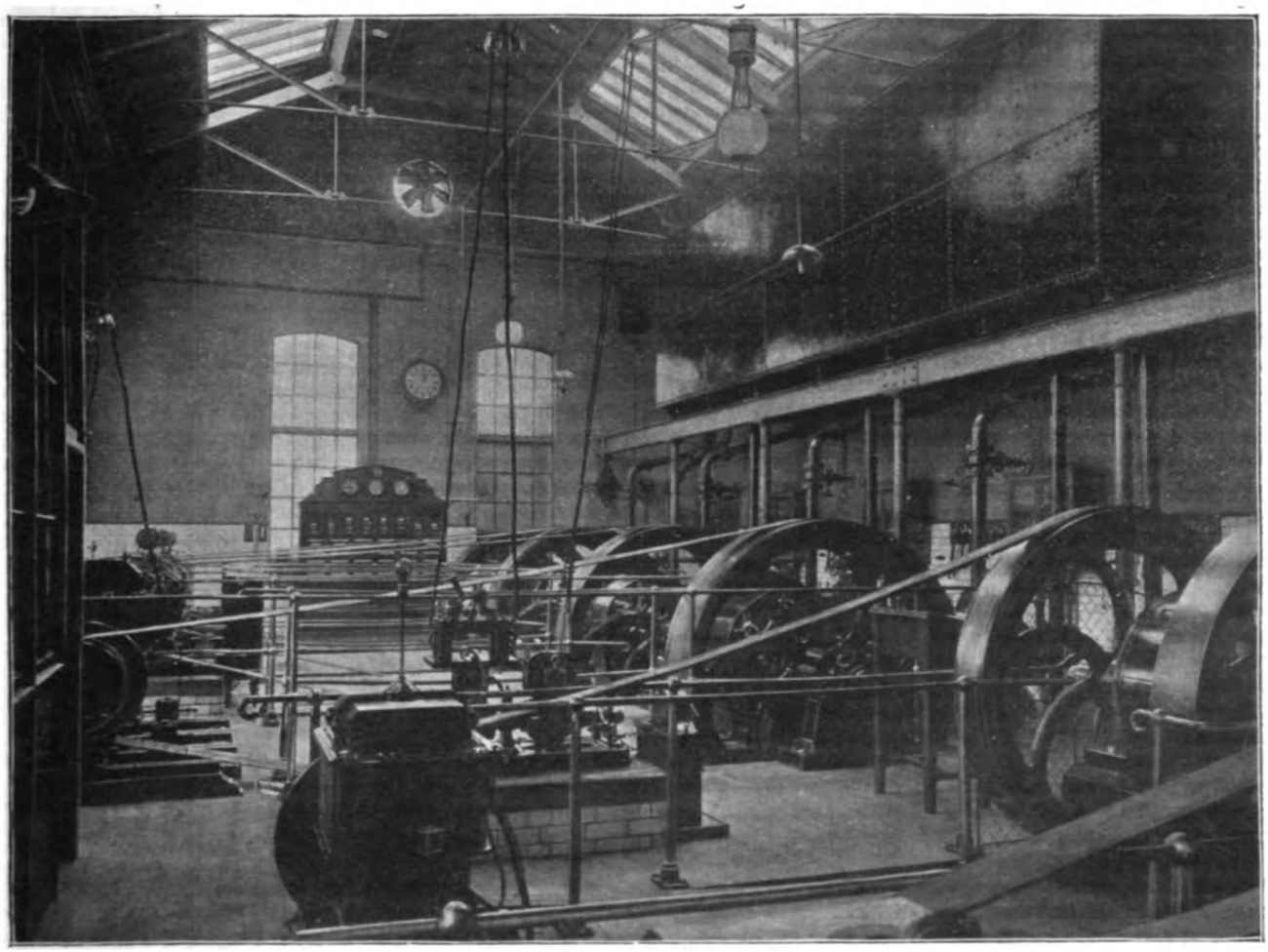

FIG. 4.—Machinery Room of the Leicester (Midland Railway) Gas Power Electric Light Station.

It may be stated that, as a rule, all valves are cleaned once a week all the year round, and, if necessary, are freshly ground. The exhaust valves are turned up every twelve months, and the air valves every two years; but up to the present it has not been necessary that the gas valves should be put into the lathe. There is no doubt, we are informed, that valves require more cleaning with Dowson gas that with coal gas. The coke

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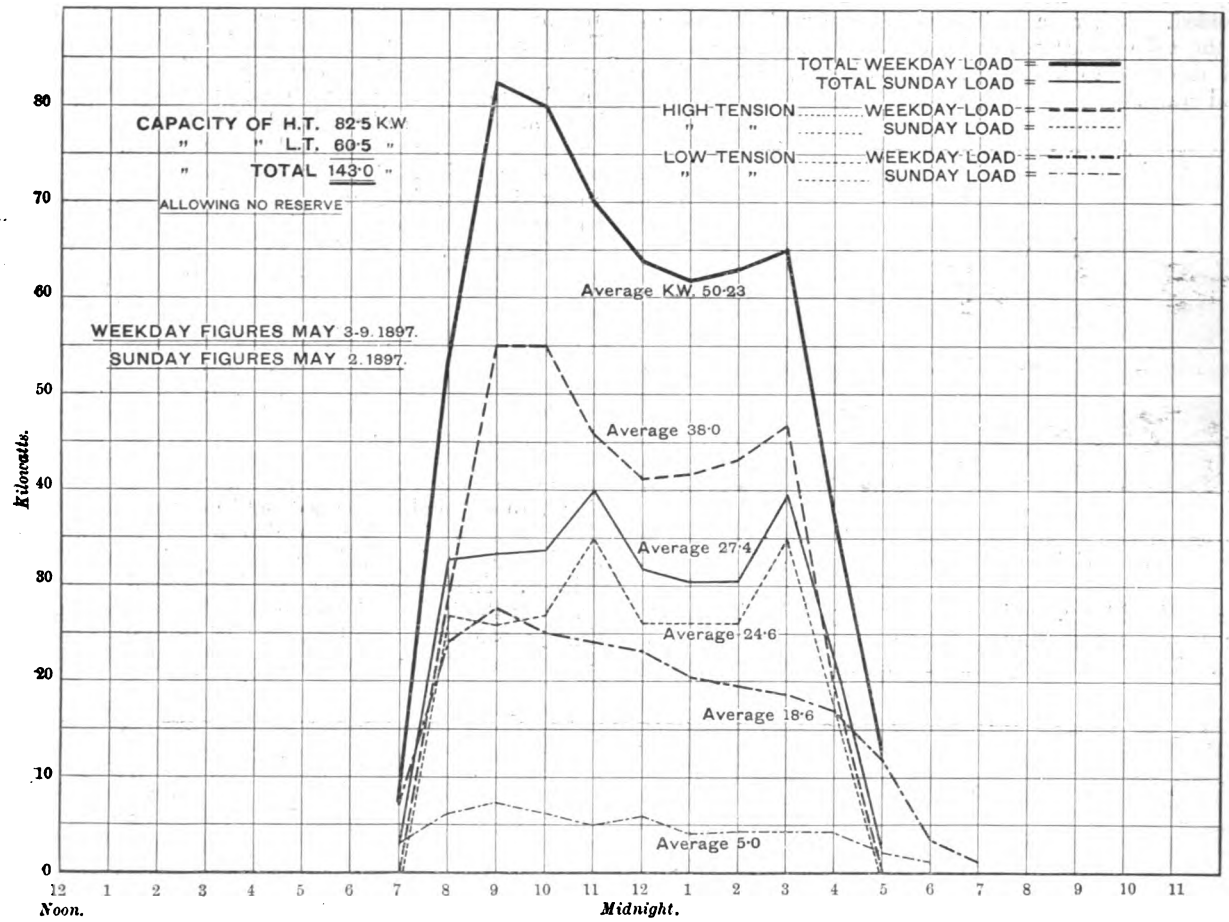

FIG. 5.—Load Diagrams of the Gas Engine Electric Light Station at Leicester.

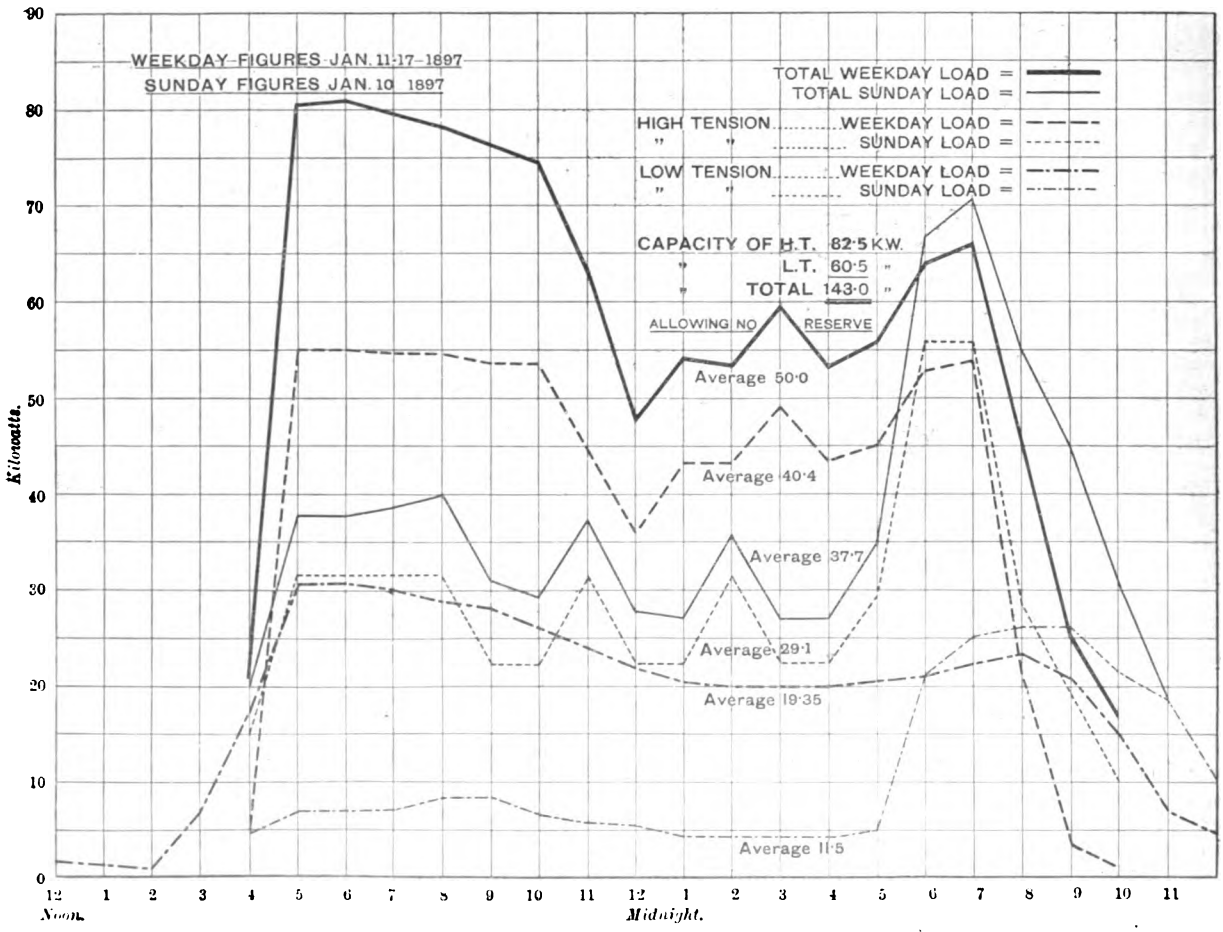

FIG. 6.—Winter Load Diagrams of the Gas Engine Electric Light Station at Leicester.

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Statistics of Cost of Working various Electric Light Plants of the Midland Railway Company during the Half-Year ended June 30, 1897.

Name of installation.	Number of arc lamps.	Approximate number of incandescent lamps.	Total units.	Total expenditure. £ s. d.	Total expenditure per unit. d.	Cost per unit for labour. d.	Cost per unit for material. d.	Cost per unit for repairs. d.
Somerstown (steam)	246	—	193,770	2,557 17 5	3·16	1·38	0·67	0·2
Leicester (gas)	141	283	137,070	1,604 15 9	2·80	1·49	0·86	0·16
Derby (steam)	8	2,512	93,490	1,054 0 4	2·70	1·22	0·69	0·41
Birmingham, Lawley-street (steam)	137	52	126,009	1,373 9 5	2·61	1·2	0·61	0·42
Nottingham (steam)	112	233	97,782	1,045 9 3	2·56	1·14	0·82	0·19
Sheffield (steam)	115	350	104,956	1,155 0 6	2·64	1·34	0·62	0·23
Bradford (steam)	194	784	153,213	1,661 15 9	2·58	1·13	0·51	0·38

in the scrubbers is renewed every six months, and the whole of the removed coke burnt in the boilers. The sawdust scrubbers are renewed about every 100 hours of working, averaging, say, 10,000 I.H.P. hours. Each renewal of sawdust costs about 2s. 6d. per scrubber. The generator fires are cleaned every 24 hours by raking the grate over; clinkers are broken up and removed to the dead plate, and then brought round to the fire door and taken out. About 9 per cent. of the weight of the total fuel burnt is used in the small vertical boilers employed in raising steam for the air injectors of the generators. As a rule, coke is burned in the boilers, and anthracite "peas" are used in the generators, but it is possible to use coke in the generators instead of anthracite. As already stated, the capacity of the gasholder is about 2,000 cubic feet, sufficient to run the whole electrical load for only about ten minutes.

With respect to the economy of working the gas generators at very low rates of production, from full load to one-fifth load the gas produced is found to remain practically of the same quality, giving about 40 calories per cubic foot.

Several other electric lighting stations are owned and worked by the Midland Railway Company for lighting their property. These all, with the exception of the station at Leicester, are worked by steam power. A comparison of the costs of working these various stations is, therefore, of great interest and value. Such a comparison is afforded by the Table at the top of this page.

In conclusion, it is satisfactory to be able to state, and it will gratify everyone interested in gas engine electric supply stations to know that the authorities responsible for the introduction of gas power at Leicester Midland Railway lighting station have, on the whole, no reason to complain of the results obtained thereby.

ELECTRIC COAL MINING IN PENNSYLVANIA.

At the ordinary meeting of the Institution of Civil Engineers on Tuesday, November 23rd, Sir John Wolfe Barry, K.C.B., F.R.S., the President, in the chair, a Paper, entitled "Central Station Electric Coal-Mining Plant in Pennsylvania, U.S.A.," by Mr. W. S. Gresley, Assoc.M.Inst.C.E., was read. The author described and illustrated the application, to a somewhat scattered group of mines, of the electrical transmission of power for haulage, drainage, ventilation, coal-cutting, &c., from a central station conveniently placed on the property. The extent of the mining operations had become such that mule haulage on main roads, furnace ventilation, steam, mule- and hand-pumping, siphoning and bailing of water, pick-mining, &c., were too expensive and unsatisfactory; and electricity had been decided upon as the most reliable and practicable form of power for general use throughout the property, which was about 5,800 acres in extent. Direct current, at a pressure of 500 volts, was employed, with the generating station situated about the middle of the mines. There were four 100-kilowatt generators, each belted to a 150-H.P. non-condensing high-speed engine, and six 125 H.P. tubular boilers. The generators were joined in parallel. Five collieries were equipped with electric motors; in three the coal was hauled about one mile by a 50-H.P. locomotive working on the overhead trolley system; each mine had a triplex 200-gallon pump, fitted with a motor developing 5 H.P. to 10 H.P.; three of the pits were equipped with Capell fans, driven from belted motors of 25 H.P. to 50 H.P.; and in two of the pits most of the coal was undermined by Jeffrey electric chain machines. Outside the mines the circuits were of bare copper wire carried on stout poles, but the river was crossed by five submarine heavily-armoured cables attached to pole lines on each bank. In the mines most of the wires were bare, and were hung along the walls or fixed to blocks or pins on the roof. The locomotives hauled about 1,100 tons of coal each per 10-hour day. They displaced about 39 mules with their drivers. The three locomotives were similar, each weighing 10 tons, and all their electrical apparatus was interchangeable. Their speed was 8 miles per hour. Particulars of the comparative advantages of haulage by electric motors and by mules were set forth in a table, and sections, plans, &c., of the roads were given. The coal seam, the "Pittsburg bed," was about 5½ft. thick and lay fairly level; each mining-machine undercut about 120 tons per day. The "room and pillar" system of working was employed. Eleven coal-cutting machines were in use; each absorbed about 15 H.P., and cut about 2½ tons in 4½min.; but the actual cutting time was only six hours out of every 24, the rest being lost in moving the machines from place to place, changing the bits, and between shifts. Machine-mining required about one-third fewer miners than pick-work. About 70 per cent. of the output was cut by machines. The electric pumping consisted almost entirely of keeping water out of numerous branches or dipping sections of each mine, so that the suctions consisted of long lengths of pipe fitted with valves, in charge of which men were employed to regulate and keep down the water as required. Particulars of the ventilating fans, &c., were shown in tabular form, for comparison with which data relative to the old furnaces, as well as to one of the fans when run by a steam engine, were given. All the fans were belted direct to pulleys on the armature shaft, which ran at 625 revolutions per minute, the speed of the fans varying according to the requirements of the collieries. All were at present running light. The fans were of the Capel exhaust type, set up in brick races with iron covers and chimneys. The entire plant was in charge of an electrician with a staff of machinists. The machinery had been started in July, 1895. The daily coal-consumption was about 17 tons—mostly slack and fine coal, produced in the under-cutting. Load curves under different conditions of working were given, and indicated in a marked manner the extremely variable and sudden changes of load upon the dynamos, and showed what a large reserve of power must be provided for to successfully work such a plant. The average day load was about 42 per cent. of full load, the night load being only about half the day load. The total length of circuits already in use was about 40 miles, and the most distant motor from the power-house as yet in operation was a 30-H.P. fan motor, situated nearly 3½ miles from the central station. The success of the plant had been such that additional coal-cutters, &c., were now contemplated. One man had been killed from shock received through the trolley wire, but he was not concerned with working the locomotive or with the wiring. The installation had cost about £23. 10s. per horse-power developed by the engines; repairs and working cost about £5 per horse-power per year, or about 1½d. per ton of coal produced.

THE PATTON ELECTRIC LOCOMOTIVE.

A locomotive, resembling in some respects the Heilmann locomotive, has been developed by Mr. W. H. Patton, and experimented with on the street railways of Chicago. The striking feature of this car, says an American contemporary, is the use of a gas or rather gasoline engine as a prime mover. The engine is coupled direct to a dynamo, which supplies power to motors, storage batteries being provided to help the generating unit at times of great power consumption, the power given out by the battery at such times being restored by the generating unit at times of light load. During the construction of the overhead work on the suburban railroad in Chicago, a locomotive was at first used to move the tower car from place to place. The expense of fuel and labour on this locomotive amounted to about £2. 12s. per day, anthracite coal

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being used. Later a Patton motor car, with an 18 H.P. gas engine, a 12 H.P. generator, a 35 H.P. motor, and 92 150-ampere-hour storage cells (the total weight being 11 tons), was substituted for the steam locomotive. This resulted in a reduction of the cost to 12s. 6d. per day, only one man being required and 15 gallons of gasoline being consumed daily. The loads handled were surprisingly large. Five standard steam railroad cars, loaded with rails and ties, were repeatedly hauled, the weight on the drivers being frequently increased by posting as many as 50 workmen aboard the motor car.

Encouraged by the success obtained with this machine, which was at best an improvised affair, a more carefully-designed car has recently been built, and is now on exhibition on steam railroad tracks in Chicago. This car consists of a closed car-body, measuring 16ft. over all, mounted on outside journals in the ordinary manner. Between the wheels are special bearings supporting a steel frame, on which is mounted the engine and dynamo. These inside bearings are fitted with rubber cushions to give, in a measure, a spring support. The engine is a vertical Raymond two-cylinder 25 H.P. gasoline engine, running at 300 revolutions per minute. The cranks are enclosed in a case partly filled with oil for lubricating purposes. An overhead tank of 25 gallons capacity contains the gasoline, two other tanks with a capacity of 75 gallons containing water for cylinder cooling purposes. This water circulates by gravity through a system of cooling pipes, which can be extended to trailers to serve for heating purposes in cold weather. Coupled to one end of the engine shaft is a six-pole 15-kilowatt Crocker-Wheeler generator, the other end carrying an 850lb. fly-wheel. The generator is shunt-wound, and designed for 220 volts. One hundred cells of 200 ampere-hour capacity are connected straight across the generator terminals. The truck is fitted with two 35 H.P. single-reduction motors, which are controlled with ordinary series parallel controllers. The storage battery is kept continually charged, except in cases of emergency, and is only used to smooth out heavy loads of short duration, rendering the load on the engine almost constant. As is well known this sort of work can be admirably done by a battery, which would soon get into trouble if depended upon for full charge and discharge. The simple shunt winding of the generator and the governing of the gas engine effects without further complication the proper distribution of load between the battery and the dynamo. The battery serves also as a very handy means of starting the engine.

CORRESPONDENCE.

THE LATE MR. EDWARD GRAVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Edward Graves, my brother, who was recently assassinated at Karwan, between Jask and Choubar, about 90 miles from the former place, was born in the parish of Clifton (near Shefford), Bedfordshire, on Dec. 5, 1844. He entered the Electric and International Telegraph Company's service at Southampton in 1857, and, after being temporarily placed in the Isle of Wight, was sent to Aldershot Camp. This step led him to join the Royal Engineers at Brompton, and being a good telegraphist, he was selected as one of the pioneer corps of Royal Engineers who, in the autumn of 1863, went out to Persia to erect the first telegraph line through that country.

I have in my possession letters which are dated in 1864 from the following places:—Kermanshah, Kham-a-bad, Nouberan, and Hamadan. In 1865 he was chiefly at Teheran. In 1866 he was at Ispahan, Julfa, and Koomeshah; in the first half of 1867 he was stationed at Ispahan, and in August of that year his letter is dated from Teheran, where he remained until the end of the year. In January, 1868, he wrote from Ispahan. Most of his letters after this are from Teheran, until 1889, when he wrote from Ispahan, as he also did in 1891 and 1892, a solitary letter being dated January 15, 1891, from Shiraz. The last letter I received from him was dated New Year's Day, 1897, in which he informed me that he was in camp near Jask, having left Jask on November 6, 1896, for the purpose of putting the land line in order, renewing insulators and stays, and removing numerous bad joints which had been burnt in the process of soldering; and he hoped to have all straight by January, 1898, and then shortly after his return to retire on his well-earned pension; but his hopes have been most cruelly frustrated by his recent barbarous murder.

The above brief *resumé* of his career will show that my brother had completed 40 years' of telegraphic service, 34 of which have been spent in Persia. Parenthetically I may mention that although he has been home several times on leave during that period I have never seen him since I bade him "Good-bye" in 1863, there having always been some circumstance or other to prevent his reaching Valentia. He was twice married, firstly to an Armenian lady at Ispahan, who died in Teheran of typhoid fever on March 6, 1877; secondly, he married in England on Sept. 23, 1881. His widow and one son, aged nearly 15 years, survive him.

Naturally I am very anxious (as also are other members of his family) to obtain authentic details of his cruel murder, in which feeling I am sure many of his comrades join with us.—Yours, &c.,

JAMES GRAVES.
Superintendent Anglo-American Telegraph
Dec. 18, 1897. Company, Valentia, Ireland.

THE CHITTY DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the letter from Messrs. Willans and Robinson (Limited), appearing in your issue of the 10th inst., we beg to be allowed to state that when our private prospectus was prepared it was intended to append (in addition to the dynamo tests given on pages 8 and 9) a report by Messrs. Willans and Robinson of tests with the same machine as a motor, hence the use of the word "reports" in the paragraph named. The motor tests were, however, dropped out, as it was considered undesirable to add so much technical matter. We take it that the figures given on pages 8 and 9 are correctly referred to as "*reports*" *of tests.*

We are greatly indebted to Messrs. Willans and Robinson for having publicly endorsed the facts upon which all our claims are based, namely, those set forth in the tables on pp. 8 and 9, and the diagram on p. 13 of our propectus, but we think they distinctly contradict themselves when they say that "no copies of reports by us are appended." We are surprised that Messrs. Willans and Robinson should go so far out of their way to insinuate misrepresentation, With reference to their statement that the prospectus marked "for private circulation only," was to their knowledge "widely distributed," we beg to point out that as a matter of fact only 1,000 copies of the final prospectus were printed, and even these have not been all distributed. If, for reasons of their own, they desire it to appear that they have expressed no opinion as to the merits of the Chitty machines, we would remind them that they gave expression to their views in the most practical manner possible in the proposals which they made to Mr. Chitty after the trials at their works.

We cannot be held responsible for such carelessness, as would lead anyone to suppose that the notes on p. 7 of our prospectus could have emanated from Messrs. Willans and Robinson, and it is well known to Messrs. Willans and Robinson that these explanatory notes are merely put forward as an analysis of the tests following them, and that they were, in fact, originally prepared for their express benefit by Mr. Chitty and Mr. R. H. Housman when the negotiations to which we have referred were proceeding. The note on p. 10 and the diagrams on pp. 11 and 12 are in no way put forward as coming from Messrs. Willans and Robinson.

We are pleased to forward you herewith copies of motor tests, also copies of trials made with same machine as a dynamo, and the combined efficiency curve. As these matters may be of interest to many subscribers, please to understand that you are at liberty to publish them should you feel disposed to do so.—Yours, &c.,

For the Chitty Dynamo and Motor Company,
H. W. EVANS, Secretary *pro tem.*
St. George's House, Eastcheap, London, E.C.,
Dec. 14, 1897.

[The above letter is accompanied by a copy of what purports to be a report from Messrs. Willans and Robinson, signed by "P. A. Low," giving the result of a trial of a "Chitty" motor at Thames Ditton, Jan. 23, 1893. This report is not printed in the prospectus referred to in the above letter.—ED. *E.*].

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LEGAL INTELLIGENCE.

Re Currie and Timmis's Patent.

In the House of Lords last week Lords Hobhouse, Macnaghten and Davey and Sir Richard Crouch heard a petition by Mr. Illius Augustus Timmis for an extension of the term of letters patent granted to Mr. Stanley C. C. Currie and petititioner, on Dec. 12, 1883, for 14 years, for an invention relating to "Improvements in the Means for Working and Interlocking Railway Signals by Electricity." This invention, for which an extension of time was asked consists in operating signal-arms of railway signals by electricity instead of mechanically. An electro-magnet is placed on or near the post on which is the signal-arm, each signal post and arm in a station being so fitted, and each is connected by wires or leads to a source of electricity, which may either be a battery or a dynamo. The inventors claim that the interlocking of signals with each other and with points electrically is safer and more economical than when done mechanically. The levers used need only be small, taking up but little room, and the working of the apparatus is claimed to be such that it can be at any time actually proved that all the points are in proper position. The petitioner, owing to the objection of the companies to adopt novel and untried systems in such all-important matters as railway signalling, was unable to get any of them to work the invention, even experimentally, until in 1891 the Liverpool Overhead Electric Railway was constructed. That railway was fitted up with the electric signalling system invented by the petitioner, and it had in operation proved reliable, economical and satisfactory. It was also at work in a small way on the Swansea Dock Railway. Owing to the cause shown the petitioner had not derived profit from the invention, but had been greatly out of pocket in endeavouring to introduce the system on railways in this and other countries. As objection to use the system had now been removed by the experience gained at Liverpool, there was every hope that it might be adopted in the future, and the petitioner asked for a prolongation of the term of the patent. Mr. Currie and Mr. Timmis had obtained similar patents in other countries, but many of them had lapsed. By an arrangement come to in 1890 the English, foreign, and colonial patents were assigned to Mr. Timmis, and the American and Canadian patents to Mr. Currie.

Several witnesses gave evidence of the merits of the invention, which it appeared had also been tried with success on the Woodside branch line of the Great Northern Railway and elsewhere. The cost of the electricity for working the system on the Liverpool Overhead Railway for 20 hours was 6s., the system being there worked automatically by the trains. In a large station lighted by electricity the cost of working the signals by this system would be almost nil.

Lord HOBHOUSE delivered judgment, and said their Lordships were of opinion that the petitioner had established two points of considerable merit in his invention—one that it could operate at a distance quite unattainable by any previously tried system, and the other that it had the effect of releasing as well as locking the signal arms. It was quite clear and not disputed that he had not only received no remuneration, but had undergone very considerable loss in his continued efforts to bring his invention into work. With respect to his want of success their Lordships appreciated what had been said of the great difficulty in the introduction of such a system—that the ground was occupied by machinery of other systems, and that a new system could not be introduced except at great cost. They appreciated also the difficulty of erecting generating machinery, in new countries especially, before Mr. Timmis's patent could be brought into working. Therefore their Lordships were of opinion that it was a proper case for them to advise Her Majesty to grant an extension of the term of patent; and, having regard to the great difficulties and to the certainty that it could only be very gradually introduced, and perhaps only in the case of new railways, they thought that a ten years' extension would not be too long a period. This would be their Lordships' unanimous decision.

The Improved Electric Glow Lamp Company v. the Edison and Swan Company, Limited.

In this action, Mr. BOUSFIELD, Q.C., moved, before Mr. Justice North, in the Chancery Division, for an interim injunction to restrain the defendants until the trial or further order from making certain glow lamps, in infringement of the plaintiffs' patent. The action had been standing over for some time in the hope that the parties might be able to come to some arrangement, but being unable to do so he felt compelled to bring the motion on.

Mr. FLETCHER MOULTON, Q.C., for the defendants, said that he was willing to keep an account and to give an undertaking, as there was a serious question to be tried. He would give the undertaking on the understanding that it would not be made use of for the purposes of advertising.

Mr. BOUSFIELD said that he would accept the undertaking on those terms, and the motion was accordingly ordered to stand till the trial.

Suckling-Baron v. New Zealand Electrical Syndicate.

In the Queen's Bench Division, on Monday, the Lord Chief Justice and a special jury heard an action brought by Mr. Suckling-Baron, electrical engineer, to recover damages for alleged wrongful dismissal, commission of 1s. per lamp fitted up by the defendant or under his supervision, and a reasonable commission on the net profits of all the agencies introduced by him to the defendants. The plaintiff, who was Managing Director of the defendant Company in New Zealand, went out to New Zealand for them, where he superintended an installation for the supply of electricity to the city of Wellington. During the currency of the agreement, the Company by which the plaintiff was employed had a receiver appointed by the Court of Chancery, and plaintiff was appointed deputy-receiver at a salary of £500. The main question now in dispute was as to what sum the plaintiff was entitled under the altered circumstances of his employment.

After hearing the evidence, the LORD CHIEF JUSTICE summed up, and left it to the jury to say whether the agreement was continuous; whether it was put an end to by the plaintiff, and if not, to what notice he was entitled; and what commission the plaintiff was entitled to on the installation of electric lamps, 8-c.p. lamps being taken as the unit.

The jury found that the agreement was continuous, that the plaintiff did not end the engagement, and that he was entitled to six months' notice. As damages in lieu of notice they gave him £262. 10s., and they found, in addition, that he was entitled to a commission of 1s. per lamp from Sept., 1892, to Sept., 1895. They further found that he was entitled to £65 in respect of commission on agency profits.

Judgment was reserved, his LORDSHIP expressing a hope that on some points the parties would come to an agreement.

Westminster Electric Supply Corporation (Limited) v. the London Hygienic Ice Company (Limited).

This case was heard in the Court of Appeal on the defendants' appeal from an interlocutory order granted by Mr. Justice Day to restrain them in what was technically an action for a nuisance caused, it was said, by the brine and other materials used by the defendants in their manufacture of ice percolating through the floors and walls of their building to the damage of the plaintiffs.

It was eventually arranged that an expert should be called in as arbitrator to say what could be done to remedy what was complained of, both parties signing an undertaking to bear the expense accordingly as he might determine, the injunction in the meantime to be stayed until further order.

H. M. Salmony and Co. v. Theerman and Co.

This was an action tried in the Westminster (London) County Court on Wednesday, in which plaintiffs made a claim of £8, the price of an electrical instrument sold and delivered to the defendants, electrical engineers at Liverpool. After some evidence had been given it was decided to adjourn the case until January for the attendance of a material witness and the production in Court of the apparatus which was the subject of dispute.

Ryman v. H. M. Salmony and Co.

This was a case heard in the same Court, in which the plaintiff, a traveller, formerly in the employ of the defendant Company, sought to recover £10, balance of commission alleged to be due. He stated that in June last he was engaged as traveller on a fixed salary and commission of 5 per cent., and in the following August was discharged. For the defence Mr. Salmony stated that the commission was fixed at 2½ per cent., and that upon that basis there was only a few shillings due to the plaintiff. It was true that plaintiff had been refused access to the Company's books, but that was in consequence of his extremely bad behaviour, owing to which it had been necessary to order him off the premises. Judge Lumley Smith said he was quite satisfied that the commission had been fixed at 2½ per cent, and that 8s. 10d. was the amount due to the plaintiff. Judgment accordingly.

Laing v. Wilson

This was a case heard in the same Court and was a claim to recover £13. 4s. 6d. for electrical work done to order. The claim was admitted and £10 paid into Court, but defendant contended that another firm of electrical engineers had had to be called in to complete plaintiffs' work. Plaintiffs called evidence to show that the work had been properly carried out, and that if there was any defect it was due to circumstances over which they had no control. Judge Lumley Smith, after hearing the evidence, said he was quite satisfied the work had been properly done, and found for the plaintiffs for the full amount claimed with costs.

Tracey v. London Electrical Omnibus Company (Limited).

In the same Court also was heard an action brought by the plaintiff, an electrical engineer, to recover £57. 8s. for work done and materials supplied to defendant Company's order. The case was remitted from the High Court. £33 had been paid on account, and plaintiff now sought to recover the balance. His charges, he contended, were fair and reasonable, the whole of the work being carried out in accordance with instructions from Mr. Radcliffe Ward. For the defence Mr. Radcliffe Ward, a Director of the defendant Company, and several other witnesses were called and affirmed that some of the work had been rendered useless in consequence of not being carried out to instructions. This evidence did not, however, weigh with the Judge, who awarded plaintiff £52. 10s. and costs. It will thus be seen that the London Electrical Omnibus Company have begun their litigation early and badly.

Fire Prevention.—The British Fire Prevention Committee, presided over by Mr. Edwin O. Sachs, forward us a copy of the third publication issued by the Committee, entitled "The Paris Charity Bazaar Fire." The issue of this pamphlet is opportune at this time, as the London County Council are approaching Parliament next session on the subject of the protection of places of public entertainment and assembly which are not at present under their control. The pamphlet contains comments from experts on the best principles of fire prevention.

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TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 2d. each, post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES" Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. New and enlarged edition, 3s. 6d. net.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"SECONDARY BATTERIES."—By E. J. WADE. *In the Press.*

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced, and all the usual important articles, &c., which have made the book indispensable to the industry, will be brought up to date and amplified where necessary.

Tenders Invited.—From our advertisement columns it will be seen that the Dundee Gas Commissioners require tenders for a supply of service fuse boxes for their electric lighting department. Specifications and forms of tender may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Electric Lighting Station, Dudhope Crescent-road, and tenders must be lodged with the clerk of the Commissioners (Sir Thomas Thornton), City Chambers, Dundee, by Monday, the 20th inst.

——— The Hammersmith Vestry invite tenders for the supply of slow-speed vertical engines, and 300 kilowatt fly-wheel alternators coupled direct. Tenders to the Vestry Clerk, Town Hall, Hammersmith, London, W., by 5 p.m., 22nd inst.

——— The Corporation of Bootle invite tenders for the supply and erection of (1) Lancashire boilers and Green's economisers; (2) engines, dynamos, switchboard, condensers, condensing and feed-water pumps, &c., wiring of electricity works and alterations and additions to wiring at Town Hall; (3) secondary batteries and accessories; (4) feeder and distributing mains, &c.; and (5) running of the electricity supply works for a period not exceeding three years. Tenders, addressed to Chairman of Watch Committee, by noon of Jan. 10.

——— The Electric Lighting Committee of the Borough of Bedford require tenders for the supply and erection of a 420 B.H.P. double-acting compound enclosed engine, and a 250 unit alternator, with stationary armature. Tenders to the Town Clerk (Mr. T. S. Porter), Town Hall, Bedford, by Jan. 10.

——— The Electricity Supply Committee of the City of Gloucester invite tenders for the supply and erection of (*a*) Lancashire boilers and accessories, mechanical stokers, feed-pump, injector, economiser and electric motor; (*b*) steam dynamos and accessories; (*c*) overhead travelling crane; (*d*) switchboard and instruments; (*e*) accumulators; (*f*) insulated cables and trenching; (*g*) arc and incandescent lamps and lamp-posts; and (*h*) meters. Tenders to Town Clerk (Mr. Geo. Sheffield Blakeway), Guildhall, Gloucester, by Jan. 18.

——— The Vestry of St. Pancras (London) invite tenders for the supply and erection of electric lamps, posts, and circuit complete; also fitting and distributing mains. Tenders to Mr. C. H. F. Barrett, Vestry Hall, Pancras-road, N.W., by noon, 28th inst.

——— The Barking District Council invite tenders for the erection of electricity supply station buildings. Tenders to the Clerk (Mr. E. H. Lister), Public Offices, Barking, by 5 p.m. of 21st inst.

——— The County Borough of Southampton invite tenders from local tradesmen for wiring the electricity station, Back-of-the-Walls, Southampton. Tenders to the town clerk (Mr. G. B. Nalder) by 1st prox.

——— The Secretary for Foreign Affairs has received a dispatch from H.M. Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tenders for the construction and equipment of the line, which, with branch, is 30 miles in length. Further particulars of the conditions of the tender may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6. Tenders must be sent in by Feb. 28, 1898. Full particulars can be had of Señor Alcalde Azpeitia, Guipuzcoa, Spain.

——— Tenders are being invited by the Municipal authorities of Laredo for the concession for the electric lighting of the town. Tenders to El Secretario del Ayuntamiento, Laredo (Santander), Spain, by the 22nd inst.

——— The Kattowitz Direction of the Prussian State Railways is inviting tenders until the 29th inst. for the supply of the arc lamp carbons for the twelve months ending March, 1899. Tenders to the Königliche Eisenbahn Direction Kattowitz, Germany.

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Tenders Invited.—The General Direction of Roumanian Posts and Telegraphs, Bucharest, invite tenders for the supply of 25 tons of galvanised steel telephone wire. Tenders by 31st inst.

——— Tenders are being invited until the 27th inst. by the Municipal Authorities of Utrera (Seville) for the concession for the electric lighting of the town and suburbs for five years. Tenders to El Secretario del Ayuntamiento de Utrera (Seville), Spain.

War Office Supplies.—Messrs. James Lewis and Son, of Liverpool, write that the War Office recently invited tenders, to be sent in by Monday next, for 250 tons electrolytic copper, specially stipulating that it must be of American make, although electrolytic copper of equally good, if not superior, quality is made by several English firms. In the same way, Messrs. Lewis point out, English railway companies give preferential rates on the carriage of American copper from Liverpool to Birmingham, charging less than for the shorter distance from smelting works at Widnes to Birmingham.

Tenders Accepted.—The Edison and Swan Company inform us that they have secured the contracts for the supply of incandescent lamps to the National Telephone Company and the Great Western Railway Company, and the contract for the whole of the electrical supplies, including lamps, to the West Sussex County Asylum, Chichester.

——— The Londonderry Town Council have accepted the tender of Mr. G. Braulik for the supply of arc light carbons.

Appointments Vacant.—The Council for the Foreign Community of Shanghai require a chief municipal electrical engineer. Salary (at present rate of exchange) about £460 per annum, with quarters, coal, &c. Some particulars are given in our advertisement columns, and further information may be obtained from Messrs. John Pook and Co., 6, Jeffrey's-square, St. Mary Axe, E.C., to whom applications should be sent before Jan. 15 next.

——— The Government of Trinidad require an electrical engineer to examine and report upon the various electricity supply and telephone undertakings in and adjacent to the Port of Spain. Engagement three months, with option to the Government to extend to any period not exceeding twelve months. Salary, £25 per month, and half salary during voyage out, with free first-class passage out and home again on satisfactory termination of engagement. Some further particulars appear in our advertisement columns, and applications should be sent in to the Crown Agents for the Colonies, Downing-street, S.W., by Jan. 6th.

Vacancies.—The Vestry of St. Mary, Islington, require for their electricity department a skilled man, accustomed to the adjustment and repair of arc lamps, transformers, &c. Wages £2 per week. The Vestry also require an arc lamp trimmer. Wages 32s. 6d. Applications in both cases to the electrical engineer (Mr. Albert Gay), 50, Eden-grove, Holloway, N., by noon of Wednesday, 22nd inst. See advertisement.

——— The City of Bradford require for their electricity department the services of a jointer for street work. Wages £2 per week. Applications to the city electrical engineer (Mr. A. H. Gibbings), Town Hall, Bradford, by Tuesday, the 28th inst. See advertisement.

Business Notices.—The Incandescent Lamp Company (Limited), manufacturers of the "Robertson" incandescent lamp, inform us that they have taken possession of their new building at Brook Green. The new premises will enable the Company to more than double their output.

——— Messrs. Hill, Gifkins and Co. have started business as electrical, mechanical and hydraulic engineers at 68, Victoria-street. Both Mr. Hill and Mr. Gifkins have for some years past been with Messrs. Drake and Gorham. The new firm have, we learn, already secured several engineering contracts.

——— The offices of Dr. John Hopkinson, F.R.S., will on Jan. 1st be removed to Victoria Mansions, 26, Victoria-street, London, S.W.

Dissolution of Partnership.—The partnership business of Messrs. Thomas Harrison and Charles Smith (trading as Harrison and Smith), electricians and electrical engineers, Whitley and High Bridge, Newcastle-on-Tyne, has been dissolved. Debts by Mr. Harrison.

Bankruptcy.—The public examination of S. Bousfield Tatham, electrical engineer, 26, Thurloe-place, South Kensington, was held last Tuesday before Mr. Registrar Linklater at the London Bankruptcy Court. The accounts showed total liabilities £2,534. 11s. 10d., of which £2,510. 8s. 1d. are expected to rank against assets £41. 2s. 1d. Bankrupt stated that from 1889 to 1895 he was a member of a firm of electrical engineers carrying on business at Davies-street, Berkeley-square, but owing to disagreements in August, 1895, he ceased to act as a partner. The following January he started on his own account as an electrical engineer at 6, Gloucester-terrace, and a few months afterwards removed to Thurloe-place, where he traded until his stock and fixtures were sold under an execution last October. The examination was concluded.

Bankruptcy.—A first and final dividend of 17s. 4d. in the £ is payable at Bankruptcy-buildings, Carey-street, London, in the bankruptcy of Oswald Ricketts Swete, some years ago trading with William Charles Main as Swete and Main, electric light contractors and engineers. This dividend announcement will, we think, come as a welcome surprise to the creditors, who must have long ago given up all hope of any division.

Chloride Cells.—We are informed that the Chloride Electrical Storage Syndicate have received instructions to supply a complete set of cells to H.M. yacht "Victoria and Albert." The battery is to be exactly similar to that supplied some time ago to the yacht "Osborne," the property of the Prince of Wales.

"Brush Plant."—The Brush Electrical Engineering Company have sent us an advance copy of their new catalogue of engines, dynamos, motors, alternators, transformers, &c. Not only is the catalogue printed and illustrated in a high-class manner, but its arrangement is most practical. For each type of machine tables of weights and dimensions of the various wires are given, these being both in English and metric measure, and the characteristic features of each machine are duly set forth. Besides the well-known types of Brush continuous and alternating current machines, a price list of alternating-current single-phase motors on the Kolben system is included, the dimensions and prices of motors of 100, 85 and 50 ∿, and from 0 2 to 20 H.P., being quoted. In the section on transformers we note that Mordey-Victoria transformers are now made if required up to the 30 kilowatt size, in cast-iron cases, suitable for burying directly in the ground. Bates's patent high-tension protected switch-fuse has now been adopted as a standard type by the Brush Company, and is made in four different sizes.

Fancy Fittings, Electroliers, &c.—The Edison and Swan Company forward Section VI. of their catalogue, which deals with fancy fittings, electroliers, &c. This Company make a speciality of fittings of every kind from special designs for public buildings, mansions, churches, hotels and theatres, and the present catalogue is especially intended for architects, contractors and installers of the electric light in such buildings. The catalogue is replete with illustrations of hundreds of designs (simple and elaborate) in electric light fittings suitable for use in the most elaborate architectural and artistic surroundings. With some of these designs we are familiar, but many of them appear in the catalogue for the first time. As usual with the Edison and Swan Company's publications Section VI. is very fully and admirably illustrated and printed.

Electro-Medical Supplies.—The General Electric Company forward an excellent catalogue of electro-medical supplies manufactured and supplied by the Company. The catalogue comprises all the requisites for faradisation, galvanisation, and electro-cautery, and gives a complete list of Röntgen-ray apparatus. This is the fifth edition of this catalogue, and almost every class of apparatus used in medical work will be found here fully illustrated and described. Prices are also given, and a useful subject index.

"Cryselco" Lamps.—The Crystal Electric Lamp Company, of Kempston Works, Bedford, forward a useful catalogue of incandescent electric lamps manufactured at the Company's works, and which can also be obtained at the Company's London offices, St. Stephen's Chambers, Telegraph-street, E.C., or of agents throughout the country. A distinctive feature claimed for this lamp is its filament, which is said to be harder, more solid and uniform, and has greater specific resistance than any other filament at present on the market. The continued growth of the Company's trade and connection generally has necessitated large additions to the plant at Kempston. The catalogue illustrates a great variety of lamps, and a number of lamp holders.

Electric Bells, Telephones, and Electric Light Supplies, &c.—Messrs. Croggon and Co. have just issued a very complete illustrated price list of general trade requirements which will be found of service to those requiring general electric supplies. A varied assortment of goods is described in nearly 120 large pages of illustrations and text. Messrs. Croggon and Co. have, owing to increase of business, been compelled to take additional premises adjacent to their already large Upper Thames-street offices and warehouses.

"Automotor and Horseless Vehicle Journal."—No. 3 of this journal is now ready, and contains articles on "Automotor Vehicles," by Mr. W. Worbey Beaumont, M.I.C.E.; on "Electric Traction," by Mr. L. Epstein, M.I.E.E.; and other interesting matter relating to automotors.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 8 to Dec. 14, with the ports of destination:—

Argentina—La Plata, £11. *Australasia*—Adelaide, £42; Albany, £28, Auckland, £71; Brisbane, £184; Melbourne, £1,379 (including £980

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telegraph material); Sydney, £603 (including, £333 telegraph material); Wellington, £179. *Belgium*—Ostend, £18. *Chili*—Boca, £234 (telegraph poles). *Egypt*—Suez, £5,200 (telegraph cable). *France*—Boulogne, £11; Marseilles, £286 (telegraph material). *Gibraltar*—£2,213. *Holland*—Amsterdam, £120; Flushing, £263. *India*—Bombay, £26; Calcutta, £48; Madras, £30. *Italy*—Naples, £50. *Japan*—Yokohama, £480. *Norway*—Christiania, £269. *Portugal*—Lisbon, £25. *Russia*—Libau, £50; Novorossisk, £64; Reval, £22. *South Africa*—Cape Town, £1,099; Durban, £120; East London, £180; Port Elizabeth, £825 (including £775 telegraph material). *Spain*—Malaga, £375. *Sweden*—Gothenburg, £110; Stockholm, £435 (including £335 telegraph material). *Turkey*—Constantinople, £13. Total, £15,063, against £53,178 in the corresponding week last year (Dec. 9 to Dec. 15).

Acton.—The District Council have pledged themselves to the erection of an electricity supply station in the district, and an Electric Lighting Committee, consisting of all the members of the Council, has been formed for the purpose of taking the necessary steps to carry out the scheme.

Barrow-in-Furness.—Mr. R. H. Bicknell will hold an inquiry here on Wednesday next into the application of the Town Council to borrow £30,000 for electric lighting purposes.

Battersea (London).—The Vestry have appointed Prof. Kennedy as consulting engineer to prepare an electric lighting scheme for the parish.

Bexhill.—A Local Government Board inquiry will shortly be held in this district to inquire into the application of the District Council to borrow £20,000 for electric lighting purposes.

Bolton.—At the last meeting of the Electricity Committee the tender of Messrs. Robinson and Co. was accepted for covering the steam pipes of the new engine at the electricity works with steel sheets. The alterations suggested by the electrical engineer (Mr. A. Ellis) to the switchboard were approved of, tenders being ordered to be obtained for carrying out the work. The application to the Board of Trade for a Provisional Order authorising the supply of electricity outside the borough was approved. A communication from Messrs. J. Musgrave and Sons (Limited), asking the terms for the supply of electricity for motor driving purposes was referred to a sub-committee. The electric light mains are to be extended to Shifnal-street. Mr. Ellis was requested to report to the Committee upon the extension of plant necessary for electric lighting during next season. An application from the Director and Secretary of the Technical School that the electrical engineer should be allowed to undertake the teaching of electricity classes at the Technical School was acceded to.

Bootle.—Lieut.-Col. A. C. Smith, R.E., held a Local Government Board inquiry here on Friday, into the application of the Town Council to borrow £35,000 for electricity supply works. The Town Clerk (Mr. J. H. Farmer) said that the Council obtained a Provisional Order in 1895, and the decision to apply for sanction to the necessary loan was come to in July last. The area of supply mentioned in the Order comprised the whole of the borough. They already had an installation in the Town Hall and adjacent public buildings. The cost of erecting the new station, which would be built on land abutting on the Leeds and Liverpool Canal, was estimated at £6,000. The consulting engineer (Mr. T. L. Miller) had originally prepared a scheme involving a capital expenditure of £23,152, but the Electric Light Committee thought it advisable to increase this sum. They hoped to be in a position to supply current to about 8,000 8-c.p. lamps at the outset, but provision would be made to increase the capacity of the station to 20,000 lamps, and the land at their disposal would enable them to provide for supplying current to 60,000 lights. It was only proposed to light a few of the principal thoroughfares electrically. Mr. Miller then submitted plans and gave technical details of the scheme, which was also supported by Councillors Hall and Brown, of the Watch Committee. There was no opposition, and after the conclusion of the inquiry the inspector visited the suggested site for the generating station.

Bournemouth.—At the meeting of the Town Council yesterday an effort was made to induce the Town Council to reconsider their decision in regard to the proposal to construct a network of electric tramways in Bournemouth and district, but, after some discussion, it was decided by 10 votes to 6 to adhere to the previous decision to *oppose the scheme.*

Bristol.—Some time ago the City Council passed a resolution in favour of erecting 200 additional arc lamps in various streets in the borough. Plans and estimates of the cost of this work have now been obtained by the Electric Committee, who recommend that the scheme be carried into effect, and that the necessary money (£23,000) be borrowed on the mortgage of the district fund and general district rate.

The National Telephone Company have purchased a site in Baldwin-street, upon which is to be erected a new exchange at an estimated cost of £10,000. The continued demand for the telephone in this town has necessitated this extension.

Bury St. Edmunds.—The Town Council proposed to apply to the Local Government Board for sanction to borrow £20,000 for erecting an electricity supply station, and Mr. F. H. Medhurst, the Council's consulting engineer, has been instructed to prepare the necessary plans and specifications.

Buxton.—A Town's meeting was held on Thursday last to consider the proposal of the District Council to establish electricity supply works. The consulting engineer (Prof. Kennedy), who was present, gave some particulars of the scheme and answered several queries. The meeting concluded by passing a resolution disapproving of the Council putting down electric lighting plant, and recommending them to make the best possible terms with a company. The Council's Order was obtained in 1895, and the Buxton District Light and Power Company, who are applying for powers, have submitted a proposal for a transfer of the Council's Order.

Cambridge.—On the recommendation of the Sewage Disposal Committee the Town Council have decided to introduce the electric light at the pumping station at a cost of £181. 5*s.*

Cardiff.—A report on the electric lighting of the Cardiff Sanatorium has been submitted to the Health Committee by Mr. N. Appelbee, the borough electrical engineer. The anuual cost of electric lighting is put at £491, but if an independent installation were put down the capital expenditure would be £4,000, and interest on this sum, sinking fund, &c., would amount to £200 per annum, leaving £291 to meet working expenses. The cost of gas is put at £320.

Carnew (Wexford).—A proposal has been made to light this village electrically.

Castleford.—The Gas and Water Committee have under consideration a scheme for the electric lighting of the district. The Council are desirous of emulating the neighbouring Parish Council of Treeton, who recently established electricity supply works.

Chester.—The Town Council have decided to apply to the Local Government Board for sanction to borrow £2,446 for wiring and fitting up the Town Hall, Public Market and Free Library for the electric light. The Lighting Committee have been authorised to have the streets and courts bounded by the city walls lighted by incandescent electric lamps at a cost not exceeding £680.

Chichester.—At a special meeting of this Council last week a formal resolution in favour of proceeding with the application for a Provisional Order was passed. A communication was also read from the Electric Supply Corporation (Limited), offering to take a transfer of the Order and submitting terms upon which they would undertake to establish electricity supply works. The maximum charge for current would be 7d. per unit for the first two hours, and 4d. afterwards, which was, the Company stated, equivalent to gas at 2*s.* 7d. per 1,000, according to the table published in "The Electrician" Electrical Trades' Directory and Handbook. The Corporation would have the option of purchasing the undertaking at the end of 7, 14, 21, or 28 years on certain conditions.

Coatbridge.—With regard to the proposal to construct a light (electric) railway between Airdrie and Coatbridge it was reported at the last meeting of the Council that, since the recent decision to oppose the scheme of the British Electric Traction Company, who proposed to construct the railway, the engineer of the Company had had an interview with the Council, and had submitted particulars of their proposal. The other Company, with which both burghs were in negotiation, would not now be in a position to apply to Parliament this year, and it was agreed to continue the negotiation with the British Electric Traction Company, with a view to ascertaining how far the scheme would suit the town.

College Lighting.—St. Edmund's, Douai (France), is now lighted electrically, current being supplied for the first time on the 27th ult.

Darjeeling (India).—The electricity supply works which were recently inaugurated by the Lieut.-Governor, have proved a decided success. Water power is employed in generating the current, which is supplied both for public and private lighting.

Dartford.—Mr. Reginald P. Wilson has been appointed consulting electrical engineer to the Dartford Town Council.

Dock Lighting.—The Bo'ness Harbour Commissioners have decided to light the docks and harbour electrically, and have purchased the generating plant recently used in the Public Library at Edinburgh. About 20 arcs will be erected in and around the docks.

The Graving Dock Committee of the Tees Conservancy have just put down a complete electric light and power installation. The work has been carried out to the specifications of Mr. J. G. W. Aldridge. The plant comprises two vertical double-cylinder, double-acting high-speed engines, each of 30 H.P., and two dynamos, each capable of supplying current to 300 16 c.p. lamps. The dock is illuminated by means of 10 arcs, of 3,000 c.p. each, and the workshops are lighted by 4 arcs of 1,000 c.p. each, and 47 incandescents (48-c.p., 35 16-c.p., and 8 32-c.p. lamps). Twenty-four 32 incandescents

are provided to light the inside of vessels and under ships' bottoms, each lamp being fitted into a watertight portable lantern, with 100ft. of armoured flexible cable to each. Electric motors are to be employed for drilling and other purposes in the repairs of vessels.

Douglas (Isle of Man).—The Isle of Man Tramways and Electric Power Company and the Gas Company have been invited by the Town Council to submit terms for the lighting of the Promenade and other parts of the town for a period of three years from July 1 next. An electrical expert is to be engaged for the purpose of preparing a full report on the advisability of the Council establishing municipal electricity supply works.

Dover.—The second section of the municipal electric tramways was opened on Saturday last.

East Stonehouse (Devon).—The District Council have recently decided to put down a duplicate plant for the electric lighting of the Town Hall, and on the advice of their surveyor, Mr. A. W. Debnam, have put in a 16 B.H.P. Crossley gas engine and a Newton dynamo, the plant having been supplied and erected by Messrs. Lord and Shand, of Plymouth. The Council are applying for an electric lighting Provisional Order.

Electricity in Mining.—At the meeting of the Hall Mines (Limited), on Wednesday, the Chairman (Sir Joseph W. Truch) stated that the smelting works at Nelson (Canada) had been added to during the past year, and a complete electric lighting plant had been installed. The tramway tunnel in the mines is also now lighted throughout by electricity.

The Pike's Peak Tunnel Mining Railway, which is at present appealing to the public for subscriptions for 100,000 shares of £20 each, proposes to adopt electricity for lighting its tunnels and for working the trains. Electricity will also be available for reduction works and other purposes. Power will be generated by the water conveyed through conduits in the tunnel and having a fall at each outlet of upwards of 200ft.

Garston (Lancs.).—The District Council are purchasing a site for their proposed electricity supply and refuse-destructor works.

Glasgow.—According to the *Glasgow Herald*, Sheriff Jamieson, who presided at the recent official inquiry into the telephone service, has presented his report and judgment on the evidence. It is stated that this opinion is to the effect that the evidence is strongly in favour of the contention of the Corporation of Glasgow.

At the meeting of the Corporation last week the minutes of the Watching and Lighting Committee, recommending that the question of lighting the Springburn-Mitchell-street tramway route electrically be deferred for the present, were remitted back for further consideration, the majority being of opinion that the work should be carried out forthwith.

Govan.—The Town Council have remitted a communication from a company offering to establish an electricity supply station in the burgh to the Electric Lighting Committee for consideration and report.

Great Grimsby.—The Borough Engineer presented a report to the Town Council last week on the condition of the tramway lines. The local tramway company were about to commence the work of reconstruction, and asked whether the Corporation would be prepared to arrange for the supply of current for traction purposes. If so the Company would put down heavier rails and construct the lines so as to be suitable for electric traction.

Harrogate.—The Town Council have received the sanction of the Local Government Board for borrowing £15,750 for electric light extension purposes, the period of the loan being the usual 25 years.

Hereford.—The Town Council are applying for a Provisional Order, and on the advice of their consulting engineer (Mr. T. L. Miller) propose to confine themselves at the outset to a capital expenditure of £24,196.

Huddersfield.—The Town Council have decided to give the National Telephone Company short shrift in the form of three months' notice to entirely remove the telephone poles, wires, &c., erected at Longwood, it being the desire of the Council that the telephones of the borough should be municipalised.

Hull.—The Works Committee's minutes, presented at last week's Council meeting, stated that city engineer and the electrical engineer had submitted schedule of and draft report upon the tenders received for electric tramway equipment. They were of opinion that the choice of the site should be governed almost entirely by first cost, and that unless an exorbitant price had to be paid for land the advantages were in favour of a central site near the docks. The Council were recommended to authorise the Committee to acquire a suitable site for a power station in a central position. The minutes were approved.

Leamington.—The Electric Extension Company, who are in negotiation for the purchase of the undertaking of the local tramway company, have approached the Council with a view to obtaining an extension of a further 21 years' lease of the lines. The General Purposes Committee, however, recommend the Council not to entertain the matter at present.

Lectures.—On Thursday last, Mr. H. A. Mavor gave an interesting lecture on "Recent Applications of Electrical Engineering," before the Glasgow University Engineering Society. The lecturer described the application of electricity to street cars, railways, and conveyances generally; and a number of excellent slides illustrating the application of electricity to cranes, and to boring, planing, and other special tools, were shown.

Dr. J. A. Fleming delivered an interesting lecture at Scarboro' last week entitled, "Electrical Inventions during the Queen's Reign." Dr. Fleming has previously lectured in Scarboro' and is, here as elsewhere, assured of a large and appreciative audience. On this occasion more than usual interest was taken in the lecture, in which many important historical facts were presented in an extremely popular form, aided by some excellent lantern slides.

Mr. R. H. Housman recently read a Paper on "Transmission of Electric Power," before the Mason College Engineering Society. The lecturer compared the cost of production of electric current in factories with that of typical supply stations.

Mr. H. J. Dowsing gave a lecture on Saturday evening last at the Public Buildings, Ealing, before a large audience on "Electricity as a Means of Motion." The various systems used in electric traction (overhead trolley, underground conductor, and storage) were explained and illustrated with models, and a large selection of views were shown on a screen illustrating electric and other motor carriages. A large audience was greatly interested in the lecture.

Leyton.—A report from the resident electrical engineer (Mr. H. Collings Bishop) recommending extensions to the electricity supply works was considered at the last meeting of the District Council. Mr. Bishop pointed out that it would be necessary to spend £17,931 during the forthcoming year, and various other sums, making a total of £51,000, would have to be expended during the next four years. The Electric Lighting Committee recommended that, as it was absolutely necessary that immediate extensions should be provided for, application be made to the Local Government Board to sanction a loan of £20,000 to cover the cost of the 1898 extensions. A long discussion ensued, and eventually an amendment in favour of borrowing £15,000 instead of £20,000 was adopted. The fire stations on the route of the electric cables are to be lighted by electricity instead of gas.

Light Railways and Agriculture.—Speaking at the annual dinner of the Central and Associated Chambers of Commerce and Farmers' Clubs, held in London last week, Mr. Walter Long, M.P., gave (as a hopeful sign for the future of agriculture in this country) particulars of the applications for light railways. He pointed out that 58 applications for lines, with a mileage of 594 miles and a share capital of three and a-half millions, had already been presented to Parliament for England alone; while for Scotland 17 applications for the construction of 166 miles of railway, involving £878,000 capital expenditure, had been lodged; and for Wales 11 applications for 112 miles of line, with £531,000 capital. He claimed that this was a very healthy beginning. A number of these lines, as our readers are aware, are electrical.

Liverpool.—At a meeting of the Lighting Committee on Saturday, the estimates for the forthcoming year were submitted and approved. It is proposed during 1898 to expend £136,987 in the extension of the electricity supply undertaking, principally with the object of supplying electric current for the new tramways and motive power to factories and business premises. The expenditure on revenue account was estimated at £46,080, but it was stated that the profits would fully cover all charges on the additional outlay. During the past year the Committee have erected 96 arcs, which illuminate 2½ miles of streets. Altogether current is now being supplied to 153 street lamps.

A sub-committee of the Tramways Committee has been appointed to confer with a sub-committee of the Lighting Committee with regard to utilising the trolley poles of the tramways for electric lightings.

London County Council.—At Tuesday's meeting the General Purposes Committee reported that they had received an application from Mr. R. F. Stubbs, an assistant in the electric lighting branch of the Council's engineering department, for permission to patent an invention connected with the automatic electric call system, for which provisional protection had been obtained by Mr. Stubbs. The Committee reported that the invention appeared to them to save expense in wiring for the electric light, and the following recommendations by the Committee were approved by the Council:

That Mr. Stubbs be allowed to patent his invention on the following conditions: (1) That the Council do have the right to make use of the invention for all buildings and places belonging to or under the management or control of the Council without being liable to pay any royalty for

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the same. (2) That the Council be at liberty to employ any contractor for the purpose of providing lighting according to the patent. (3) That if at any time the Council so desire the patent shall be assigned to it upon such conditions as the Council may think fit to impose. (4) That the name of the Council be not used in any way for the purpose of advertising the patent.

The report of the Highways Committee dealt with the question of the present position of the telephone service in the Metropolis. Reference was made to the Select Committee appointed by the House of Commons, in 1895, to consider the telephone question, and to the evidence which was given by Mr. W. H. Dickinson, the then Deputy-chairman of the Council, and the estimates which were submitted to the Committee on the Council's behalf. This Select Committee reported in July, 1895, and recommended that a similar Committee should be appointed in the next ensuing session of Parliament, but nothing, however, had been done by the House of Commons in the matter. This brought the Council to the inquiry recently held in Glasgow on the application made by the Glasgow Corporation to the Postmaster-General for licence to work a municipal telephone service in that city. The Highways Committee of the County Council now recommended that it would be a public advantage that a similar inquiry should be held in London. The consideration of the Committee's report and recommendations was postponed.

Lowestoft.—Mr. W. C. C. Hawtayne has sent in his report to the Town Council on the proposal to establish electricity supply works. Mr. Hawtayne, who recommends the adoption of the high-tension alternating current system, strongly urges the Council to themselves carry out the work, and is of opinion that within a short period the demand for current would be equal to about 16,000 8-c.p. lamps. A commencement could be made by laying down plant capable of supplying 4,000 8-c.p. connected. Mr. Hawtayne also suggests that from the Pier to Carlton-road and from the railway station to the Pier be lighted by means of arcs, and that the existing gas lamps in the streets traversed by the mains should be adapted for the electric light.

Mansion Lighting.—Strathallan Castle, Perthshire, which was some time ago leased by Mr. Graeme A. Whitelaw, has been fitted throughout for the electric light. The water of the river Machany is used in the generation of electric current, and current is conveyed to the castle by overhead wires on poles. A battery of accumulators is also provided.

Marylebone (London).—The Board of Trade are to be invited in the forthcoming session to settle the claims of four rival applicants for Provisional Orders for this district, viz., the Central Electric Supply Company, the County of London and Brush Provincial Company, the Marylebone Electric Supply Company, and the Marylebone Vestry. The Metropolitan Electric Supply Company already possess powers to supply current in the parish. At the meeting of the Vestry last week, Mr. T. H. Brooke Hitching, chairman of the Electric Lighting Committee, moved that the application of the Vestry be proceeded with. He pointed out that if the Vestry obtained the Order "they could sell it for £30,000 cash. Such sum might be offered by a company if the Vestry found the undertaking did not pay." He had, however, very little doubt on the point, and he advocated that the work should be carried out by the Vestry. The motion was unanimously adopted.

Motherwell.—The Police Commissioners have authorised the Lighting Committee to inspect the electricity works at Ayr, Edinburgh, Glasgow and Dundee, in order to obtain further information as to the most suitable system of electricity supply for the burgh. The Committee were also granted permission to visit, if necessary, some English stations.

Northwich.—Electric current was supplied for the first time last Saturday by the Northwich Electric Supply Company.

Norwich.—A report from the Tramways Committee on the lines proposed to be constructed by the Norwich Electric Tramways Company was considered at the meeting of the City Council last week. The Committee recommended that authority be given for the construction of four lines, the work to be carried out under the superintendence of the city engineer. The £10,000 required to be deposited under the Norwich Tramways Act has been placed in Messrs. Lasson's bank to the credit of the Town Council. The contract for the construction of the permanent way has been let to Messrs. Pauling and Co.

Nottingham.—There has been an increase of 60 per cent. of the customers of the Electricity Supply Department during the past year compared with 1896, the total at present being 424, with an equivalent of 33,000 8 c.p. lamps.

Partick.—As the result of a conference between the Electricity Committee of the Glasgow Corporation and a deputation from the Burgh of Partick, it has been decided to oppose the application of the Kelvinside Electricity Company for a Provisional Order for the burgh.

Plymouth.—At Monday's meeting of the Town Council Mr. Debnam (Chairman of the Electric Lighting Committee) announced that tenders for the erection of the electricity works at Prince Rock had been received, and as the amount of the lowest tender was largely in excess of the sum included in the estimate upon which the loan sanctioned by the Local Government Board was based, it was resolved that it be referred to the Chairman, the Borough Surveyor and the Electrical Engineer to endeavour to devise a scheme which would materially reduce the cost of the works, and to report to the Committee thereon at the earliest possible date, and that, meanwhile, the further consideration of the tenders be deferred. Only one tender was received for the construction of the underground transformer chambers, which was also referred to the same officials. Mr. Debnam said he was pleased to inform the Council that, without taking one foot away from the building, and without impairing its advantages, they could save close upon £3,000. It was their intention, if possible, to be in a position to supply current by next winter.

Portsmouth.—By a practically unanimous vote the Town Council have decided to proceed with the promotion of a Bill in Parliament empowering them to purchase and work the local tramways. It is also proposed to equip the lines electrically.

Rothesay.—At the monthly meeting of the Harbour Trust and Town Council last week, a resolution in favour of applying for a Provisional Order was unanimously passed. A report on the proposed electric light installation by Mr. T. C. Fulton, of Glasgow, was also submitted and discussed.

Southampton.—The Team Labour Committee have been authorised to invite designs and tenders for motor vehicles for house refuse collection.

Stirling.—The Police Commissioners have received an offer to take a transfer of the Stirling Provisional Order. The matter has been referred to the Lighting Committee, who were instructed to obtain a report from Prof. Kennedy on the offer.

St. Pancras (London).—At the last meeting of the Vestry it was decided to offer consumers of electric current the option of being charged for current on the "maximum demand" system. Under the new scale, which comes into force on the 1st prox., 6d. per unit will be charged for the first three hours, and 3d. after. The Electricity Committee also submitted a scheme for laying mains in West Hill, the Grove, South-grove, and High-street, Highgate, at an estimated cost of £3,180. Mr. Gauntlett moved an amendment in favour of including the side streets, which was carried by 33 votes to 18. The amended scheme involves an expenditure of £7,585.

The Strike.—On Friday last the representatives of the Federated Employers issued a verbatim report of the proceedings at the Conference prior to its adjournment, so far as these proceedings related to the demand for a 48-hours working week. This subject was advocated before the conference, on the men's behalf by Mr. Barnes, the secretary of the Amalgamated Society of Engineers, in a speech of less than ten minutes' duration, the basis of the demand being made upon the views published some time ago by Mr. Mather (of Mather and Platt) that the eight hours' day had proved eminently satisfactory in that firm's works at Salford, Manchester. Mr. Barnes stated that the Postmaster-General, Mr. Hills (of the Thames Ironworks Company) and other large employers of labour were favourable to the principle of an eight hours' day. Col. Dyer followed on the employers' side, and promptly put a question to the mens' representatives, asking how, assuming a 48-hour week were adopted, it was proposed to work a double shift. This view of the subject had not apparently received any consideration from the men's representatives, and on the important question of "overlapping" a spirited discussion took place between the two sides. The employers' representatives then retired to consider the whole question, with the result that the set of detailed "proposals" which appeared *in extenso* in our last issue was presented. The conference, as previously announced, then adjourned (on the suggestion of the men's representatives) until Tuesday of this week.

On Tuesday, the conference resumed its deliberations and, so far from breaking up, the day's deliberations was greatly to improve the prospect of a conciliatory settlement. Three members from each side were nominated as a committee to discuss the points of difference between the parties on the question of workshop management, and whether these divergent views could not be reconciled. The result of this Committee's deliberations had not, up to last evening, been announced.

On Tuesday the judgment of the House of Lords was delivered in the important trades union action "Allen v. Flood and Taylor." This judgement reverses the judgments of the lower courts and sustains the appeal of Messrs. Flood and Taylor. It is considered in trades union circles to be a most important legal decision in support of trades union action.

On Wednesday the official figures of the ballot of the members of the engineering societies affected by the strike were announced. The acceptance of the employers' proposals was approved by 752, against their rejection by 68,966.

Taunton.—The Town Council on Tuesday discussed the result of the recent application to the Light Railway Commissioners

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for an Order to construct an electric tramway and light railway in this town. It was ultimately decided to petition the President of the Board of Trade to review the decision. The Mayor (Alderman W. Potter), who is also Chairman of the Electric Light Committee, said that the decision of the Commissioners was received not only with disappointment in Taunton, but in many other towns throughout the kingdom, as it was felt that the decision struck a serious blow at the extension of light railways throughout the whole country. The result of this was that authorities in other towns and influential companies and bodies, including the London Chamber of Commerce, brought influence to bear upon the President of the Board of Trade to see if it was not possible to set aside the decision of the Commissioners, the general feeling being that the Commissioners had the necessary jurisdiction to deal with such an application. Ultimately the President of the Board of Trade consented to receive a deputation, and he told them that he could not alter the decision of the Commissioners or set aside the law on the point; he, however, said that in the interest of the country generally and by way of settling the question once and for all, if the Taunton Corporation would send in a memorial asking that the decision of the Commissioners might be reconsidered, he would submit it to the law officers of the Crown and get their opinion as to the jurisdiction of the Light Railway Commissioners.

Underground Telegraph and Telephone Wires in the City.—The Commission of Sewers (London) will appeal to the Railway Commissioners against the recent decision of Mr. Commissioner Kerr in the dispute with the Postmaster-General as to the laying of telegraph and telephone wires underground in the City.

Wakefield.—The City Council have offered to supply electric current for lighting the West Riding Asylum at 6d. per unit for the first two hours and 3d. per unit after.

Wave-Power Experiments off Dover.—The experiments being made off Dover by the Morely-Fletcher Wave Power Company have again ended in disaster to the vessel employed in the work. The barque "Wendla" was on Wednesday driven from its moorings by the high wind, and drifted on to the rocks. The shore attempts to save the crew were unavailing, but the wind subsided as the tide receded, and the crew were able to get ashore without further accident. This is the second vessel employed by the Company which has been wrecked through heavy weather.

Weston-super-Mare.—Electric lighting matters in this town have assumed a more hopeful outlook during the week. At the adjourned meeting of the District Council, on Wednesday, a long discussion took place on the merits of rival electric lighting schemes which had been submitted to the Council, but ultimately it was decided to adopt Mr. Hawtayne's scheme, No. 2, some particulars of which were given in recent issues of *The Electrician*. This resolution was carried by 11 votes to 7, one of the members who has hitherto voted against the scheme now voting with the majority.

Whitehaven.—The Town Council had before them last week a proposal to put down additional machinery at the electricity generating station, and to extend the electric light mains to the outlying districts, at an estimated cost of £7,500. It was decided to apply to the Local Government Board for sanction to borrow this sum.

Wills.—Amongst recent wills which have been proved is that of Mr. Joseph Moseley, of the well-known firm of David Moseley and Sons, Ardwick, Manchester, the personal estate being valued at £264,061.

Withington.—A conference took place on Tuesday between the Electricity Committee of the Manchester Corporation and a deputation from the Withington District Council, as to the terms offered by the former for the supply of electric current to Withington. The deputation approved the terms offered by the Committee as fair and reasonable, and will probably recommend their acceptance by the Withington Council.

Wycombe.—The Wycombe Borough Electric Light and Power Company have purchased a site for an electricity generating station from Earl Carrington.

Yarmouth.—The Electric Lighting Committee have decided not to entertain the free wiring offer recently submitted by Messrs. Crampton and Co., and the surveyor and the electrical engineer (Mr. A. W. Ranken) have been directed to frame a scheme for the Council to carry out on its own responsibility. The receipts of the electricity department for November show a surplus of £261 over working expenses, to meet capital charges of £191 per month. There are at present 423 customers, representing an equivalent of 11,760 8-c.p. lamps.

BABCOCK AND WILCOX (LIMITED).—A meeting of the shareholders of this Company was held on Tuesday, at which resolutions were passed increasing the capital of the Company to £320,000 by the creation of £8,000 Ordinary shares of £10 each, and authorising the directors to offer these shares at par to the holders of Preference and Ordinary shares.

COMPANIES' MEETINGS AND REPORTS.

Rand Central Electric Works (Limited).

The annual ordinary general meeting was held at Winchester House Old Broad-street, London, E.C., on Tuesday, under the presidency of Sir C. Rivers Wilson, G.C.M.G., C.B.

The SECRETARY (Mr. H. Militz) having read the notice,

The CHAIRMAN said: The Company has now been in existence for something over two and a-half years, and I think the shareholders may reasonably expect to know what substantial results have been obtained by the expenditure and the labour which have been bestowed upon the undertaking. Before, however, I offer any remarks upon our actual position and our prospects, it may be useful to recall to you the salient features of the engagement between the Company and the contractors. Those of you who have studied the contract will remember that it was contemplated that the works should be completed within 18 months of May 3rd, 1895—that is to say, by November 3rd, 1896; and, as I explained to you last year, we had, under powers conferred upon us, extended that date to November 20th. Then, at the conclusion of this period of construction, after the fulfilment of the contract had been certified by our engineer, we were to enter upon the period of maintenance, which was to last three years, during which the works were to be maintained at our cost by the contractors. This period of three years coincides with which was called in the contract the period of guarantee, during which a minimum dividend is guaranteed by the contractors. Following upon the period of maintenance comes another period of five years, during which the contractors will act as our consulting engineers. The period of construction was, as I have said, to terminate on November 20, 1896. Before the period expired, however, it became evident from the reports which reached us that it would not be possible for the contractors to complete their work within the time stipulated. The reasons for that will, I think, be easily understood by you. You must take into consideration first of all the enormous difficulty and complexity of this work, which in many of its features had a novel character; and I own myself that I remember at the very outset of our enterprise I thought that our contractors had shown some amount of boldness in undertaking to finish these great and difficult works in so comparatively short a period. At the same time the undertaking they entered into was founded on their confidence in their resources and the other advantages at their disposal. No blame can be attached to them; on the contrary, one cannot help feeling admiration for the enterprising spirit in which they entered upon this great work. Think of the distance materials had to be transported—about 7,000 miles—consisting of enormous machinery, boilers, dynamos, instruments of every sort and description, many of them of great delicacy and others of enormous weight. Therefore I felt—and my colleagues felt most strongly with me—that far from imputing any blame to the contractors for not being precisely up to time, every forbearance should be shown to them; and we thought that they should be treated with the same liberality with which they have, I am bound to say, met us on every occasion. Having, then, made up our minds that there must be an extension of the time, we had carefully to consider our position. According to the strict wording of the contract the position was this:—Failing the completion of the works by November 20, 1896, it was under the contract within the competency of the Board of the Company to impose a penalty upon the contractors. The penalty was £500 a week, and the period over which this penalty might run was one year. Well, we had to consider in all the circumstances—weighing especially those considerations I have just mentioned to you—whether we should apply this harsh provision of the contract, or whether it would not be wiser and better, in the interests of the Company, and at the same time due to the contractors themselves, to arrive at some compromise, some modification of that somewhat drastic provision. When we approached Messrs. Siemens and Halske upon that subject we were met again with that same spirit of liberality with which they have treated us all through, and our negotiations eventuated in an agreement which we have made supplementary to the original agreement, and which, I think, while meeting the views of the contractors, has amply satisfied the interests of the shareholders. The position is this: If we had exacted the penalty I have mentioned as from November 20th, we should have been in receipt of these weekly sums of £500, and that arrangement might have gone on for one year. But those cumulative payments would not have been more than sufficient to meet the administration and working expenses of the enterprise, and there would have been nothing for the shareholders during that period, because you will understand that the period of guarantee would not have run during that period. The arrangement we have made by the supplemental agreement is this—that the period of completion is taken to be January 1, 1897, instead of November 20, 1896, an extension of only six weeks, the contractors undertaking that from January 1, 1897, their guarantee of dividend should begin to run. I consider that arrangement to be of a beneficial character in the interests of the shareholders. It is sufficient for you, I think, to know that the works have now been completed, and that as from January 1st, last, you are in receipt of the full guaranteed dividend at the rate of six per cent. per annum. To come to the question of work done, and prospective: the nature of the work we contracted to perform is principally in connection with supplying motive power to the mines; but we have also entered into arrangements, with the consent of the Government, for supplying lighting power. We have undertaken to supply lighting power to two stations of the Netherlands Railway, and also to a portion of Johannesburg township. It will be satisfactory for you to learn that we have contracted for the whole amount of the horse-power we are in the position to supply. On October 15th last the engineer

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gave his certificate to the effect that the works had been completed to his entire satisfaction as from July 1st last. The works, however, as you will see from the report, have been in operation since the early part of May last, but only partially. At the present time the machinery is in full operation. We work with three engines only instead of four, keeping one in reserve, but the three are amply sufficient to supply the whole of the horse-power we have contracted for, and upon that I should mention that the engineer, in his certificate, and in the reports he has periodically supplied to us, has declared that the engines and motors supplied by the contractors are in a position to supply considerably more—some 200 horse-power more—than the amount originally contemplated by the contract. You will not be surprised to learn that the working of the undertaking has not been without certain incidents of a not altogether agreeable character. There have been occasional stoppages and some interferences with our lines. On the main conductor we had some trouble with the insulators, but I believe precautions have now been taken by which that has come practically to an end. We were also subjected to certain outrages on the part of malignant persons, or Kaffirs, but since we have offered £100 reward for the apprehension of any of these offenders, we have not heard any further complaints on that head. Again, in the central works there have been a few accidents, but in consequence of the provision to maintain in store separate parts of the machinery, I do not anticipate that there will be much trouble in that direction in the future. At the same time, looking, as I said just now, to the great extent and the delicacy of some portions of the machinery, and to the fact that the enterprise is in many respects of a novel character, I think we may fairly congratulate ourselves that this wonderful work has been accomplished with so few drawbacks and stoppages. I think it would be interesting to the gentlemen present if, after the meeting, they would examine some admirable photographs of the central works, as they will enable you to form some idea of the machinery and its dimensions. It will be agreeable to you to know that our relations with the Government have been of the most satisfactory description—a matter of no small importance in that country. On September 18th our works were honoured by the presence of President Kruger, Gen. Joubert, members of the Executive Council of the Volksraad, and a large party who came from Pretoria and Johannesburg. You may have seen some account of this visit in the newspapers. There was an enthusiastic meeting, and all the visitors on that occasion expressed their admiration and satisfaction with the work we had accomplished. I may say, in fact, that under the influence of the moment, perhaps, President Kruger made quite a reassuring speech, which I think had a good effect in quarters outside our Company. I cannot leave this reference to the President without mentioning that we have made a very good arrangement with him personally for a supply of water out of his own dam, which, in view of the occasional droughts out there, is a matter of great importance. Well, gentlemen, I think you will be satisfied with this sketch of our present position, and I have no doubt you will be glad to know our views as regards the future. Of course, in a matter of this sort one must not go too fast; but at the same time we are looking ahead. Those of you who have made yourselves acquainted with our contracts will remember that the equipment contract contemplated the early erection of a fifth engine, and provided that the plant and the machinery should be so erected, that space should be reserved for a fifth engine, to be supplied with dynamos, boilers, and all the necessary apparatus precisely upon the same scale as the other four engines. We have, therefore, carefully considered the question of the supply of this fifth engine, and it is now engaging our attention. I hope that circumstances may be such that we may shortly see our way to take steps in the direction of ordering a fifth engine; and, looking still further ahead, I can only anticipate that that will be the first step in advance in the development of our business, which may be followed in the future by many more. I do not wish to be too optimistic, but I tell you candidly that I foresee for our Company, started under its present auspices, great extension and development, to the advantage of all interested in it. I daresay you will have looked at the balance-sheet which is appended to our report. You will observe that although it is a balance-sheet covering an entire year, yet it is what I may call a temporary and informal balance-sheet, only explanatory of our general position, without reference to a revenue account. We are bound to hold a meeting every year, and to present a balance-sheet, but we are not in a position yet to present a balance-sheet which will bear on the question of dividend. In the early part of next year we shall issue a complete balance-sheet to December 31st, and it may be necessary, to call a meeting for the purpose of submitting that balance-sheet to you. Inasmuch as the guaranteed period now runs from January 1st, 1897, and January 1st will be the commencement of our year in future, in order to put ourselves in order, we shall probably hold that meeting and then start afresh, and be able to submit to you a perfect balance-sheet early every year with respect to the year preceding. I do not dwell—although, no doubt, it is a question which interests you very much—upon the subject of dividend, but I think you will have quite understood from what I said just now that the dividend is secured, and that it will be payable in the early period of next year. It is necessary first of all that the accounts should be made up to the end of December, and that they should be examined and passed by the auditors. It is necessary to see what profit has accrued which will go in diminution of the guarantee of Messrs. Siemens and Halske. The accounts will be submitted to Messrs. Siemens and Halske, and no doubt in the early part of the year the dividend will be distributed. You know that the guarantee is in respect of the net profits available for dividend after carrying 10 per cent. to reserve, and upon that question of reserve there is one item in the balance-sheet to which I should like to call your attention. I refer to a special reserve fund amounting to £4,777, which you will find on the debtor side of the balance-sheet. This is money which had been earned prior to the period of the guarantee taking effect, and it is money not made out of working profits, but made, I may venture to say, perhaps, from the good management of your directors. We have got the best interest we could obtain for your money, and we have in other ways been enabled to accumulate this modest sum; and we thought that we should have your approval in placing it to a special reserve for construction purposes, inasmuch as it is not properly available for dividend, not having been made out of working profits. There is one other matter which I must bring to your notice. It is necessary that two directors should retire every year, and they may offer themselves for re-election; and in the report distributed to you it was stated that two of our body—Messrs. Barsdorf and Tarbutt—would so retire. But in the period which has intervened since the report was circulated we have received a communication from Messrs. Siemens and Halske intimating that they thought it would be desirable in their interests and in the interests of the Company that there should be a second representative of theirs on the Board. As you are aware, Mr. Carl Von Siemens, the chief partner in the great firm of Siemens and Halske, is already one of our body, but he resides in Berlin, and although it is a matter of importance that he should be a member of our Board, yet his attendances are necessarily infrequent. That being so, Messrs. Siemens and Halske suggested that it would only be reasonable, and certainly useful, that they should have a second representative on the Board who would be able to attend the Board meetings more regularly, and who would thus be in a better position to supply information to us and to them. Well, they recommended a gentleman, with whom we were already very agreeably acquainted—Mr. Charubin—their representative in London. On receipt of this communication we felt in a little difficulty, as the report mentioned the retirement of two gentlemen and recommended their re-election: but upon the matter being considered by us—assuming, as we did assume, that this was a reasonable and good suggestion—we had to determine what steps should be taken to carry it into effect. Although the articles of association contemplate the possibility of a Board of eight directors, yet we have hitherto been only six, and in so fixing the number of six it was thought important to keep in reserve at least two directorships in view of the future development of the Company, and the desirability of adding to our Board gentlemen who might be of use to our undertaking. That being so, the question arose as to who should retire from the Board in order to give effect to the proposed arrangement. Mr. Tarbutt originally joined the Company as the representative of great interests in South Africa, which were connected with our undertaking and were identified with us, but that interest has ceased. The company with which Mr. Tarbutt is associated having thus no longer any interest in our Company, Mr. Tarbutt, in the kindest possible way, and in a manner most creditable to himself, proposed that he should retire to make place for the representative of Messrs. Siemens and Halske.

A SHAREHOLDER: Is there any reason why they should not both sit on the Board?

The CHAIRMAN: What I explained just now was that it was the policy of the Board to retain two directorships, in view of what I hope will be the larger development of the Company. That being so, Mr. Tarbutt, in the most handsome manner, placed his resignation in our hands.

The SHAREHOLDER: But Messrs. Siemens and Halske would only fill up this one position on the Board.

The CHAIRMAN: That would make the number seven instead of six; and our solicitor reminds me that the Chairman could not have an effective casting vote at the Board if there were seven Directors. Well, Mr. Tarbutt having withdrawn his name we shall propose to you that Mr. Charubin, whom I am glad to see present, be appointed one of your directors. I have nothing more of interest to add, although I shall be very glad to answer any inquiry put to me. I will therefore propose the following resolution:—

"*That the report and accounts as submitted to the meeting be and are hereby received and adopted.*"

Mr. GEORGE ZWILGMEYER seconded the resolution, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. ALFRED H. MARKER, Mr. August Barsdorf was re-elected a director; and Mr. R. Charubin was also appointed a member of the Board in the place of Mr. Tarbutt, resigned.

The auditors, Messrs. Price, Waterhouse and Co., were afterwards re-elected.

The proceedings then terminated with a vote of thanks to the Chairman.

The report of the Directors for the year to June 30th states that the capital of the Company is fully paid up, no calls being in arrear; and reference is made to the contractors having been, through unforeseen and unavoidable circumstances, prevented from completing the works at the specified time, a subject which is fully dealt with in the Chairman's speech given above. The guarantees and specification described in the equipment contract have (the Directors state) been amply fulfilled, and the various tests made of the engines and plant at Brakpan have given satisfactory results, the engines exceeding their guaranteed efficiency of together 2,100 H.P. by about 10 per cent. When simultaneously working with an equally divided delivery of power over the whole length of the main conductor the works will thus be capable of supplying about 200 H.P. above the guaranteed capacity. The delivery of coal has been satisfactorily maintained. The last two or three seasons at the Transvaal having been exceptionally dry, it was considered desirable not to rely entirely on the water supply from the dam at Brakpan, especially in view of a possible extension of the works; and, in order to ensure an uninterrupted working, the Directors have completed negotiations for obtaining a supply of water from President Kruger's dam, to be used as a reserve, and sufficient to meet future requirements. Up to June 30th last 85 per cent. of the amount of the equipment price had been paid to the contractors, and the balance is now in course of settlement.

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Other payments figuring in the balance-sheet have been made on account of mine installations, which remain the property of the Company, the total expenditure being estimated to amount to about £30,000. These installations are for various purposes, viz., pumping, hauling, driving, lighting, etc., and, as the different modes of adapting the Company's power require various types of transformers and motors, which have had to be ordered in Europe, several months must elapse before all the connections can be ready. It will be borne in mind that the work which has been undertaken was of a novel character, involving many features of special difficulty, which have been ably overcome by the contractors, and the Directors have every cause to congratulate the shareholders on the excellent manner in which the central station at Brakpan has been erected, and on the good prospects of the Company.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26½d. per oz. (Dec. 16). Consols (2¾ per cent.) 112⅜—112⅞ for money, 112⅛—113 1/16 for account; 2½ per cent. 106—106⅛ (Dec. 16). Stock Exchange Settling Days: Consols, Jan. 3; Stocks and Shares Continuation Days, Dec. 28 and Jan. 11; Ticket Days, Dec. 29 and Jan. 12; Pay Days, Dec. 30 and Jan. 13; Mining Share Carry-over Days, Dec. 24 and Jan. 10.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY COMPANY (LIMITED).—During the week the Electric and General Investment Company (Limited), on behalf of the County of London and Brush Provincial Electric Lighting Company (Limited), offered for subscription 6,000 Four and a-Half per Cent. Cumulative Preference shares of £10 each (at £10. 10s.) and 6,000 Ordinary of £10 each (at par) in this Company which has been formed, with a capital of £150,000, in 7,500 Four and a-Half per Cent. Cumulative Preference shares of £10 each and a like number of Ordinary shares of the same value, to acquire the interests of the County of London and Brush Provincial Company in the Bournemouth Electric Supply Company (Limited).

BRITANNIA MOTOR CARRIAGE COMPANY (LIMITED).—At a meeting of the shareholders of this Company held on Wednesday at the Britannia Motor Mills, Woodstock-road, London, W., the Chairman (the Hon. J. H. Berkeley) referred to the progress made by the Company during the past twelve months, and stated that they had not too much working capital left unexpended, and that the Company should be strengthened in this direction. They had therefore for some time had under consideration a scheme for bringing this about. It was proposed that the Britannia Motor Carriage Company should sell the whole of its undertaking and assets to another company, to be called the Britannia Electric Motor Cab and Omnibus Company (Limited), which, with a nominal capital of £120,000, would have a working capital of £30,000. If the shareholders expressed a desire that the scheme should be carried through, the Directors would call an extraordinary general meeting to submit formal resolutions to the effect indicated. The Directors' proposal was approved.

BRITISH COLUMBIA ELECTRIC RAILWAY COMPANY.—A circular issued to the shareholders of this Company showing the working results for the first half-year of the Company's existence (actually representing 24 weeks' operations) gives the actual net profit as £1,330, after payment of all charges in London and British Columbia. This satisfactory result is due to steady improvement in business. A water-power installation is in course of construction at Victoria, and, the Directors anticipate, will be finished about March 31. In connection with this work the Board sought the advice of Mr. J. M. Campbell, electrical engineer, of Toronto. Mr. Campbell has confirmed the expert opinion previously obtained by the Company, and put the increased annual profits to be derived by substitution of water power for steam power, and the other improvements in Victoria now in hand, at £9,000 per annum. The installation of water power at Vancouver has been deferred for the present.

BULUWAYO WATERWORKS COMPANY (LIMITED).—At the recent ordinary general meeting of this Company the Chairman referred to the electric light installation at Buluwayo. He said that this had been completed, and had run successfully during the week of the festivities in connection with the railway opening at Buluwayo, and it would run continuously as soon as the reservoirs were connected with the dams, and they could get a continuous supply of water for the boilers. The charge for current authorised by the Government was 2d. per hour per light of 16 c.p. He expressed every confidence in the success of the undertaking.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for August were £2,612, against £3,997 in the corresponding month of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—CORRECTION.—The transfer books of this Company will be closed from Jan. 7th to 14th inclusive, and not as notified by the Company last week, "from the 7th to the 14th inst."

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—Notice is given of the second half-yearly drawing of 154 debentures of this Company, amounting to £2,610, which will be paid on and after Jan. 1 next at the offices of the trustees, the Electric and General Investment Company, 1 and 2, Great Winchester-street, London, E.C.

ELECTRIC AND GENERAL INVESTMENT COMPANY (LIMITED).—The warrants for the interim dividends on the Ordinary shares of this Company for the half-year ended Nov. 30 have been posted.

GAS, WATER AND GENERAL INVESTMENT TRUST (LIMITED).—The transfer books of the Four per Cent. Perpetual Debenture stock of this Trust will be closed from the 20th to the 31st inst. inclusive.

GATESHEAD AND DISTRICT TRAMWAYS COMPANY.—An extraordinary general meeting of this Company was held on Thursday last, when a resolution was passed approving of the agreement entered into for the sale of their undertaking to the British Electric Traction Company. The local authorities interested are now to be approached, with a view to obtaining their sanction to the equipment of the lines electrically.

GREAT HORSELESS CARRIAGE COMPANY (LIMITED).—The shareholders in this Company have been notified that an extraordinary general meeting will be held at Coventry, on the 22nd inst., for the purpose of considering resolutions under which it is proposed to re-organise the affairs of the Company and to wind the same up voluntarily, to enable the Company to enter into an agreement with the British Motor Syndicate (Limited), and further to enable them to enter into an agreement with a Company to be formed and to be called the Motor Manufacturing Company (Limited). This notification is accompanied by a circular which states that as the result of less than twelve months' manufacturing operations the Directors have been able "to lay the foundation for several working departments." The Directors confidently prophesy that, if their present policy be continued for another six months the Company will have attained the position of a profit-earning undertaking. This, it is urged, is as much as the most unreasonable shareholder could possibly have expected from the operations of the Company at this early stage. The Directors further rely upon the support of the shareholders in continuing the policy adopted by the Board. A statement of accounts is being prepared and audited and will be produced at the meeting.

GREAT NORTHERN TELEGRAPH COMPANY.—The coupons due on the 1st prox. on this Company's bonds should be presented for payment between 11 and 2 at the offices of Messrs. C. J. Hambro and Son, 70, Old Broad-street, E.C. Coupons must be left three clear days for examination.

MUNICIPAL LOAN.—The Wallasey Urban District Council require a loan of £17,500 for electric lighting purposes, to be repaid in 25 equal annual instalments. Tenders to the accountant to the Council (Mr. J. J. Burnley), Public Offices, Egremont, Cheshire, by the 21st inst.

NATIONAL TELEPHONE COMPANY (LIMITED).—The transfer books of the Three and a-Half per Cent. Debenture stock of this Company will be closed from the 18th to the 31st inst. inclusive.

PACIFIC AND EUROPEAN TELEGRAPH COMPANY (LIMITED).—Notice is given that the coupons on this Company's Four per Cent. Guaranteed Debentures due 31st inst. will be paid on and after that date at Parr's Bank (Limited), Bartholomew-lane, London, E.C. Coupons must be left at the bank for three clear days.

SMITHFIELD MARKETS ELECTRIC SUPPLY COMPANY (LIMITED).—It is stated that the shares in this Company's recent issue were over-subscribed.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have appointed Thursday, 23rd inst., a special settling day in £125,000 Five per Cent. Debentures (numbers 1 to 1,250) of the Amazon Telegraph Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Dec. 10 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,773.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Dec. 11	3,437	+427	...	...	...
Bristol Trams & Carriage	„ 10	2,256	+379	23	60,428	+9,082
City & South London Ry.	„ 12	1,101	+ 26	24	22,981	- 41
Dover Tramways	„ 11	81	...	14	1,583	...
Dublin United (Southern)	„ 10	383	- 64	23	14,669	- 770
Liverpool Overhead Rly.	„ 12	1,296	+198	24	33,878	+4,570
Sheffield Tramways	„ 12	952	+108	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Dec. 8.	Price Wednesday, Dec. 15.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 11. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£250,125	£10	3/0	Central London Ordinary	9¼ 10	9¼ 10	3 0 0	June and December	9¾	9¾
142,166	10	1/1	Do. (6s paid)	5¼ 5	5¼ 6	3 0 0	„ „	5⅞	5 11/16
£000,000	Stock	2½	City and South London Railway Con. Ordy.	66 68	66 68	2 15 2	January and July	67½	66
8,410	£10	5½	Do. 5% Perpetual Preference	14½ 16	14½ 16	3 2 6	„ „	15½	..
£ 785,701	Stock	4½	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	..	..
54,000	10	7/8½	Waterloo and City Ordinary	12½ 13	12½ 13	2 6 1	June and December	..	..
87,500	10	8½	Liverpool Overhead Railway Ordinary	11 1/16 11 3/16	11 1/16 11 3/16	2 11 11	February & August	..	..
150,000	10	5½	Do. 5% Preference	16 16½	16 16½	3 0 7	„ „	..	..
250,000	Stock	4½	Do. 4% Debentures	110 112	110 112	3 11 5	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price Dec. 8.		Price Wednesday, Dec. 15.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 11.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£923,960	Stock	14/0	Anglo-American	58	60	58	60	4 12 6	Feb., May, Aug., Nov.	58½	..
£3,038,020	Stock	28/0	Do. Preferred	104½	105½	105	106	5 8 6	" "	105½	104⅝
£3,038,020	Stock	5/0	Do. Deferred	12¼	12⅝	12	12½	..		..	..
£137,400	£100	4%	*African Direct Telegraph (Red)	101	105	101	105	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	5⅛	6⅛	5⅛	6⅛	..		..	..
130,000	10	5/0	Brazilian Submarine	16	16½	16	16½	4 4 10	Mar., June, Oct., Dec.	16⅞	..
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	114	118	114	118	4 5 10	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	183	183	183	188	4 5 1	Jan., Apr., July, Oct.	..	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105	107	105	107	3 14 9	" "	106⅜	105⅞
16,000	10	8/0	Cuba Submarine	8½	9½	8½	9½	8 8 5	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18½	19½	18½	19½	5 2 7	" "	..	..
12,981	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10	10½	10	10½	5 14 3	Jan., Apr., July, Oct.	10⅜	..
400,000	£10	2/6	Eastern	17	17½	17	17½	3 14 4	" "	17½	17⅛
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18	19	18	19	3 3 8	" "	18½	18½
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	130	133	130	133	3 0 6	May and November	131	..
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 14 9	February & August	..	..
250,000	10	2/6	Eastern Extension	18⅛	18⅞	18⅛	18⅞	3 17 9	Jan., Apr., July, Oct.	18⅛	18⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	131	134	131	135	2 19 3	February & August	133	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	100	104	100	104	4 17 4	January and July	103	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	100	104	100	104	4 17 4	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103	103	103	106	3 15 8	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞	111⅞	108⅞	111⅞	3 12 1	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	11⅛	12	11⅛	12	3 15 0	Jan., Apr., July, Oct.	11⅛	11⅜
180,042	10	6%	Do. 6 per Cent. Preference	17⅛	18	17⅜	18	3 6 8	" "	17⅜	17⅛
159,000	10	5/0	Great Northern of Copenhagen	25½	26½	25⅝	26½	3 15 6	January, April, July	..	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1865 issue Series "B"	102	105	103	105	4 15 3	March & September	26¼	25⅞
17,000	25	12/3	Indo-European	52	55	52	55	4 10 11	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	107	110	107	110	5 9 7	March & September	53½	52
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	107	110	107	110	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	7⅞	8½	7½	8⅓	4 14 1	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	136	141	136	141	4 5 1	" "	138½	..
15,609	10	6/0	West African Telegraph	4½	5½	4½	5½	5 0 0	..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 14 4	March & September	..	..
30,000	10	2/0	West Coast of America	¾	1½	¾	1½	..		..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	106	108	107	110	3 14 9	June and December	..	..
88,321	10	1/0	West India and Panama	⅛	⅜	⅛	⅜	..	May and November	⅜	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7¾	8¼	7¾	8¼	7 5 5	" "	8¼	7⅞
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	9½	10	9½	10½	2 18 5	May and November	9⅛	..
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	7⅞	7½	7⅞	3 17 8	" "	7⅞	7⅞
33,129	7½	1/6	Do. Deferred Ordinary	2½	3	2⅝	3¼	..	" "	2⅞	..
£382,230	..	4%	Do. 4 per Cent. Debenture Stock	106	109	106	109	3 14 1	June and December	..	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	103	107	103	107	6 10 10	Feb., May, Aug., Nov.	..	..
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	£5	4/0	Chill Telephone (fully paid)	3	3½	3	3½	5 14 4	August	..	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	1/16	1/16	1/16	..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent Preference	2	2½	2	2½	8 0 0	October	..	..
484,597	5	3/0	National	6½	6¾	6⅝	6⅞	4 10 7	February & August	6⅝	6⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 10 7	" "	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14	16	14	16	3 15 0	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6	6½	6	6½	3 16 11	" "	6⅜	6
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104	109	104	109	3 5 0	June and December	105½	105¼
171,504	1	0/4	Oriental	1/16	¼	1/16	¼	4 2 4	April and October	..	..
58,000	5	5/0	United River Plate	3¾	4¼	3¾	4¼	5 17 8	July	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	107	102	107	4 14 4	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.								
£150,000	5	4½%	Birmingham Electric Supply (fully paid)		11		10½ 11	..	March	..	..
£50,000	5	..	Do. (New Issue) £3. 10s. paid		..		..	..		..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	26½	27½	26½	27½	2 10 11	February & August	27½	26⅞
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17	18	17	18	3 6 8	January and July	17⅛	17¼
£409,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131	136	131	136	2 14 3	June and December	134½	133½
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12½	13½	12½	13½	2 8 2	February & August	13⅜	13
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 6 8	" "	6⅞	6½
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	—	—	January and July	—	—
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	10½	11	10½	11	3 8 2	March	10⅛	10⅜
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	116	113	116	3 14 7	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	14⅞	15½	14⅞	15½	..		15½	14⅞
20,000	£10	6/0	Do. 6% Cumulative Preference	15½	16	15½	16	3 15 0	March & September	15⅞	15½
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9½	9¾	9¼	9½	..		9⅜	9⅜
10,000	£5	7%	Do. 7 per Cent. Preference	11	11½	11	11½	3 0 11	March & September	11⅜	11⅛
111,000	£5	..	London Electric Supply Ordinary	2½	2¾	2⅝	2⅞	..		..	..
48,050	£5	..	Do. Preference	5⅞	6⅛	6	6¼	..		..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	19	20	19	20	2 15 0	April and October	19⅛	19⅛
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	18½	19½	18½	19½	..	" "	19	18⅝
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119	123	119	123	3 13 6	June and December	..	..
6,452	10	8/0	Notting Hill Electric Ordinary	17½	18½	17½	18½	2 3 3	March	18¾	18⅝
275,000	1	—	Rand Electric	1⅝	1¾	1 7/16	1⅝	..		..	..
£125,000	Stock	..	River Plate Elec. Lt. Tr'c'n, Ltd., 5% 1st Mor. Deb.	93	98	93	98	..		..	..
150,000	$100	..	Royal Electric Company of Montreal Shares	148	150	148	150	..		..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	104	103	104	106	4 5 4	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	16½	17½	17	18	3 3 11	February & August	17¾	17
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	10½	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	103	106	103	106	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	16	17	16	17	2 19 0	March & September	16⅝	15⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	1/6	Brush Electrical Engineering	1⅞	2	1⅞	2	—	—	2	1⅞
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	2½	2⅝	2½	2⅝	..	—	—	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	107	111	108	112	4 1 1	February & August	111	110
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	104	103	105	4 7 7	June and December	20½	—
10,000	£10	..	British Aluminium Ordinary		..		—	—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference		..		—	—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7	8	7	8	6 5 0	June and December	..	..
£99,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	108	113	108	113	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½	1⅝	1¼	1⅜	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	2	2½	2	2½	—	—	—	—
£82,850	100	..	* Do. 5% First Mortgage Debentures (red.)	89	94	89	94	5 6 5	January and July	—	—
99,261	5	1/9⅔	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3½	5 1 6	February & August	3	2⅞
17,139	5	2/9⅔	Do. (£5 paid)	4½	5½	4½	5½	5 0 0	" "	5½	5
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101	103	101	103	3 17 8	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2½	2⅞	2½	2⅞	4 0 0	February & August	2⅞	2⅜
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3⅜	3⅝	3⅜	3⅝	4 3 4	August	..	..
91,196	1	10/0	Elmore's Patent Copper Depositing	½	⅝	½	⅝	..		..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	20	21	20	21	4 15 3	February & August	20⅝	20½
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 12 0	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 10	" "	114	—
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	22½	23½	23	24	4 3 4	" "	23⅜	22⅞
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	103	107	3 14 9	March & September	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	36	39	36	39	4 12 4	March and July	37⅜	36½
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July	—	—
£22,500	£5	3/6	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	8⅛	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	7	7½	7	7½	4 0 0	" "	7 7/16	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	104	106	104	106	4 4 11	May and November	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

We have already noted the steady and persistent appreciation of electric lighting shares, especially of those relating to the London electric supply companies. In a recent issue the *Statist* directs attention to the very considerable improvement in these shares since April last, when it commented on "the attractiveness of electric lighting shares as investments." Since that date City of London shares have risen from 19½ to 27, Metropolitan from 15½ to 19, Charing-cross and Strand from 11 to 13, Chelsea from 9¼ to 10¾, Notting Hill from 12½ to 18, and so on. Our contemporary reviews the present position in the light of altered circumstances. It finds that the average period yet to elapse is 35 years before the properties can be acquired by the authorities at their then value without any allowance for goodwill, and it calls attention to the provision of a reduction in the scale of charges when a dividend may exceed 10 per cent., the following conclusions being drawn:—

> Of course, there is every probability that in respect of 1897 the total dividend paid will be larger, and in some cases much larger, than was the rate paid in 1896; but the point to which we have now to call attention is that investors appear of late to have been discounting the future a little too much. For an industrial undertaking of such a character it seems fair to assume that the investor ought to get £4 for every £100 put into the Ordinary capital. Of this £4 we might roughly ear-mark £3. 10s. to be regarded as income, and 10s. to be regarded as sinking fund for redemption of capital when the time comes that the authorities can take over the enterprise. Assuming, therefore, a 4 per cent. yield, we have Ordinary shares valued on the basis of expectation of 10½ per cent. dividend on Charing Cross (which last year paid 6 per cent.), of 8½ per cent. dividend on Chelsea shares (which in 1896 paid 5 per cent.), of 10¾ per cent. dividend on City of London (against 7 per cent. paid in 1896), of 7¾ per cent. on Metropolitan (against 5 per cent.), of 7¼ per cent. compared with 4 per cent. in respect of the Notting Hill Company, of 14 per cent. (against 10½ per cent.) on St. James's Ordinary shares, and of 13¾ (against 9 per cent.) on Westminster hares.

The unfortunate breakdown at the Sardinia-street station of the Metropolitan Electric Supply Company last Friday evening arose from a very simple cause. It appears that one of the cable ends behind the switchboard dropped from the thimble connecting it to the board, the cable probably having been imperfectly "sweated" into the socket. An arc was instantly formed and, before it could be extinguished by throwing sand upon it, set fire to five rubber-covered cables, which served as feeders for a portion of the area supplied from this station. The disaster occurred at about six o'clock, and as soon as possible the feeders were disconnected at the basement, the supply to the circuits in which current had been interrupted being continued by means of temporary connections with the mains from the Rathbone-place station. The obvious remedy, to dispense with rubber and other inflammable insulation for the cables behind the switchboard, has already suggested itself, we believe, and will be acted on when making good the damage done.

Heroically facing the problem of a future decline in the coal supply of this country, and its probable effect upon our industrial supremacy, the *Spectator* recently suggested a remedy that, while it may interest, will scarcely be assented to by electrical engineers. While agreeing with Mr. Courtney in a recent speech that England's physical circumstances are "somewhat hazardous," our contemporary remarks:—

> There is, however, one factor in the industrial future on which, although it occurred to Mr. Courtney's mind, he did not dwell; we mean the substitution of electricity for steam as the motor power. This will, in our judgment, revolutionise industry as soon as our electricians have succeeded in effecting such discoveries as will solve the problem of accumulation and cheapen the cost of distribution. We may even hope more from this source than from any other in the solution of what are technically known as "labour troubles," and of the problems presented by large aggregations of people. The tendency of electricity as an industrial force will be to disperse, as that of steam has been to centralise; to make for individual independence, as that of steam has been to foster dependence on the single employer, firm or syndicate. But, quite apart from these probable gains, the general adoption of electricity will relieve anxiety as to the failure of coal and of the steam generated from it as a motor force. Now Great Britain, surrounded by the sea, is in a particularly good condition for the development of electrical industry. Her water rather than her coal supply may prove to be not merely a source of political but of industrial power and stability in the future.

This passage betrays lamentable ignorance both of the chief sources of electrical energy in this country, and of the social influence of an electrical supply of power. The allusion to the water surrounding our shores suggests that the writer in the

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Spectator believes water and water-power to be practically synonymous. If our coal must fail so must our native sources of electric power; the one depends on the other, unless, indeed, we unexpectedly discover an abundance of petroleum beneath our soil. And as to the matter of electric supply abolishing "labour troubles" by a decentralising process, we have more than once shown that idea to be a fallacy, and that practically no such decentralisation on any important scale is likely to take place. The new industrial city and the numerous large factories that have sprung up around Niagara Falls bear witness to the truth of our assertion.

On the principle of "Heads I win, tails you lose," the London County Council has sought to impose on one of its assistant officials such conditions in regard to securing a patent as would effectually tend to quench inventive ability in its staff. We gave in our last issue (p. 275) the terms upon which the Council had agreed to allow an assistant in its electric light department to complete a provisional application already secured; but we may now direct attention to their bearing and significance. Not only does the Council claim special privileges in regard to exemption from royalties, and in being allowed to get any firm it pleases to carry out the patent on its behalf, but it also makes the fundamental and startling claim that "if at any time the Council so desire the patent shall be assigned to it *upon such conditions as the Council may think fit to impose*."! (The italics are our own.) To act in so high-handed a manner were indeed an imposition. The inventor, it would appear, must bear all the expense and trouble if he wishes to develop his invention; and at any time—perhaps when he has made it a commercial success—he must part with every shred of his interest in it at the *fiat* of the County Council, and upon conditions over which he is to have no control. Such flagrant disregard of the private rights of the individual can only be characterised as monstrous; the tyranny that prompted it differs no whit in principle from that of the most tyrannical of absolute monarchs.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Otranto—Vallona	Oct. 11, 1897 ...	—
Emden—Vigo	Nov. 28, 1897 ...	Dec. 17, 1897
San Thomé—Loanda	Dec. 15, 1897 ...	—

A New Physico-Chemical Institute.—The Physico-Chemical Institute of the University of Leipzig, of which Prof. W. Ostwald is Director, will, says *Nature*, be formally opened by a ceremony to be held in the large lecture theatre of the Institute on Jan. 3.

Erratum.—In Mr. F. C. Raphael's description of the Liverpool telephone exchange, in our issue of December 10th, p. 231, the sixteenth and the following lines from the bottom of the second column, the words "and a high inductance" should be deleted. The coils are, in fact, made of german-silver, and are doubly wound.

The Berlin Electricity Works.—The question whether the electric supply stations of Berlin, the property of one company, should be taken over by the municipality, has been before a committee of the town authorities for some time past. It has finally been decided that the works be left in the hands of the Company as heretofore.

Consolidation of Iron Wire Interests in America.—It is reported that the entire iron wire industry in the United States has been brought under the control of a single corporation at the head of which is the well-known financial house of J. P. Morgan and Co. The object of the new corporation is to control the manufacture of iron and steel wire and rod for all purposes, including telegraph and telephone line wire.

Nomenclature.—An American exchange contains a cutting from the Albany *Argus* stating that a company is being formed which will provide an electric system for towing canal boats. After mentioning some of the distinctive features of the system the note concludes with the following sentence: "Several local capitalists are deeply interested in the scheme, and it is not at all unlikely that next season will see the 'electric mules' in operation." Is not this rather unkind to the local capitalists?

Design of Motor Cabs.—A correspondent writing to *The Times* says:—

"In the interest of humanity and of the public safety I would suggest an alteration in the body of the cab motor cars that ply for hire in our streets. The unfortunate person knocked down by one would have no chance of escape. Owing to the depth of the body of the car, which comes so near the road, its victim must be shockingly mangled. I would sooner take the chance of going down under an omnibus, horses and all, than under one of those Juggernaut cars. As a fact, a man I know cycled into an omnibus which, with the horses, completely passed over him, and he came out at the other end almost unhurt, though his machine was smashed to pieces. I leave it to those to suggest a remedy who understand motor power and coach-building. I merely diagnose the disease."

Bracing the Wheel-Pit at the Niagara Falls Power Station.—The Niagara Falls Power Company intend to brace the walls of their wheel-pit extension, and it is likely that the original section of the pit will be similarly treated. This is in order to give additional support to the sides of the pit, so as to lessen the danger to machinery that may be installed there. The method of carrying this out will be by struts or columns of iron weighing six tons each, and measuring 18ft. long by 30in. at their widest part. Each strut is made hollow and with eight ribs, each 2in. wide and 4in. deep. The ends of the struts will rest on brackets secured by anchor bolts to the sides of the pit. These brackets are 3½ft. square by 18in. high.

American Practice in Smooth-Wound Dynamos.—The General Electric Company of America is constructing two 200-kilowatt 10-pole smooth-wound generators for the Edison Electric Illuminating Company of Paterson, N.J. The peculiar feature of these machines, from the American point of view, lies in the armature being built up on a laminated soft steel core without teeth, having coils in the shape of a rod or pressed stranded conductors, connected by radial end bars which form the surface of the commutator. The adoption of this method of construction saves losses due to resistance in commutator leads and segments, and is of importance in generators of low potential with large current output.

Direct Cable Communication to the West Indies.—The c.s. "Britannia" has returned from the West Indies, having found a suitable bed for the new cable to Jamaica. The c.s. "Scotia" left the Thames on Monday for Bermuda with the cable, manufactured by the Telegraph Construction and Maintenance Company, on board. The new cable is expected to be laid and opened by January 31st. Hitherto messages to the West India Islands and British Guiana have been sent *via* the United States and Cuba, but the new cable will enable messages to be sent *via* Bermuda over entirely British territory. The rate for messages to Jamaica will be reduced by nearly 50 per cent., which will doubtless prove a great boon to West India merchants.

Personal.—It is announced that Mr. H. C. Fischer, C.M.G., Controller of the Central Telegraph Office, will retire from the service in February next, after an honourable career of 44 years' duration. Mr. Fischer commenced his telegraphic life in the service of the Hanoverian Government in 1853, and in 1856 joined the Electric and International Telegraph Company. There he held the position of superintendent of their foreign branch, and afterwards of their central office in the City. At the transfer to the State in February, 1870, he was appointed controller of the central office, a position which he has held ever since. Mr. Fischer was created a Companion of St. Michael and St. George in the New Year honours of 1896.

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Inter-Urban Telephony in Italy.—Up to the present, says the *Elektrotechnische Zeitschrift*, telephony has not been developed much in Italy. The number of subscribers is small compared with those in other civilised countries, and most of the apparatus is antiquated. Inter-urban telephony has shown no progress, and it is only quite recently that the first trunk lines, those connecting the local exchange systems of Milan, Como, Monza and Legnano, were erected. On November 14th last a trunk line between Venice and Treviso was inaugurated in the presence of the Minister of Posts and Telegraphs, and the Minister declared that it was the intention of the Government to add numerous other inter-urban lines—as soon as the State finances permitted it.

Electric Traction in Copenhagen.—An amalgamation of the Frederiksberg tramway companies at Copenhagen for the purpose of introducing electric working has, says *Engineering*, just been completed and sanctioned by the authorities. With regard to the kind of electric traction to be chosen, the question has been left open, the concession comprising both the accumulator and the trolley systems. The latter is, however, most likely to be adopted, the more so, as the accumulator system recently introduced on another Copenhagen tramway line does not give much satisfaction. It is also proposed to introduce a uniform 10 ore (1¾d.) fare. The capital has been fixed at 3,500,000 kr., or about £200,000, with permission to increase up to 4.000,000 kr. The erection of a new central electric station is part of the programme.

Direct-Connected and Belt-Driven Generators.—Some comparative tests have recently been made at Chester, Pa., with a view to determining the relative efficiencies of direct connection and belt-driving. A tandem compound condensing engine was direct connected to a 400 kilowatt generator running at 100 revolutions per minute, and in another test two condensing engines, at 80 revolutions, were each belted to a 225 kilowatt generator. The result of the test showed a saving in coal of 22·7 per cent. in favour of the direct-connected engine. The difference in the interest on the cost of installation, however, would be comparatively small, and would reduce this figure only about 7·5 per cent. The brush holders are so arranged that by one hand-wheel they may be simultaneously shifted, or by another all raised at one time from the face of the commutator.

The Ostend Electric Tramway.—The following figures relating to the Ostend electric tramway are given in *Engineering*:—The accumulator system has been adopted, each car being fitted with 12 cases of nine Laurent-Cély cells each, which have a capacity of 140 ampere-hours, and can give a discharge of 50 amperes. Charging takes from three-quarters of an hour to two hours. The cars weigh 7½ tons each, batteries excluded, and can accommodate 50 passengers. The motors, of which there are two to each car, are of 18-kilowatt capacity, and were supplied by the Westinghouse Company. They drive the axles through gearing which reduces the axle speed to one-fifth that of the motor spindle. One charge of the battery is sufficient for a run of 44 miles. The tractive force is found to be 17·6lb. per ton at starting, and 8·8lb. per ton when running on the level at a speed of 11 miles per hour.

Storage Battery Plant for Buffalo Tramways.—The Buffalo Railway Company has decided to instal a storage battery plant in their power house in Buffalo. The Electric Storage Battery Company, of Philadelphia, are furnishing the plant, and it is expected that its installation will be completed in March next. The Buffalo Railway Company are customers of the Niagara Falls Power Company, and have also a generating station of their own, in Buffalo; and it is with the object of making the load even both on their steam plant and on the Niagara supply line that the storage battery is being put down in order to meet the widely varying demand by the cars. The battery is to have a capacity of 1,200 H P. hours, and is to consist of 290 cells, each weighing 1,200lb. It is to be constructed in large iron tanks, occupying a floor space of 2,800ft. A fireproof building adjoining the power house will be erected for this battery. The tanks are to be larger than is necessary for present requirements, so that it will be possible, by adding extra plates, to increase the capacity of the battery 66 per cent. This company were the first users of Niagara power in Buffalo, and expect profitable results to accrue from their use of accumulators in connection with traction.

Coast Signalling in the United States.—"Announcement is made," says the *Western Electrician*, "of a plan that is being perfected by the Navy Department for the establishment of a complete system of signal stations along the Atlantic coast, by which ships of the navy passing near the shore may receive messages from and send them to the Washington authorities. It is intended to use, when practicable, the life-saving stations for signal towers, and where such stations are not well located new ones are to be established for the exclusive use of the signal service. A board has been appointed to report a practicable measure. Along the Long Island shore, and at other points where the life-saving service cannot be utilised for the new scheme, stations will be placed in charge of members of the State militia, which will have entire charge of the system in time of war. Communication from one station to another will be made by telephone and telegraph, so that it will be possible for the movements of a fleet sailing well inshore to be kept in touch with the entire system. It is probable that the government will have a special line of wire to Washington, in order that it may be kept in prompt communication with the signal stations, when necessary. For years Great Britain, France and other European powers have used a like system extensively, and with a chain of life-saving stations extending from Maine to Florida it will not be difficult for the navy to apply it there."

The Proell Auxiliary Cut-Off Gear.—At the opening meeting, at Glasgow, of the present session of the Institution of Engineers and Shipbuilders in Scotland, Mr. Hermann Kühne read a Paper on "The Proell-Corliss Engine and Proell Valve Diagram." We are indebted to a writer in *The Steamship* for the following particulars of the Proell auxiliary cut-off gear. This apparatus provides a means of converting an ordinary throttle-governed steam engine (with invariable point of cut-off) into an automatic expansion engine, and is easy of application to existing engines. Briefly, the gear consists of a Proell governor controlling the tripping point of a trip gear worked by a single eccentric. This operates a double-beat valve, controlling the steam admission to the ordinary slide or Corliss valve on the engine, which latter merely determines to which side of the piston the steam is admitted, and controls the exhaust. The whole gear, including governor, trip gear, and valve, is quite self-contained, and is intended to be fitted to the steam chest, or as near as possible thereto, in order to reduce clearance to a minimum. The governor is fitted with a driving pulley for a belt and a rocking arm to be connected to the expansion eccentric rod. Provision is made for adjusting the speed 10 per cent. either way from the mean, and this adjustment does not alter the sensitiveness of the governor, which requires an increase of speed of 1½ per cent. to open it through its entire range.

Electric Distribution in U.S. Navy Yards.—Prof. C. O. Matthews, Chief of the Bureau of Yards and Docks, U.S N., in his annual report to the Secretary of the Navy, sets forth some of the advantages to be gained by the distribution of power in the navy yards by electricity from one central point. Arguing in favour of this method of distribution, he calls attention to the economy of operation resulting from centralising or uniting all the plants. By the installation of a modern power plant, composed of economical boilers with good coal and ash-handling facilities, compound condensing engines of a size to supply the average demand, and electric generators of an efficient type, combined with a proper distributing system and motors for the machinery, economy will result from the following causes, namely: Larger percentage of the power supplied to the shops will be utilised in driving the machinery; this power will be supplied from engines operating more economically; the reduced steam consumption resulting from the above causes will be supplied from boilers operating under more economical conditions; the number of employes connected with the present power, light and heat plants can be very much reduced. A purely hypothetical ca e

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will perhaps best illustrate the gain to be made in centralising the plants. Suppose, he says, we have one large shop, containing ten large machines or groups of machines, running intermittently; that some machines or groups require 50 H.P., others 75 H.P., other 100 H.P., and so on. Would any engineer instal a separate boiler and engine, with their attendant firemen and engineers, for each engine or group? They would bank their boilers, reduce the number of firemen, and operate enough boilers to supply the average demand. They would instal one, or perhaps two, large economical engines, and correspondingly reduce the number of engineers. Now, suppose these engines to be scattered over a wider territory. The result of this would be that the transmission of power by belts or ropes would be rendered uneconomical, necessitating several engines. Moreover, it renders steam distribution to these engines from one boiler plant uneconomical, owing to the condensation in long lines of steam piping, and necessitates scattering the boilers. Herein lies the essential difference between the present plants and an electric one. We can generate the power in one place and distribute it, and the loss in distribution can be made as small as we wish.

Cork Electric Tramways.—These tramways are situated in the city of Cork, and consist of about 11 miles of track. The gauge is 3ft., which is the same as that of other lines running out of the city. The rails weigh about 83lb. per yard. The power station buildings about to be equipped for electrically working the line will comprise an engine room, boiler room, battery room, car shed and repair shop, covering an area of about 12,000 sq. ft. In the boiler room there will be three Babcock and Wilcox boilers, each of 2,531 sq. ft. heating surface, and capable of evaporating 8,000lb. of water per hour. There will also be an auxiliary heater, combined hot-well and filter tank, and a duplicate set of filters. The chimney stack will be of steel, 7ft. internal diameter, and 130ft. high. The engine room will contain three McIntosh and Seymour side-crank tandem compound engines directly connected to 200 kilowatt generators, running at 150 revolutions. The engines will be run condensing, two Wheeler, Admiralty type, standard surface condensers, each having a capacity of 12,000lb. steam per hour, being erected on the engine room floor. The compound feed-water pumps will also be in the engine room. Condensing water will be taken from the river about 500ft. distant. The battery room will contain 256 Tudor cells, capable of discharging at 110 amperes for seven hours. A booster of suitable capacity will also be supplied for regulating charge of cell, the booster being in the engine room. The switchboard will consist of a combination of lighting and railway panels, the same machine being interchangeable for railway and lighting service. The lighting distribution using 220 volt lamps will be on the three-wire system, at 440 volts across the outers. The battery and regulators will be connected in the neutral, so as to control the balancing current. The dayload will be taken from the railway generators by a motor generator consisting of a motor and two 220 volt generators on the same bed plate. The generators also act as regulators when a single 440 volt generator is supplying the lighting current direct. There will be 18 double-decked cars, seating 44 passengers, mounted upon single Peckham trucks with double motor equipments and series-parallel controllers. The line construction will consist of iron poles with brackets, side brackets being used for single track, and double brackets with centre poles for double track. There will be 94 arc lamps mounted on the top of the poles, constant potential arc lamps being used, connected to the underground network of lighting mains. The railway feeders will be supplied by Messrs. Callender and Co. The entire undertaking is being carried out by the British Thomson-Houston Company.

The Magnetic Separation of Non-Magnetic Material.—Mr. John H. Darby read a short Paper upon this subject before the Liverpool section of the Society of Chemical Industry on Wednesday evening, Nov. 24. This method of concentrating ores—especially the ores of iron—is coming daily into more extended use in the States, though up to the present it has not been employed in this country or in Europe, where the older system of concentrating by means of mechanical jiggers is in vogue. Quite recently there has been a new application of the magnetic method of separation upon a very large scale of operations in New Jersey, and the plant designed by Mr. Edison for crushing and concentrating the iron ore found in this district is said to be working with the greatest success. After referring to the usual classification of all metals into two groups of paramagnetic and diamagnetic metals, Mr. Darby stated that nearly all minerals were found to be similarly affected when exposed to the influence of a sufficiently intense magnetic field. The idea of separating the constituents of composite minerals in this way, and of effecting thus a concentration of the more valuable component, first occurred to a Mr. Wetherell, of Lehigh Zinc and Lead Works, Pennsylvania, and the experiments made by this gentleman with various classes of ore led to the design of a magnetic ore separator, which was patented in the States and other countries. In this type of machine the crushed ore is carried into the magnetic field upon a travelling band, the paramagnetic portion of the ore is picked up as it passes the poles of the electromagnet, and is carried off by a second travelling band, which passes over the space of the lower pole. The capacity of these machines varies with the ore treated, and ranges from $\frac{3}{4}$ to 3 tons per hour. In Mr. Edison's type of machine for treating the New Jersey iron ore the crushed mineral is allowed to fall between the magnetic poles, and the separation or concentration is effected by the slight diversion experienced by the paramagnetic portion of the ore. The current and voltage required to produce a field of high magnetic intensity are only small, the energy being confined within a comparatively limited area of action by the poles of the magnet used. The actual conditions of current and voltage required to obtain the best possible results in the case of any mineral can only be found by direct experiments, and the degree of fineness to which the ore was crushed was found to materially affect the results. This latter also varied greatly with different minerals, in some cases a moderately coarse crushing being sufficient. A careful grading of the crushed mineral was always necessary, different current conditions being required for the separation of the more valuable portion of the two grades of crushed mineral. As examples of the current and E.M.F. used in certain cases, Mr. Darby gave the following figures: Franklinite, 3 to 8 amperes at 16 to 30 volts; Clinton fossil ores, 4 to 8 amperes at 16 to 30 volts; limmonite, higher. The above are all ores of iron. Sulphide ores of iron cannot be treated in this way, but all other ores of iron can be concentrated by use of the magnetic method. The commercial importance of this method is great, because the richer ores of iron have now in most localities been worked up, and a very great saving in freight and carriage is effected by concentrating the poorer ores which are now being used by the iron smelters. As an instance of the application of this method to a mineral, generally held to be inseparable into its constituents by dry methods, Mr. Darby referred to the separation of Irish bauxite from Antrim into two portions—one rich in iron, the other in alumina—which he had successfully carried out by use of the Wetherall magnetic concentrating machine. Successful results had also been obtained with the wolframitic tin ores of Cornwall, while still more striking advantages were claimed for the method when applied to a copper ore from South America containing large amounts of worthless garnet. No details of the actual cost of treatment by these machines were given, but in answer to direct enquiry upon this point Mr. Darby stated that it was low, and almost negligible in comparison with the saving effected. The chief expense was that involved in breaking down the ore to the required degree of fineness and in grading it, but this was a necessary preliminary operation in all methods of concentrating ores—wet or dry.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TUESDAY, December 28th.

ROYAL INSTITUTION.

3 p.m. Christmas Lecture I. (adapted for young people) on "The Principles of the Electric Telegraph," by Prof. Oliver Lodge, F.R.S.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Contact Electrification of Amalgams.—Jets of zinc, cadmium lead and tin amalgams are uninterrupted for a greater length in air, oxygen, or sulphurous acid than in hydrogen or carbonic acid. The length increases with the pressure of the former gases and the concentration of the amalgam. C. Christiansen has studied this effect for a variety of amalgams under various conditions. Potassium, sodium, magnesium, aluminium and thallium amalgams must be added to the above list. The effect is due to incipient oxidation of the amalgamated metal, which produces contact electrification. The length of the uninterrupted jet may be determined with extreme accuracy by letting it impinge upon a mercury surface kept at a known level and making the jet part of a circuit containing a galvanometer. The latter is only stationary while the jet is continuous. It begins to be unsteady long before the eye can detect a break in the jet. Dry air or oxygen has no effect upon the length of a jet of pure mercury. But it oxidises all the amalgams mentioned, and their contact electrification, and the consequent lengthening of the jet, may even be used as a delicate test for rates of diffusion of gases. The great difficulty attending these experiments lies in the presence of traces of moisture, which lead to rapid oxidation and the formation of tubes of oxide round the jets.

[Christiansen, *Wied. Ann.*, No. 12, 1897.]

Mercury Arc Lamps.—In describing his amalgam arc lamps, Gumlich mentioned that the cathode exhibited strong disturbances, whereas Arons had attributed these to the anode. L. Arons now explains that he had erroneously considered the cathode as hotter than the anode. The reverse is the case. The mercury anode gradually distils over into the cathode, and is therefore hotter than the latter. The cathode not only shows a stormy surface, but the discharge proceeds from a constantly shifting bright point on it. The anode is quiet, and glows steadily. The mercury arc lamp suffers, like the amalgam lamp, under the disadvantage produced by the glass walls being covered with finely-divided matter. But this is probably due to condensation, and not to spirting.

[Arons, *Wied. Ann.*, No. 12, 1897.]

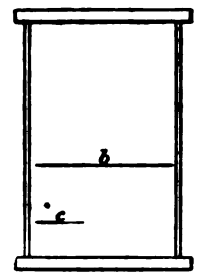
Deflection of Cathode Rays.—W. Kaufmann showed some time ago that the amount by which cathode rays are magnetically deflected simply depends upon the discharge potential. This result can only be brought into harmony with the projection hypothesis if the ratio e/m of the charge of the projected particle to its mass is made 10^7 electromagnetic units per gramme. Such particles would neither be identical with the molecules of the kinetic theory of gases nor with electrolytic ions, and are, therefore, not suited as a test for the projection theory as against the wave theory. W. Kaufmann and E. Aschkinass have, therefore, had recourse to another measurable property of cathode rays, viz., their deflection by a second cathode. They calculate the deflection produced, according to the projection hypothesis, by a field which is constant throughout the short distance traversed by the cathode ray. This condition is fulfilled at a fairly large distance from a plane cathode. In the arrangement adopted the rays are screened off by a diaphragm which partly consists of a narrow slit. After passing a field produced by a tube crossing the other at right angles, the rays enter a large vessel which has a flat end painted with chalk. The field is measured by two electrodes in the path of the cathode beam. The results show a constancy of the ratio AV/F, where A is the deflection, V the discharge potential, and F the field. This is in strict accordance with the projection hypothesis. The absolute value is 70·5 instead of 66, as calculated, but it diminishes nearer the deflecting cathode, where the field is more constant.

[Kaufmann and Aschkinass, *Wied. Ann.*, No. 12, 1897.]

Magnetic Deflection of Cathode Rays.—The above result, in conjunction with J. J. Thomson's recent work, indicates a probable victory of the projection hypothesis. This makes an exact determination of the ratio e/m a matter of great interest, and W. Kaufmann has, therefore, re-examined his figure of 10^7 by means of a close study of the field intensity inside a magnetising coil. This was done by a small exploring coil and ballistic galvanometer. Differences from the theoretical value were found to amount to 0·2 to 1·4 per cent. Small as these differences are, they produce a considerable effect when inserted in the equations. The ratio becomes $1{\cdot}77 \times 10^7$, which is the correct value of e/m.

[Kaufmann, *Wied. Ann.*, No. 12, 1897.]

Species of Cathode Rays.—According to E. Wiedemann and G. C. Schmidt, cathode rays emerge from a point of the cathode in two essentially different manners. The first kind consists of a solid cone, which produces a patch on the glass wall. The second is a hollow cone, which produces a green ring on the tube wall. Both forms occur simultaneously. To study the second kind in their utmost simplicity the authors first of all experimented with electrodeless tubes between the terminals of a Lecher wire system with one bridge. The vessels used were glass spheres, which were placed against a ball electrode. A small bright point appeared against the electrode, and a hollow cone of rays proceeded from that point. Measurements of the angle of this cone showed that it slightly decreases as the sphere decreases in size, but that it rapidly increases with the curvature of the electrode and with the exhaustion of the vessel. If the electrode is not a sphere but a circular ring of thick wire with its plane at right angles to the surface, the figure produced on the wall is of an oval shape, with its major axis normal to the plane of the ring. Ring figures may also be obtained in electrodeless cylinders terminating in plane glass plates. If a ball electrode or a ring is placed against the centre of one of the plates, rings and ovals are obtained just as in the case of the



sphere. In one experiment of considerable theoretical interest, the two plates were covered with tinfoil on the outside. A chalked screen, *b*, was introduced into the cylinder, and a smaller paper screen, *c*, was placed as shown in the figure. A bright red ring then appeared on the chalk, separated from the cylindrical walls by a black ring. Inside the red ring there was some light, especially towards the centre. As exhaustion proceeded the dark ring steadily crowded the bright ring towards the centre. The screen *c* threw a shadow on *b* corresponding to cathode rays perpendicular to the plane ends. The authors conclude that the cathode rays proceed from the separating surface between a solid and a gas in the direction in which the currents producing the oscillations traverse that surface.

[Wiedemann and Schmidt, *Wied. Ann.*, No. 12, 1897.]

Mutual Influence of Two Spark Gaps.—J. I. Károly uses a kind of Lecher system with spark gaps added to the condensers and the distant ends well earthed. He observed that the shape of the electrodes had no very perceptible effect upon the mutual influence, this being the same with point electrodes as with spheres. As regards Klemencic's observation of a prevention of secondary sparks by ultra-violet rays, he failed to observe it. When the terminal plates are earthed through a water column the sparks of the secondary system are brighter. When one of the plates is insulated, the influence ceases altogether.

[Károly, *Wied. Ann.*, No. 12, 1897.]

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STORAGE BATTERIES.*

BY E. J. WADE.

(*Continued from page 194.*)

Sheet and Wire Supports.

With the object of reducing the weight of the supports in proportion to that of the active material they contain, supports have frequently been proposed in which wire or thin sheet is substituted for the heavier cast grids or grooved plates. Although not always specifically stated, in practice the necessary rigidity and strength is supplied to electrodes of this class almost without exception by a solid frame cast round the wires or sheet as the case may be.

In 1881 Faure proposed to construct electrodes of a cable of wires folded backwards and forwards on itself to form flat plates, the active material being contained in the interstices between the wires. FitzGerald, Biggs and Beaumont described the use of lead wire gauze as a basis on which to deposit spongy lead, a number of such layers being consolidated by pressure to form an electrode. Almost identical methods were also proposed by Eaton, by Kotinsky and by De Kabath shortly afterwards.

In 1882 Durham and Ward patented the use of wire of a similar cross-section to that of the pinion wire used by watchmakers, and proposed to wind it either in flat spirals or lengthways or crossways, or both combined upon a flat-back plate. Somzée also described various arrangements of open work wire netting to contain the active material, and in 1883 Arnould and Tamine proposed to construct supports by uniting a series of parallel wires in a surrounding frame.

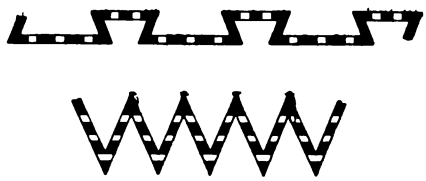

FIG. 36.

In 1889 Entz and Phillips patented a support for active material, consisting of a braiding or network of fine wires woven round a larger central wire. The active material is packed in the interstices between the fine wires, and the compound wire can be made up into electrodes in any desired manner and form. This method of construction is specially intended to be carried out in copper wire with a filling of copper oxide, for use as the positive electrode in alkaline cells, but it is mentioned that it is equally applicable to other metals, such as lead.

One of the latest applications of wire to pasted supports is that patented by Gülcher in 1896, and consisting of a woven fabric having lead wires as warp and bundles of fine fibres or filaments of glass, quartz, &c., as weft. As usual, there is a stout metal frame cast all round it.

In 1881 Sellon, in one of his patents, illustrated two arrangements of perforated sheet for supports, one dovetailed and the other corrugated or pleated (*see* Fig. 36). In 1886 Gardner constructed supports by dividing the central portion of a sheet of lead into a series of parallel sections, leaving each one attached to the body of the sheet by a small strip at either end; then he twisted these sections at right angles to the plane of the sheet, and bent up their edges so as to form a series of curved troughs or trays. Fig. 37 is a plan of a portion of one of these sheets, showing the upper part twisted and bent up into trays, and the lower part cut ready for twisting. In the cross-section the whole of the trays are bent and finished. In the same year Taylor described supports of lead strips corrugated both longitudinally and transversely, spaced some distance apart and cast in a frame. He also mentions that his lead strip may be produced by "squirting" under pressure.

A form of support patented by the Gibson Electric Company in 1889 is shown in Fig. 38. It consisted of flat sheets of lead, out of which raised semi-circular loops are pressed so as to provide keying pieces for the active material. In 1891 Niblett patented an electrode in which a combination of wire gauze and perforated sheet, either flat or corrugated, is used for the support. March, in 1894, also patented a perforated corrugated sheet support on the same lines as those previously described, and in 1895 Pirsch

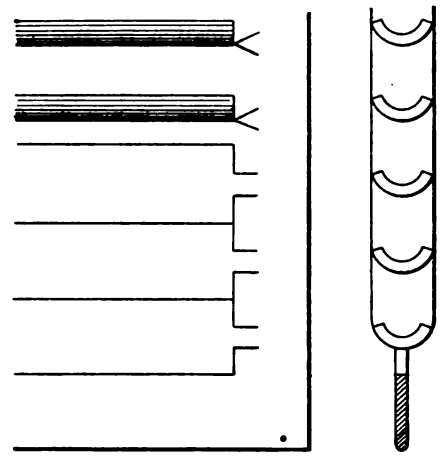

FIG. 37.

described the use of a perforated sheet, in which the holes were pushed, not punched, out, so that the displaced metal stood up in a rim all round them, and helped to hold the active material in position.

Another method adapted for reducing the weight of supports is the introduction of non-metallic non-conducting substances into their construction, ebonite or celluloid being the most usual. Sellon patented the use of two non-conducting grids clamped on either side of a central conducting sheet in 1881,

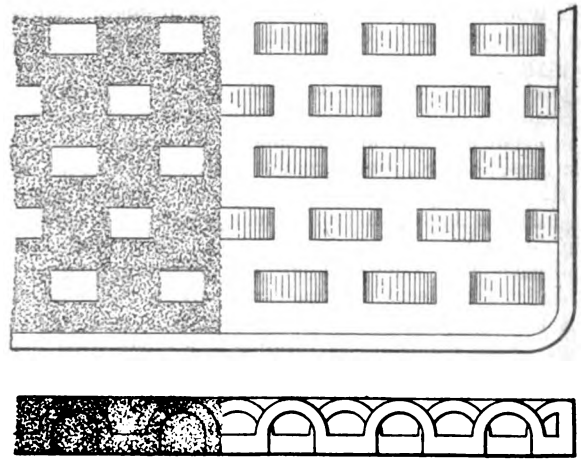

FIG. 38.

FIG. 39.

and this construction appears to have been a favourite one with inventors, for it has been proposed with various slight modifications several times since. Maxwell-Lyte described it in 1883, Pitkin in 1885, Korkogey in 1889, and in 1891 Kennedy proposed to use a slotted central conductor and to have projections on the inner sides of the grids which should meet through the slots and be united by heating and pressure.

In 1885 and 1886 Jones and Tasker described a variety of supports in which non-conducting substances were freely used. In many of these arrangements, however, they merely served as carriers for strips of gold, platinum, &c., which formed the

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conductors in electrodes of the solid peroxide or "lithanode" type. In others, thin sheet or strips or wires were partially embedded in frames of celluloid or were interwoven with celluloid strips.

In 1892 Winkler, in the United States, and Slincher and Mosher in England, patented supports consisting of a number of open troughs of insulating material set vertically in a frame, also of insulating material (*see* Fig. 39). A metallic rod conductor lay along the bottom of each trough, and was connected to a main conducting rod or bar passing up one edge of the electrodes.

In 1894 Buckland patented a support consisting of strips of celluloid passed through a slotted lead conducting plate so as to divide it up into a series of parallel chambers on either side, and in 1895 he described a somewhat similar support, but prepared in a different way by sliding perforated strips of celluloid into a series of parallel lead rods, and fixing them in position at equal distances apart.

Metallic Envelope Electrodes.

Sellon was one of the first to design supports of this type, and in 1881 he described what he called a "compound plate,"

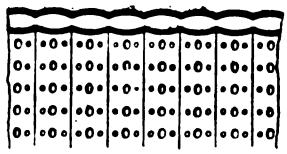

Fig. 40.

consisting of two perforated sheets of lead with active material filled in between them. The sheets were held apart by rivets, or a frame or bars could be attached to their edges so as to form a hollow receptacle enclosed at the sides. The sheets themselves could be flat, corrugated or waved. The latter form is shown in Fig. 40. Volkmar, in France, illustrated a perforated envelope type of support in one of his patents of the same year. Starr also appears to have worked at electrodes of somewhat similar construction, his results being embodied

Fig. 41.

in United States patents from 1881 to 1884. When perforating the lead sheets he did not stamp the metal out, but simply pushed it inwards to form a series of projecting burrs, and thereby give a better hold on the active material. Fig. 41 shows a portion of such a case in cross-section.

Epstein, in 1887, proposed to construct electrodes by casting a lead sheet round cakes of active material, and then cutting slots or holes through this outer envelope.

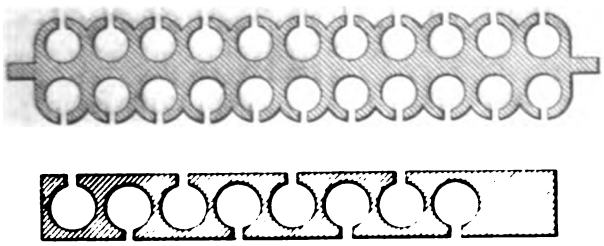

Fig. 42.

In 1889 Logan described various forms of metallic envelope supports which he preferred to slot rather than perforate, as he considered that it afforded a better allowance for expansion. Besides the usual type of flat rectangular envelope, he also proposed to subdivide the active material in supports consisting of a series of slotted tubes, such as are shown in cross-section in Fig. 42. These tubes are open at the top and closed at the bottom.

In another type of support, two examples of which are shown in Figs. 43 and 44, he still further subdivided the active material in small slotted pockets. In the construction shown in Fig. 43, the pockets on either side of the electrode are separated from each other by a solid central core plate, but in that of Fig. 44 corresponding pairs of pockets open through into each other, so that the support partakes somewhat of the nature of a grid.

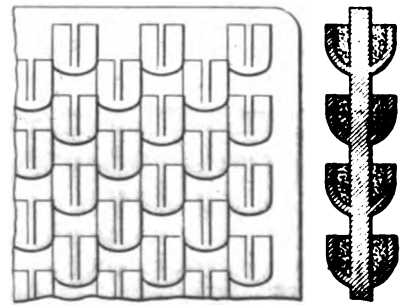

Fig. 43.

Johnson, in 1890, prepared envelope supports by folding a sheet of corrugated perforated metal double on itself, attaching the opposite ends to a main bar, and closing the sides, after filling with active material, by doubling one sheet over the other; or two separate sheets might be used (*see* Fig. 45), and closed all round in this way. Later in the year, in conjunction

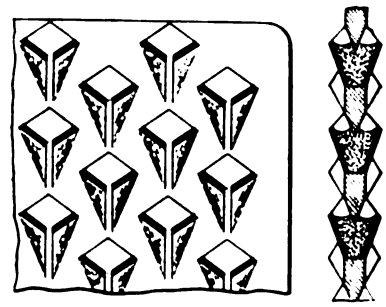

Fig. 44.

with Holdrege, he modified this construction, and used a pair of shallow trays of perforated lead for his envelopes, the trays being ribbed at intervals to divide the active material up into sections.

In 1892 Donaldson and Macrae also patented an electrode, in which the active material was contained in a pair of shallow trays of perforated lead, burned together all round

Fig. 45.

their edges. For larger plates a number of such compartments were held together by a frame or grid cast round them, or, as an alternative method, instead of joining the half compartments directly together they could be burned on opposite sides of a central lead plate of sufficient size to take the required number of them.

Fig. 46.

Still another support, consisting of a pair of shallow perforated trays burned together, is that of Barbier, patented in 1893, the speciality in this instance being the pins projecting from the inner surfaces of the trays into the body of the active material to give a more equal distribution of the current to all parts of it. Fig. 46 shows a portion of such an electrode, partly in side elevation and partly in cross-section.

(*To be continued.*)

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CLONTARF ELECTRIC TRAMWAY.

The Clontarf section of the Dublin United Tramways Co.'s lines has recently been electrically equipped over a length extending from the city boundary, at Annesley bridge, to Dollymount. The track throughout takes the line of the sea coast (Fig. 1) at the opposite side of Dublin Bay to that on which runs the electric line of the same company from Dublin to Dalkey. At the Dollymount end of the line are situated the famous golf links of the Royal Dublin Golf Club, which are largely patronised all the year round. The total length of the newly-equipped line is slightly under three miles of double track, the gauge being 5ft. 3in. (which is the Irish standard gauge), the system of equipment being that of the overhead span-wire trolley (Figs. 1 and 2) adopted by the British Thomson-Houston Company, the contractors.

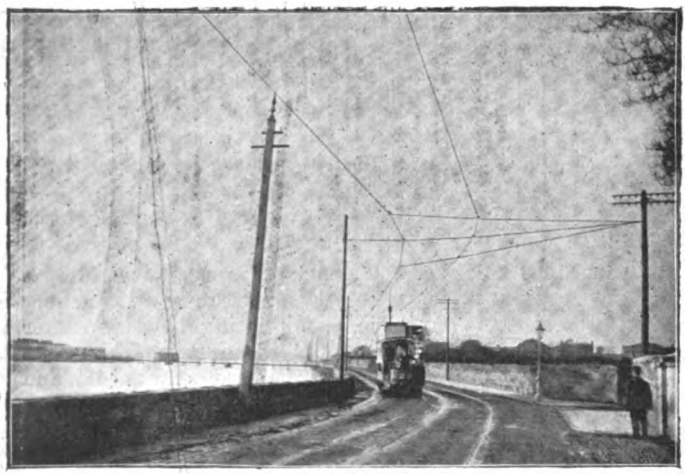

FIG. 1.—Clontarf Electric Tramway. View showing Span Wire Construction.

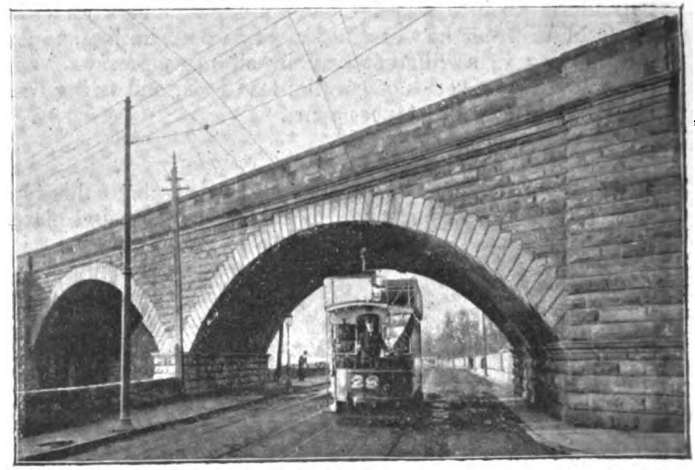

FIG. 2.—Clontarf Electric Tramway. View of Track showing Overhead Construction under Railway Arch.

The power house, which is situated at the Dollymount end of the line, is erected on a site previously used by the Tramways Company for stables and car houses, the buildings then existing being altered to suit the present requirements. It has been erected on the plans of the British Thomson-Houston Company, the building works being carried out by Mr. R. O'Connor, of Dublin, under the direction of the Dublin Tramways Company's engineer. The power house, including the car and repair shops (Fig. 3), covers a space of 166ft. by 140ft. It is divided up into boiler house, engine house, repair shop, offices and car house, the latter being capable of accommodating 26 motor cars. In the boiler house (Fig. 4) are installed three boilers of the Babcock and Wilcox type built in one and a-half batteries. The main flue, which runs along the front of the boilers, is lined throughout with firebrick, and the gases can either pass directly through to the chimney, or through a bye-pass *vid* the economiser to the chimney. The chimney is built octagonally, the inside diameter being 7ft. and the height to the top from the ground line 112ft. There is a firebrick lining from the floor level of the main flue to a height of about 50ft. Each boiler has a total heating surface of 2,197 sq. ft. and a grate area of 44 sq. ft. There are two drums to each boiler, which are cross connected. An economiser consisting of 160 tubes has also been erected in the boiler house. Water is supplied to the boilers by two direct-acting horizontal Worthington steam pumps, each being capable of delivering to the boilers 22,000 gallons of water per hour against 150lb. pressure, which is the working pressure of the boilers. A cast iron water tank with a capacity of 10,000 gallons has also been erected in the boiler house, but in view of the possibility of the supply of town water not being sufficiently constant, a storage tank with a capacity of 38,000 gallons, has been excavated on land immediately adjoining the engine house.

FIG. 3.—Power Station and Car Sheds of the Clontarf Electric Tramway.

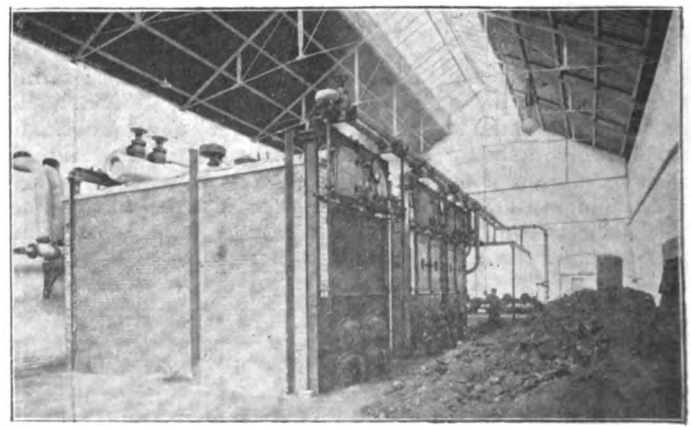

FIG. 4.—Clontarf Electric Tramway. View of Boiler House.

The feed-water piping is in duplicate throughout; it is of cast iron and so arranged that the supply can be taken from either of the water tanks direct to the boilers, or through the economiser. The steam main, also in duplicate, is of lap-welded steel pipes with cast steel flanges; branches are taken to the boilers and engines. Either steam range may be worked independently of the other.

The engines, three in number, were built by Messrs. McIntosh and Seymour, and are of the horizontal tandem compound type (Fig. 5), directly coupled to six-pole 150 kilowatt, 500 volt British Thomson-Houston Company's generators (Fig. 6)

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running at 200 revolutions per minute. The length of stroke of engine is 17in., the diameter of the high-pressure cylinder being 11½in., and that of the low-pressure 23in. Both cylinders are provided with valves of the piston type, these

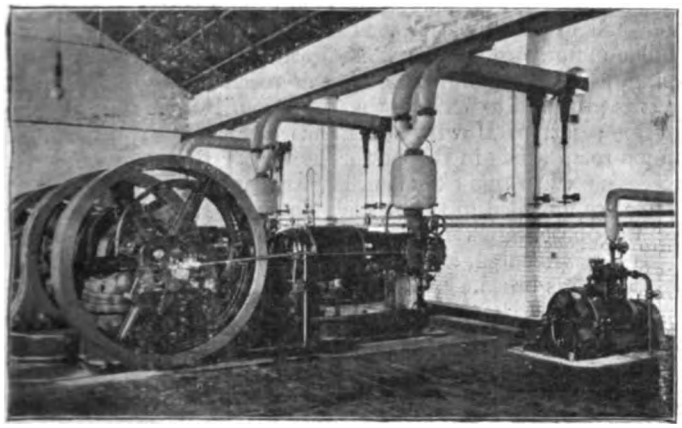

FIG. 5.—Clontarf Electric Tramway. View in Machinery Room showing one of the Main Steam Engines (left) and the Auxiliary Lighting Set (right).

valves being provided with an adjustable seat for preventing leakage. The seat consists of two rings made in one piece and connected by several bridges across the port openings which the space between them forms. All the bearings on the engines are lined with Babbitt metal, hammered in and bored out. On each engine is fitted a steam separator, this being placed immediately over the main stop valve.

The generator armatures, which are drum wound, have special ventilating ducts and highly laminated cores. The laminæ are dovetailed into the spider supported from the shaft, and are insulated from each other by means of japanning. The armature windings consist of interchangeable copper bars set into slots in the periphery of the core, insulated all over with layers of paper and mica. The end connections of the armature windings are in one piece with the body of the winding and lie upon the circumference of the same cylinder. The inner surface of the end connections are protected by a metal flange from the spider extending laterally to support these end connections. The commutator is of hard-drawn copper, insulated with mica. The field frame and magnet cores are of steel, the latter being removable without disturbing the field frame or armature. The coils are wound on separate bobbins, so that they can be readily slipped on and off. The brush-holders are supported radially, and are constructed with end play to admit of uniform wear of the commutator.

These generators are designed so as to deliver an overload of 25 per cent. above their rating for two hours without overheating. They are also capable of sustaining sudden brief fluctuations up to 50 per cent. above their rating and down to zero without injurious sparking at the commutator, and without requiring the brushes to be shifted.

The switchboard is of the British Thomson-Houston Company's standard form and construction, there being one complete panel for each generator, containing the necessary switches and instruments, including an automatic circuit-breaker of the magnetic blow out type, quick-break switches, &c. Each feeder panel is designed for two circuits, and contains circuit breakers and an ammeter for each circuit. There is also a total output panel, with Thomson recording watt-meter, and a leakage panel according to the Board of Trade requirements.

The lights for the power house are supplied from one of the British Thomson-Houston Company's marine type of generating set, consisting of a high-speed vertical engine, coupled

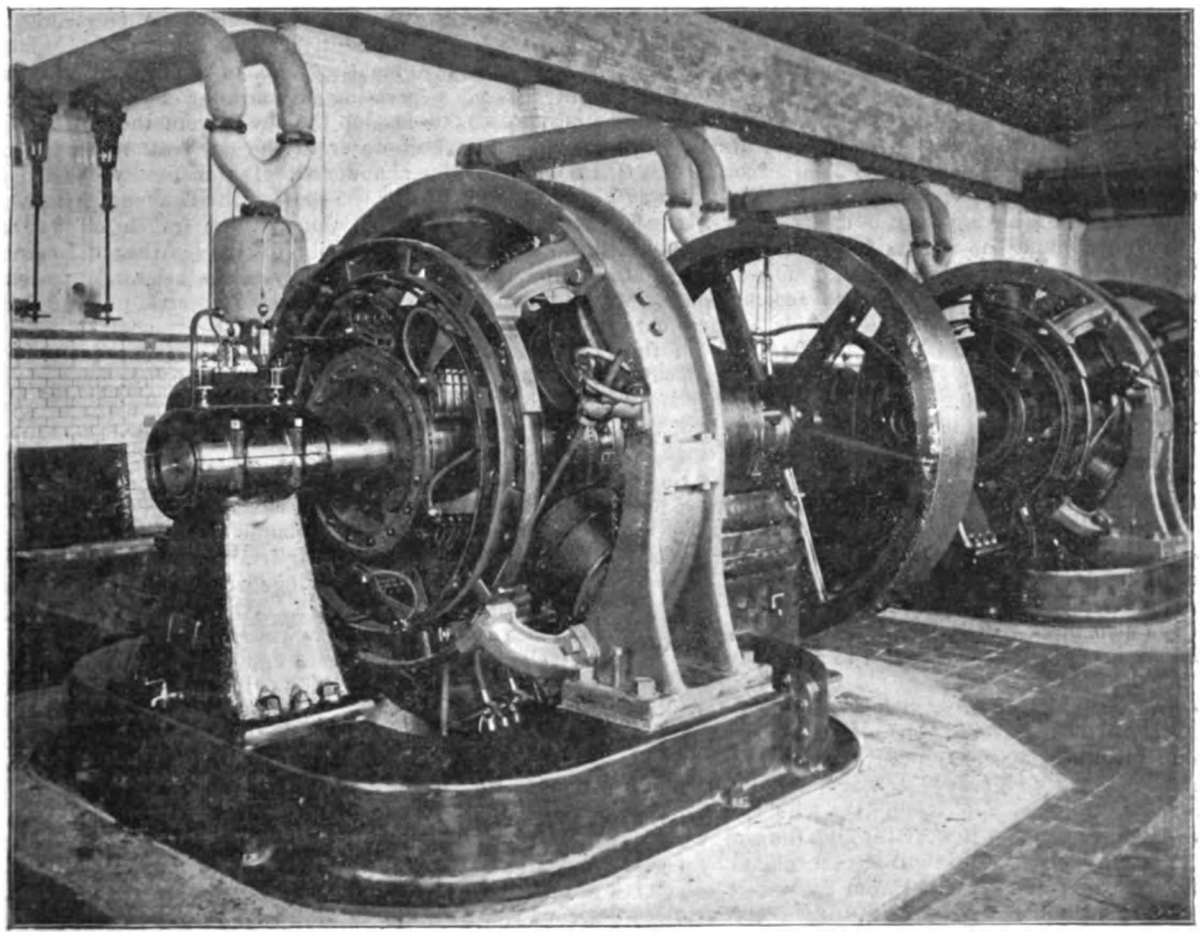

FIG. 6.—Clontarf Electric Tramway. View in the Machinery Room showing the Main Electric Generators.

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direct to a four-pole 10 kilowatt generator, running at 656 revolutions per minute. The lighting is both by arc and incandescent lamps.

An overhead travelling crane, built by Messrs. Jessop and Appleby, of six tons capacity, runs the whole length of the engine house. The lifting and traversing gears are arranged so as to be worked by hand from the floor.

There are two main feeder cables for the tramway supply, each feeder being looped at intervals into a switch pillar. Each of these switch pillars contains six quick-break switches, so arranged that any section of the line or feeder may be cut out without interfering with any of the other sections. The switch pillar also contains a magnetic blow-out lightning arrester, connected to the trolley line.

The overhead trolley line construction, which is on the span-wire system throughout, is erected in the following manner: the poles, which are 29ft. 6in. in length, are built up in three sections of 5in., 6in. and 7in. tubular steel, made with overlapping joints shrunk together while hot. This type of pole, while containing a minimum amount of metal, has been specially designed to sustain the strains incidental to the operation of an overhead trolley system. The poles are spaced at an average distance of 120ft. apart. There are two trolley wires throughout composed of No. O. B. and S. gauge hard-drawn copper wire, divided up into half-mile sections, as required by the Board of Trade. The track, which has been relaid by the Dublin United Tramway Company with a 7in. girder rail, has been efficiently bonded with Chicago 4/0 by 30in. bonds. It is also cross-bonded at short intervals. There are no grades or curves of any note throughout the entire length of line, and there is only one point where there is any variation in the height of the overhead line over the track, this being where the track passes under a railway bridge (Fig. 2). Here the line is dropped from an elevation of 21ft. to 17ft.

Both the original and the new tracks in the car shed and repair shops have all been wired, so that the cars may be moved electrically to any desired place.

Fifteen motor cars have been equipped for this tramway service, 12 of the bodies having been built by Messrs. Milnes and Co., Birkenhead, and the remaining three by the Dublin United Tramway Company. The cars are double-decked, and are exceedingly roomy. They are built to accommodate 54 passengers each, of whom 25 are carried inside. These cars are similar in most respects to those in operation on the Company's Dublin and Dalkey section. The cars are electrically lighted. The car bodies are mounted on "Peckham" cantilever trucks, with 33in. wheels. The springs supporting the car body comprise four elliptical and 12 coil springs, so combined and graduated that the weight of the car comes first upon the elliptic springs, and as the load increases the spiral springs come into play. The brake beams are of wrought-steel bars, the brake leverage being ten to one advantage. The brake-shoes are so constructed as to be interchangeable and easily removed without loosening a bolt. Each truck is also fitted at either end with an adjustable life and wheel guard, which can be adjusted to any desired height from the track.

The electrical equipment of each car comprises a trolley-pole and base, of the swivelling arm type, with the wheel mounted on a pivot fitted so as to prevent it from catching in the span-wire. There is also a special arrangement for bringing the wheel back into line should it jump the wire. This wheel is so constructed that should it wear through the rims will not drop off. The trolley pole is of light steel insulated by means of braiding, the pole being insulated from the socket, which is on a pivotted base supplied with ball bearings. The electrical connections between the fixed and rotating part is of such construction that the cables cannot be twisted off. There are two main motor switches, one at either end of the car, one of these being so designed as to act as an automatic magnetic blow-out circuit breaker. The controllers are of the British Thomson-Houston "K2" series parallel type, and embody the magnetic blow-out principle. They are fitted with an interlocking arrangement by which the power handle cannot be moved, except when the reversing handle is set to run either forward or backward. The reversing handle is so designed that it can only be removed at the "off" position. These controllers also contain an emergency stop switch whereby the car can be very quickly stopped, owing to the breaking action effected by so connecting the motors that they become, for the time being, generators. This emergency stop is entirely independent of any extraneous source of electric supply.

The motors are of the well-known "GE-800" type, there being, as usual, two motors on each truck.

It is proposed to extend the line from Dollymount to the seaside resort of Howth, a distance of about six miles, and ample room exists in the power house for the plant rendered necessary when this extension is carried out.

We are indebted to the British Thomson-Houston Company for the photographs from which the accompanying illustrations were prepared, as well as for the information upon which this article is based.

THE RAND CENTRAL ELECTRIC POWER PLANT.

Stretching east and west of Johannesburg for a distance of about 25 miles is the gold-mining district of the Rand. There is an enormous amount of power demanded for the various operations connected with the industry on the reef; in fact, it is estimated that a capacity in steam engines amounting to a total of 20,000 H.P. is installed amongst the various mines in the district. The inefficiency with which this power is developed, generated, as it is, by units of small capacity, coupled with the high price of coal at the mines, in consequence of the oppressive railway rates, render the cost of power to the mines under this *régime* prohibitive. This combination of conditions was the cause, some time ago, of a proposal to establish a central power-generating station in or close to the Rand. The first idea was to develop the power from the falls of the Vaal River, but lack of water in the dry season was the cause of this plan being abandoned. It was finally decided to erect a power station near the shaft of the Brakpan coal mine of the Transvaal Coal Trust Company. A "franchise" was obtained from the Transvaal Republic for the lighting of Johannesburg and for transmitting power by an overhead tranmission line to the Rand. A contract was also entered into with the coal company, binding it to furnish all the coal required by the Central Electric works for a period of 55 years. Work was started on the station in September, 1895, and, owing to an agreement with the railway company, the material was transmitted to the site without transhipment. A view of the station is given in Fig. 1.

The station is situated about a mile and a-half from the colliery, but a down grade exists the whole length of the line from the latter to the station, so that the only need for a locomotive under the present arrangements is to haul back the empties to the colliery. The coal or "slack" is tipped from side-discharge trucks on to a corrugated iron tunnel, whence it falls into a spiral conveyor, which in turn discharges on to a belt elevator at the western end of the boiler-house. From the elevator the coal is distributed at intervals into the bunkers by two spiral conveyors, which run the whole length of the boiler room.

This room is 250ft. long by 48ft. wide. It has two wings, each capable of housing five boilers. The two iron chimneys are 16ft. in diameter at the base, and 10ft. at top. Automatic stokers of the Leach pattern are used. The fuel conveyors and stokers are worked by electric motors. Eight boilers are at present installed, and two more are to be erected. They are of the Steinmüller multitubular type each of 600 I.H.P., with 3,300 sq. ft. of heating surface, and supply about 2·2lb. steam per hour per square foot of surface. The steam pressure is about 200lb. The limited supply of water available has rendered necessary careful arrangements for supplying and purifying the feed water. Surface condensers are used, and no fresh water is allowed to enter the boilers without being filtered. A reservoir of a capacity of 22,000,000 gallons is adjacent. Fig. 2 shows a view of the boilers and automatic stokers. The engine and dynamo room measures

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230ft. by 76ft. wide. The framework is of iron, and the roof as well as the walls are of wood covered with corrugated iron. A 25-ton overhead travelling crane spans the width of the room. There are four units at present installed, and there is room for a fifth. The engines are triple-expansion, and of the vertical marine type manufactured by the Sächsische Maschinen Fabrik, of Chemnitz. The high-pressure cylinders have a diameter of 22½in., the intermediate cylinders are 86in., and the low pressure 57in. in diameter, the stroke being 35½in. These engines have a normal brake horse-power of 1,000, and are capable of developing a maximum of 1,500 I.H.P. Coupled direct to each engine is a 1,145-kilowatt three-phase generator and its exciter. The armatures are stationary and in the form of a ring, having an internal diameter of 15ft. The field magnet revolves within the armature, being keyed to the shaft driven from the engine. The speed is 100 revolutions per minute. Each of the generators weigh 80 tons and with their engines are mounted on a continuous bed of concrete resting on hard rock about 16ft. below the level of the floor. Three only of the units are in constant use, the fourth being held in reserve. The generators supply current at 700 volts pressure. Fig. 3 gives a view of the four generators and the engine room, and Fig. 4 shows the switchboard.

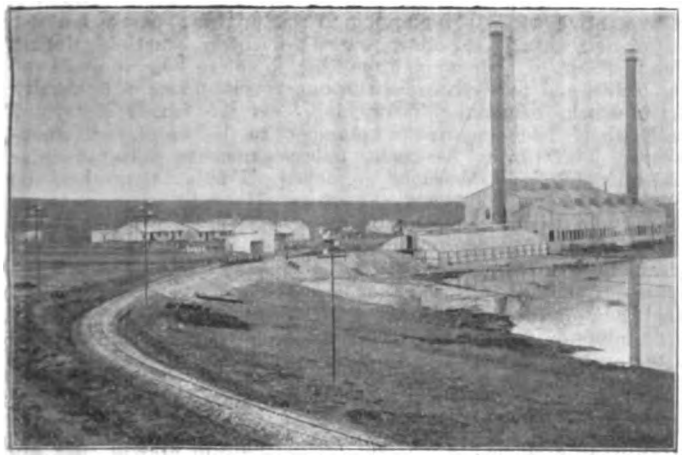

Fig. 1.—View of the Rand Central Power Station.

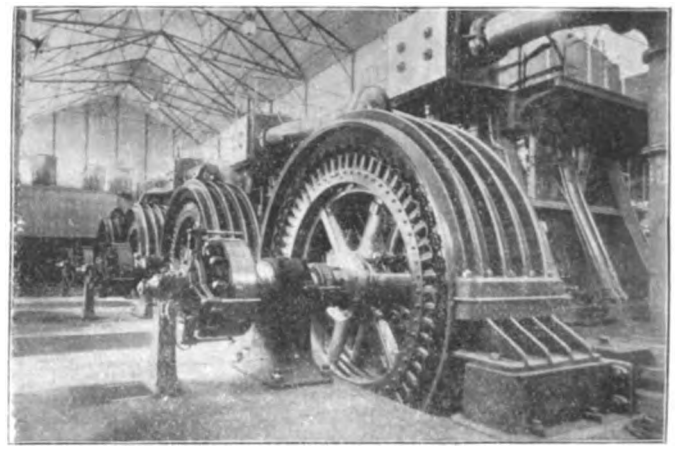

Fig. 3.—Three-phase Generators and Engines at the Rand Central Power Station.

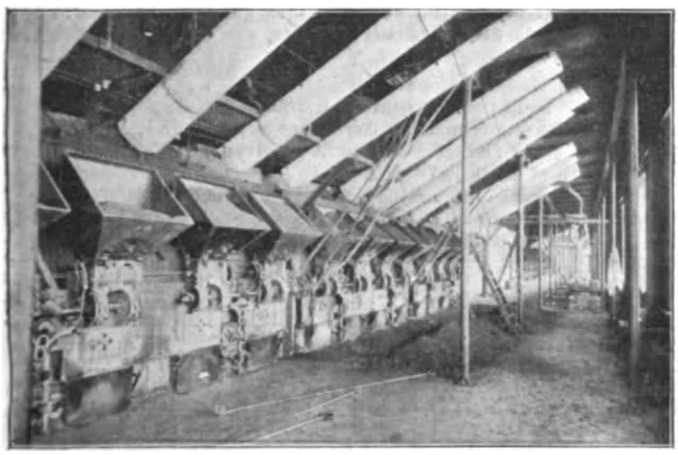

Fig. 2.—View of Boiler House of the Rand Central Power Station.

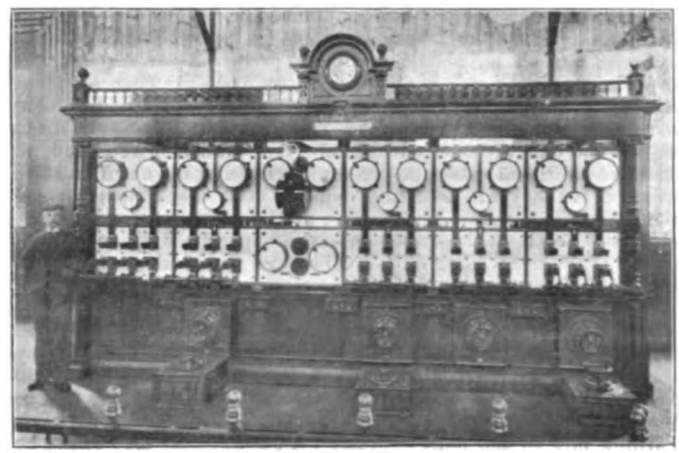

Fig. 4.—Switchboard at the Rand Central Power Station.

In a gallery at the eastern end of the building are located the step-up transformers which raise the pressure from 700 to 10,000 volts for the transmission of the current on the line. The latter consists of six copper conductors carried on steel poles 20ft. high, made by the Mannesmann Tube Company, of South Wales; the cables are fitted with a wire net-like arrangement underlying them for the purpose of catching and keeping them from the ground in case of breakage. The lines are set spirally throughout their course, and the cables are topped by a line of ordinary barbed wire to act as a lightning conductor. Further to guard against the effects of lightning the Siemens and Halske lightning arrester is employed. This arrester is shown in Fig. 5. As the figure will show, the arrester consists of two heavy copper wires bent into a certain shape. These wires are held in cast iron clips attached to porcelain insulators, as shown in the figure, while the lower ends of the wires are adjustable, so that their distance apart at the place where they are closest together may be altered. One wire is put to earth and the other connected to the circuit to be protected. When the circuit is struck by lightning the arc which follows travels upwards between the two horns (as high-pressure arcs are known to do) and fails when its length becomes too great to sustain. About 2,000 volts is the lowest limit of pressure for the line which this arrester will protect. No rain guard is required if the distance apart of the horns is not too small.

Close to each mine taking current a transformer house is erected, containing besides transformers the measuring instruments and safety devices. The transformers in these little sub-stations step the pressure down from 10,000 to 120 volts for lighting, or to 240 or 500 volts for motors. There are two methods of charging for power supplied. By one rating £45 per annum is charged per horse-power measured at the motor shaft, the power company putting up and maintaining all the electric plant; on the other system 1·85d. is charged per kilowatt hour as measured by meter. This latter payment is, however, subject to a sliding scale, by which the rate is varied according to the time of running and the amount of current used.

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The longest stretch of line is to Krugersdorp, some 28 miles from the station. It is intended to light various suburbs of Johannesburg by this power, and already some railway stations are being lighted. The demand for current is good, and eight or nine mining companies are already customers and using the power for various purposes, including air compressing, pumping, ore reduction, hauling and the working of slimes plant. There are now about 38 motors on

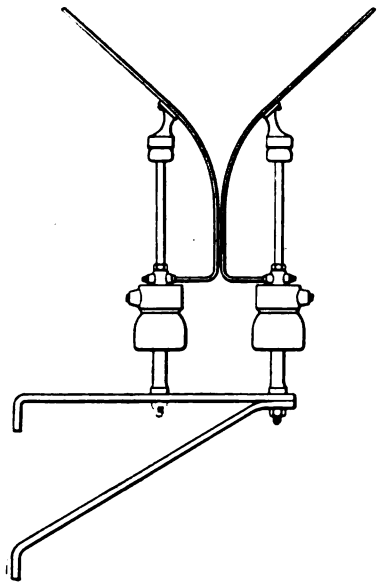

FIG. 5.—Siemens and Halske Lightning Arrester for High Pressure Lines.

the circuit, varying in capacity from 3 H.P. to 250 H.P. It should be added that the whole of the work has been carried out by Messrs. Siemens and Halske.

THE DISTRIBUTION OF ELECTRICAL ENERGY*

BY C. H. WORDINGHAM, A.M.I.C.E., M.I.M.E., M.I.E.E.

(*Concluded from page 200.*)

Mains fall broadly into two systems—drawing in and built in. The drawing-in system is very attractive in theory, and in practice is under certain circumstances to be preferred for feeders, but for distributors the title is a misnomer, for every drawing-in system becomes a built-in system as soon as T-joints are made to connect consumers to the conductors. It is impossible to draw the conductors out without cutting all the branch wires, and to draw in additional cables on the top of old ones is to court certain disaster, for they will assuredly damage both the branch connections and the main conductors. If a drawing-in system be employed, each cable should be in a separate duct, otherwise should there be an earth on one cable, and the insulating covering be damaged, the fault will almost inevitably develop from an earth into a short circuit, whereas, if the cables are held apart in separate ducts, this will not take place, and the fault may be found before disaster ensues. A drawback to these separate ducts is that they are of necessity close together, and when the main is broken into to make a branch connection, these cables are held so rigidly and so close together that it is a difficult matter to make a satisfactory joint. Turning now to the built-in system, the conductors may either be insulated throughout with a solid dielectric, or with a solid and a fluid dielectric intimately mixed, or else with a fluid and a solid at intervals. In the former case, there will be a certain leak all along the conductor; in the latter, if the fluid be air, the insulation will be perfect except at the solid points of support. In the first-class are included solid materials such as vulcanised india-rubber, vulcanised bitumen, diatrine, &c., and mixtures such as paper or other fibrous material impregnated with air or light or heavy oil. In the second class, there is less variety, the conductor usually being supported on porcelain, the chief difference in detail being in the method of support, the conductor either merely resting on the supports, or else being tightly strained at intervals. There is one important essential difference between the two classes; in the first, the insulation resistance is unusually high, but the thickness of dielectric is very small, and if the material is defective, or is injured at any point, there is almost certain to be established a considerable leak to earth, while in the second class the insulation is much lower, but the conductor, instead of being liable to leakage throughout its length, can only come in connection with earth at intervals, *i.e.*, at the supports, and the supports are of such a size that the actual distance of the conductor from earth is considerable, and even if an insulator entirely fails, there is a good chance that it may not come in contact with earth. Taking the first class of insulation, it would not be profitable to discuss in detail each dielectric available. When solid insulation only is employed, the dielectric is usually waterproof in itself, but when fluids are intermixed with the solids it becomes necessary to enclose the material in an impervious envelope to exclude moisture, and to retain the fluid if the fluid be a liquid. In the author's opinion a waterproof solid is preferable to the mixture, partly because it is less likely to allow water to enter, whether during jointing or if slight damage be done to the outside of the cable, and partly because the impervious envelope is usually lead, which, being very heavy, increases the labour of laying, and when laid requires a plumber to be employed whenever a joint has to be made, unless expensive and otherwise objectionable joint boxes be employed. Further than this, the lead being a good conductor, the effects of a fault are often transferred to points at a considerable distance from the original seat of the mischief. Turning to the second class, the conductor is usually in the form of strip, since this can be readily rolled up to bring it on the ground, and it may either be supported at frequent intervals on insulators slotted to receive it, or it may be tightly stretched at long intervals, intermediate supports being provided at a fair distance apart. Unquestionably, the latter method is the best, since the number of insulators can be greatly reduced, while their shape can be made so as to give each insulator a much higher resistance. Conductors insulated as in the first class may, of course, be used in drawing-in systems; when laid on the built-in system they are either protected with steel armouring and laid directly in the ground, or they are placed in a trough of iron or wood, and are surrounded with bitumen, pitch, or some similar material, the additional protection of armour being used in some cases.

In the author's opinion, the best system of distributing mains is that in which bare copper is tightly stretched between porcelain insulators carried by cast-iron bearers. This system was introduced a good many years ago by Mr. Crompton. A very fairly high insulation resistance is attained, higher even than is absolutely necessary. The actual result will depend largely upon the atmosphere in the culvert when the test is made. Table A gives figures under various conditions. It must be borne in mind that in most of the instances given, the insulators were reeking with moisture, the culvert being quite new, and having been closed in the instant the concrete was strong enough to bear the weight of the flags.

The question will naturally be asked—What does this insulation become under working conditions? Unfortunately, it is seldom possible to make tests after a line has once gone into use, but in one instance circumstances admitted of a test, particulars of which are given below:—

Culvert closed, June 16, 1896.
Copper strip run, September 1, 1896.
Current turned on a few days after September 1, 1896.
(Exact date cannot be given.)
Length of culvert, 78 yards.
Current taken off and main tested, February 2, 1897.

Insulation Resistance of Length.

	Positive pole of battery in line.	Negative pole of battery in line.
Positive conductor.....	161·3 megohms.	122 megohms.
„ intermediate	73·9 „	57·7 „
Middle conductor	42·3 „	34·1 „
Negative intermediate	36·5 „	36·5 „
„ conductors	24·5 „	23·4 „

The above tests show what is almost universally found—that the insulation resistance of the negative pole, whatever the system of mains employed, is substantially lower than that of the positive pole. That of the negative, however, in this case is very satisfactorily high. A great advantage of these mains is their security. The conductors being rigidly fixed at a good distance from one another, and the insulation being absolutely incombustible, there is far less danger of a short circuit than with any continuously insulated system. The durability of these mains promises to very greatly exceed that of every other kind. After two and a-quarter years' experience of this, and over four years' experience of another system of bare copper distributors, which, although very good, is inferior to the stretched system in several respects, the author is able to state that not a yard of either kind has had to be renewed, nor is there any sign of deterioration. The ease and cheapness with which service connections can

* Paper read before the Northern Society of Electrical Engineers.

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Table A.—*Insulation Resistance of Stretched Bare Copper Mains.*

Length of culvert.	Size of conductor.	Insulation Resistance. Of length.	Insulation Resistance. Per mile.	Date culvert closed in.	Date strip fixed.	Date of test.	Weather at time of test.
Yards.	Sq. in.	Megohms.	Megohms.				
56	‡	1316·0	42·0	Feb., 1897.	Mar. 25, 1897.	May 3, 1897.	Fine—dry.
		390·0	12·0				
		351·0	11·0				
		164·0	5·0				
		211·0	7·0				
107	‡	2308·0	140·0	Jan. 23, 1897, to Feb. 2, 1897.	Mar. 23, 1897.	Mar. 26, 1897.	Damp.
		860·0	52·0				
		2799·0	170·0				
		939·0	57·0				
		1069·0	65·0				
89	‡	67·0	3·39	May 13, 1897.	Aug. 31, 1896.	Feb. 1, 1897.	Very damp.
		56·0	2·83				
		165·0	8·32				
		9·0	0·43				
		98·0	4·93				
51	‡	2071·0	60·0	Oct. 27, 1896.	Dec. 4, 1896.	Dec. 3, 1896.	Fine.
		810·0	23·4				
		3589·0	104·0				
		953·0	27·6				
		1737·0	50·0				
85	‡	3735·0	180·0	Sep. 22, 1896.	Nov 23, 1896.	Dec. 2, 1896.	Raining heavily.
		12865·0	621·0				
		898·0	43·0				
		2573·0	124·0				
		957·0	46·0				
84	‡	6·3	0·3	July 29, 1896.	Sept. 3, 1896.	Nov 27, 1896.	Damp.
		8·1	0·386				
		6·9	0·328				
		36·8	1·75				
		29·8	1·42				
82	‡	103·0	4·7	Sep. 25, 1896.	Nov 20, 1897.	Nov 26, 1896.	Damp.
		42·0	1·95				
		5·3	0·246				
		23·0	1·06				
		723·0	33·68				
77	‡	104·0	4·55	Aug. 10, 1896.	Sept. 4, 1896.	Nov 25, 1896.	Damp—frosty.
		275·0	12·02				
		136·0	5·9				
		141·0	6·18				
		50·0	2·2				
86	‡	3·3	0·159	Oct. 23, 1896.	Nov 16, 1896.	Jan. 18, 1897.	Dry—very frosty.
		39·1	1·88				
		6·8	0·328				
76	‡	13·8	0·595	Oct. 22, 1896.	Nov 16, 1896.	Jan. 18, 1897.	Dry—very frosty.
		10·9	0·47				
		5·6	0·241				
58	‡	349·0	11·4	Oct. 2, 1896.	Nov 13, 1896.	Dec. 4, 1896.	Raining.
		1944·0	64·0				
		53·0	1·74				
55	‡	88·0	2·7	Oct. 26, 1896.	Nov 16, 1896.	Dec. 3, 1896.	Very damp.
		537·0	16·7				
		618·0	19·0				

NOTE—The above tests were made after one minute's electrification with the negative pole of a battery giving about 400 volts, the direct deflection method being employed. One division of galvanometer scale corresponded to about 120,000 megohms.

be made is a great recommendation. In the original Crompton system all such connections were made at an insulator, to which access was obtained by means of a box-lid. In the author's practice these insulators are flagged over, and connection made at any point, even midway between two insulators. This is done quite safely by fixing the service conductors in the wall of the culvert. They then actually assist in keeping the main conductors rigid. A porcelain insulator is placed beneath a service cable where it crosses the bare strip to prevent accidental contact. It will be noticed that, contrary to all continuously insulated systems, the T-joint does not lower the insulation resistance of the mains to any appreciable extent. The cost of the system does not differ greatly from any other good class of mains, but even if its first cost were much higher, the author would prefer it on account of its durability and safety. The relative cost diminishes rapidly as the size of the conductors increase. Without insisting greatly on the point, it may be mentioned that it is quite easy to draw in additional copper at any time, but to do this, all the T-joints must be unclamped, and the supply cut off from the main. The supposed drawbacks to the system are danger of flooding and liability to explosion of gas. As regards the former, it is difficult to see how the water could get in, but, even if it did, it is unlikely it would reach the copper, as the culverts have all a fall of at least 1 in 100, and are connected to boxes at each end, all of which are drained to the sewers. Further than this, even if the copper were immersed, supposing the water to be pure, it is quite likely that it would be found feasible to continue running on the main until the culvert could be emptied. With respect to explosion, it is of course possible that gas might find its way into the culvert, but with good ventilation, such as is recommended in another part of this Paper, the danger is small, and the author has never had an instance, though he has had several explosions where insulated cables have been run in pipes, and that without the presence of coal gas.

The author begs the indulgence of the members of the society if he be somewhat of an enthusiast in respect to bare copper; he would plead in extenuation that his enthusiasm is based upon experience, while he has observed that the strongest opponents of the system are those who have never laid or used a yard of this class of main. In Manchester there is 1 mile 308 yards of distributor laid on the slotted insulator system which have been at work for over four years, and there are 4 miles 1,690 yards, or just five miles of distributor on the stretched system which have been at work for varying periods up to 2¼ years. Both classes are in perfect order, and show no signs of deterioration. In one instance there was a short circuit with the slotted insulator system owing to the wedges becoming loose, and allowing the copper to buckle, and there was one short circuit on the Crompton system on the first length laid due to the carelessness and inexperience of a workman causing two strips to be forced together. With these two exceptions there has been no trouble of any kind with either system of distributors. The one disadvantage of bare copper is its want of flexibility; there must be a clear way of considerable cross-section for it, and in certain positions it is therefore impossible to employ it; it is not advisable either to lay bare copper in wide roadways subject to heavy traffic. When bare copper cannot be used, the author considers the next best system is a number of continuously insulated cables laid side by side, supported and separated by wooden bridges, and completely surrounded by Trinidad bitumen, held in cast-iron or wooden troughs. This system was introduced some 10 or 12 years ago by Mr. Callender, and has given excellent results; the system is used in Manchester. The insulation the author prefers is vulcanised bitumen, as it is much cheaper than rubber, is probably more durable, is very light for laying, and is easily jointed. Its insulation resistance, while considerably lower than rubber, is amply high enough. Here it may be well to correct a very widespread illusion. It is commonly supposed that the core of vulcanised bitumen cables readily decentralises. This is not the case. The material is tough, and the melting point very high; on three occasions the author has had short circuits on these cables, once from a pick being driven through them, and twice from bad joints, and on each occasion he was much struck with the small distance to which the damage had extended, the covering being intact, and not melted, quite close to the molten copper. Joints on these cables are made very expeditiously, and it will be observed that the system admits of the mains being tapped at any point. The figures given in Table B will serve as a guide to the results attained as regards insulation resistance.

The author has only used these cables for slightly over a year, but they appear highly promising, and with the exception of the short circuits above mentioned, none of which can be ascribed to the cables themselves, they have given no trouble whatever. The quantity now laid as distributing mains in Manchester is as follows:—

	⅛ sq. in.	⅙ sq. in.	¼ sq. in.	½ sq. inch.
Length of single conductor laid...	2 miles.	8 miles.	14 miles.	3 miles.

The author has laid a fair amount of vulcanised india-rubber covered cables on this system, chiefly cable which had been withdrawn from pipes, and which had had old T connections cut off, and the places made good; he would not have dared to use these cables over again, except in this way. The results so far have been very satisfactory. The main point of the so-called "solid system" is the exclusion from the cables of moisture, and of everything that can harm them. The Trinidad bitumen used for this purpose is waterproof, and it is known that it remains unchanged for centuries. In laying rubber cables in this manner, it is important to remember that the bitumen must not be used hotter than is absolutely necessary to enable it to flow, otherwise the rubber will be over-vulcanised.

It may not be out of place here to say a few words as to vulcanised india-rubber. There are laid in Manchester some 80 miles of single conductor in which this material is exclusively used, 15 miles of which has been at work for over four years, so that the author has had some experience of it. There have undoubtedly been a fair number of instances in which it has failed, but in all these cases the damage has been local—that is to say, there is no evidence of a general deterioration of the cable; it has merely failed at one particular point, and the failure appeared to be due not to the rubber, but to the way in which it is laid. The author has before expressed himself as averse to drawing-in systems. These cables are drawn into pipes. In many cases they were drawn in one after the other, though for some considerable time the author has made a practice of drawing all five in together. It is impossible to ensure that the

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Table B.—*Vulcanised Bitumen Cables laid on Callender's Solid System.*

Length of conductor.	Size of conductor.	Insulation resistance. Of length.	Insulation resistance. Per mile.	Date of test.	Weather at time of test.
Yds.	Sq. in.	Megohms.	Megohms.		
58	⅛	18568·0	612·0	May 26, 1897.	Very damp.
	¼	14442·0	476·0		
	⅜	16247·0	535·0		
	½	12998·0	428·0		
	⅝	14442·0	476·0		
187	¼	12480·0	1326·0	Nov. 4, 1896.	Very foggy.
	⅜	20800·0	2210·0		
	½	20800·0	2210·0		
	⅝	20800·0	2210·0		
	¾	15600·0	1657·0		
254	¼	12669·0	1828·3	Jan. 19, 1897.	Very frosty.
	⅜	10365·5	1495·9		
	½	5701·0	822·7		
	⅝	10365·5	1495·9		
	¾	12669·0	1828·3		
252	⅛	6003·0	859·0	Feb. 15, 1897.	Damp.
	¼	6003·0	859·0		
	⅜	85·0	12·1		
	½	2641·0	378·1		
	⅝	4002·0	573·0		
85	¼	14642·0	707·1	March 30, 1897.	Fine.
	⅜	14642·0	707·1		
	½	12812·0	618·7		
	⅝	17083·0	825·0		
	¾	17083·0	825·0		
237	⅛	10100·0	1360·0	Feb. 5, 1895.	Drizzling rain.
	¼	10100·0	1360·0		
	⅜	8912·0	1200·0		
	½	15150·0	2040·0		
	⅝	8912·0	1200·0		
18	¼	19505·0	199·0	Feb. 1, 1897.	Very damp.
	⅜	19505·0	199·0		
	½	27307·0	279·0		
	⅝	22756·0	232·0		
	¾	22756·0	232·0		
75	⅛	33726·0	1437·0	April 12, 1897.	Very damp.
	¼	25294·5	1077·8		
	⅜	33726·0	1437·0		

NOTE.—The insulation resistance was tested with the same apparatus as was the copper strip.

interior of a pipe shall be absolutely smooth, and if there be a slight obstruction, the men drawing in cannot feel the extra pull on the cables, and great damage may be unconsciously done. A pipe laid underground cannot be kept perfectly dry, and water will occasionally find its way in, the cables being thus alternately wet and dry, which is very destructive. Mechanical damage may readily arise from the rope used to draw in other cables, and rats may enter the pipe and gnaw the cables. In one instance the author found a considerable quantity of nibbled rubber in a pipe, the rat having apparently gnawed it because it was an obstruction, and not for gastronomic reasons. The most fruitful source of danger, however, has been observed by the author to be caused by cement. Wherever a vulcanised rubber cable is in contact with Portland cement and moisture, it will almost certainly fail. The author has had a good many cases in which a rubber cable passing through a glazed earthenware pipe, fixed into the side of a brick box with cement, has been attacked just at the mouth of the pipe. Large masses of salt have formed, and in several cases a considerable quantity of metallic sodium has been found. The author believes that with the exception of a few cases, not more than half a dozen, all the failures of rubber cable which he has experienced are to be accounted for either by the presence of cement, by a sharp edge or projection in the pipe, or by other mechanical damage. In connection with rubber cables, it is interesting to note that vulcanised joints have been employed in Manchester in all cases, and in no one instance has such a joint failed. It would be tedious to describe all the kinds of insulated cables made. Whatever may be the insulating material, the author would lay the cable on the solid system so as to preserve it from attack. Whatever the material, the specification should prescribe a definite insulation resistance depending on its nature, and in addition certain mechanical tests. The so-called "bending test," first introduced by the author in a specification of his in July, 1895, is a useful one. It consists in bending a sample piece of cable backwards and forwards several times round a drum of small diameter, then immersing the cable in water, and finally breaking it down under pressure. A certain ultimate dielectric strength should be settled on for each material. Stretching tests should also be included for such materials as rubber. A form of built-in system, which has met with a great deal of favour, consists in enclosing the cable in steel armour, either in the form of stranded wire or of ribbon. This armour is then lightly braided over, and the cable laid directly in the ground. In spite of its having been largely adopted in many towns, the author cannot feel any confidence in the durability of this system. It appears certain that the steel must be attacked in the course of a few years, and the cable is then subject to the action of all kinds of soils. That this advantage is being recognised appears certain from the fact that it is becoming the practice to lay such cables in a wooden trough, and to run them round with pitch or some similar material, thus practically coming to the solid system advocated above.

In main laying, great care should be paid to details. Thus the cables should all be laid on a definite plan, cables of the same polarity should always be to the right when looking down the main with the back to the station, and when this rule cannot be applied, the same pole should always be next the buildings. If a drawing-in system be employed, the cables should be differently coloured throughout their length, or two may be of one colour, one being braided, the other taped. Again, the ends of all the cables of the same polarity should be painted the same colour, a different colour being selected for each pole. Among other details, one of great importance is the treatment of the ends. The author has found the best way to avoid surface leakage is to pare down the insulation for 3in. or 4in., and the braiding or lead for a couple more; pure rubber strip is then tightly lapped round from the conductor to a point 2in. or 3in. over the braiding, *i.e.*, for a length of 8in. or 9in., this rubber is then painted over with anti-sulphuric enamel of appropriate colour. Immediately a cable is laid, the ends should be sealed until it can be treated as above, for if water be admitted to the interior, it may do great damage, even if the dielectric be waterproof. Intimately associated with mains are junction boxes. These should always be well ventilated, and the lids left loose. The former course will tend to prevent an explosion, and the latter to diminish its destructiveness if it occurred. It is very difficult to make a lid watertight, and apart from this, a packed lid takes time to open in case of emergency; in the author's judgment it is best not to attempt the exclusion of water, but to let it get in and drain it away. A ventilated cover, as devised by the author, is in use in Manchester. Junction boxes should always be drained except in very sandy soils, and plenty of room should be allowed in them. It is a great mistake to endeavour to make them small, the extra space costs little either for excavation or building, and the advantage in point of convenience and safety is great.

Balancing sub-stations naturally call for attention when speaking of junction boxes. They are most conveniently constructed under the footpath. They should be well-lighted, and means should be provided for readily bringing in plant, and removing portions for repair. It is essential that they should be absolutely fireproof, and it is advisable to maintain a slight pressure of air within them in order to obviate any risk of the entrance of coal-gas, or of noxious vapours from the sewers or soil.

The following is a summary of the distributing mains laid in Manchester up to the present time. The size of main is reckoned by one of the outer conductors, hence the lengths given are the actual main and not single conductor, some of the mains being 5-wire ones, others 3-wire, and a few 2-wire, as will be seen from the particulars:—

Length of Distributing Mains Laid in Manchester.

5-Wire.				4-Wire.				3-Wire.				2-Wire
⅛ sq. in.	¼ sq. in.	⅜ sq. in.	½ sq. in.	⅛ sq. in.	¼ sq. in.	⅜ sq. in.	½ sq. in.	⅛ sq. in.	¼ sq. in.	⅜ sq. in.	½ sq. in.	⅛ sq. in.
Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds	Yds.	Yds.	Yds.	Yds.
17,461	16,555	8,103	180	...	128	285	70	897	4,314	4,978	820	2,354

Total length of distributors, 31 miles 1,585 yards.

With the exception of those laid at the initial stage of the undertaking, these mains have all been put down by the Corporation's own workmen, under the personal supervision of the author; and, in his opinion, this is by far the wisest course, as not only is there a better chance of securing good work in this manner, but the men who have subsequently to maintain the mains are familiar with them, and know exactly where to look for weak points, should trouble arise. The author has purposely refrained from giving the cost of the various mains, partly because they are nearly all 5-wire ones, and the figures are therefore not applicable to other towns, partly because it would involve publishing contract prices, which is contrary to the practice of the Manchester Corporation.

The subject of mains may now be left, and attention drawn to service lines. It is necessary to have these very flexible, as they have frequently to be taken round corners, and often some little distance into a building. It is further desirable to be able to draw in additional cables in the event of subsequent extension by the

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consumer. The author first tried rubber cables in wrought-iron pipes. The objections to this system are :—

1. Its extreme awkwardness if there are many bends.
2. Liability to destruction of the pipe in certain soils.
3. Dangers of cables being cut by the edge of the pipe.
4. Establishment of connection between consumer's premises and main pipe or culvert, allowing bad smells to enter house.

In certain cases where no bends are required cast-iron pipes were used, thus getting rid of the second objection. In both cases the cables are liable to be attacked by the cement at the end of the pipe. The next system tried was rubber-covered cables, armoured with two steel ribbons, and drawn into a common earthenware pipe. This was a great improvement, as it allowed a much neater job to be made inside the premises, and obviated the second and third objections to the first method. The armour was also some protection against the action of the cement. Both these systems admit of additional cables being drawn in except where there are many bends. The third system, and that now exclusively used by the author, is armoured rubber cables laid solid in bitumen in wooden troughs with cast-iron covers. This system appears as near perfection as possible, the only drawback being that additional cables cannot be drawn in. This, however, merely necessitates the cutting of an additional hole in the wall, not a serious matter in comparison with the advantage of a system free from all the drawbacks named above. The distributing system ends with the service cut-out and meter. These cannot be too simple, and, above all things, it is desirable to have uniformity. The cut-outs used in Manchester have proved very successful, are cheap, give very high insulation, and all classes of services can be dealt with with only three patterns, all very similar. With regard to meters, it is well to choose one pattern, and to keep to it. Nothing is so confusing or so wasteful of time as to have a number of different types, especially when an instrument has to be changed. By keeping to few types, it becomes possible to standardise everything, even to the boards for supporting cut-outs and meters.

PHYSICAL SOCIETY.

At an ordinary meeting of the Physical Society held on December 10th, Mr. Shelford Bidwell, President, in the chair, Mr. ALBERT CAMPBELL exhibited : (1) An experiment to illustrate alternate exchange of kinetic energy. Two brass spheres, each about 1in. diameter, are suspended from the same point by equal wires. One of them is then thrown so as to describe a circular orbit. The second sphere, starting from rest, gradually takes up motion from the first sphere, and in turn describes a circular orbit. The first now comes to rest, and the reverse process takes place. This alternating action repeats itself until all the energy is lost in the wires. (2) An experiment to illustrate the low heat-conductivity of glass, and the expansion of glass by heat. A long tube is clamped at the lower end in a vertical position. One side of it is then heated with the flame of a Bunsen burner, and the glass is observed to bend, moving over a fixed mark near the top of the tube. When the flame is withdrawn the first position is quickly regained. Mr. Campbell then read a Paper on—

"Temperature Compensators for Standard Cells."

Some account of the methods adopted by the author has already been published ; he now describes the apparatus. The first compensating arrangement (3) can be used for keeping the potential difference between two points of a conducting system constant at all room-temperatures, or it can be adapted to modify the voltage of a standard cell to some convenient whole number. This arrangement (3) resembles a Wheatstone's bridge with the galvanometer-branch removed. One pair of opposite arms is of copper, the other pair is of manganin. The bridge battery is a Leclanché cell ; this supplies the auxiliary voltage, which is utilised at the two galvanometer points of the bridge, and is there applied in series with the standard cell. In an alternative method, suggested by Mr. C. Crawley, only one of the four arms is made of copper. The second compensating arrangement (4) is intended to maintain constant potential between two points at all room-temperatures. For this purpose two wires, *a* and *b*, are connected in parallel. One of them, *a*, is all of manganin, the other, *b*, is partly copper and partly manganin. Constant *current* is applied at the ends of *a* and *b*. The various resistances are chosen so as to give constant difference of potential between the ends of the manganin portion of *b*, the constancy of the current being indicated by the balance of the Clark cell across an element of *b* being maintained. By this method the potential difference can be maintained to within 1 in 2,000.

Mr. SWINBURNE said that twelve or thirteen years ago he had given a good deal of thought to compensation by wires of different temperature-coefficients. The first thing he tried was a Wheatstone's bridge. This was compensated by making the bridge-arms of wires whose temperature-coefficients differed—as, for instance, platinoid and copper. He then applied the same principle to the compensation of standard cells, using a potentiometer method that gave direct readings, and to the compensation of voltmeters and wattmeters. These results were published between 1885 and 1890 in the electrical journals. He believed that Mr. Evershed had also developed this idea, by putting "back" turns on voltmeters, and by other differential devices. The details of Mr. Campbell's apparatus had a few points of special interest. The way in which he connected up the bridge (3) seemed particularly worthy of notice.

Prof. AYRTON asked whether thermo-electric effects produced difficulty in the compounded arrangement.

Mr. CAMPBELL said the system was symmetrical, and the thermal currents were consequently neutralised.

Mr. APPLEYARD, referring to experiment (2), said it was identical with one that had been shown for the past eight years at lectures at Cooper's Hill College. It was specially interesting as illustrating the deflection that occurs with girders and bridges when exposed on one side to sunshine.

Mr. J. ROSE-INNES read a mathematical Paper on

"Lord Kelvin's Absolute Method of Graduating a Thermometer."

Lord Kelvin has investigated the cooling effects exhibited by various gases in passing through a porous plug. He found that for any gas, kept at the same initial temperature, the cooling effects were proportional to the difference of pressure on the two sides of the plug. He also found that, for any one gas, the cooling effect per unit difference of pressure varies approximately as the inverse square of the absolute temperature. This rule holds very well in the case of air ; it is not so satisfactory for carbonic acid, it fails for hydrogen. With hydrogen there is a *heating* effect that increases, if anything, when the temperature rises. Mr. Rose-Innes proposes an empirical formula, containing two disposable constants, α and β, characteristic of the gas in question. Denoting by T the absolute temperature, he finds that, very approximately, the cooling effect is given by the expression $\left(\frac{\alpha}{T}-\beta\right)$. This relation includes the three cases, air, hydrogen, carbonic acid, under one form, and thus enables them to be treated in one common investigation. Moreover, the differential equation concerned in the thermo-dynamic scale is thereby rendered more manageable; it leads to simpler algebraic results after integration. The Paper discusses the thermo-dynamic correction for a constant-pressure gas-thermometer, and the correction for a constant-volume gas-thermometer ; also an estimate of the absolute value of the freezing-point of water ; the results obtained take, for the most part, a very simple shape, using the above expression for the cooling.

Dr. S. P. THOMPSON said the empirical expression $\left(\frac{\alpha}{T}-\beta\right)$ indicated that at some particular temperature the cooling effect vanished ; that was a point suggestive of useful results if investigated by experiment.

Mr. J. WALKER read a communication from Mr. Baynes on the Paper, and remarked upon the desirability of adopting two constants. He thought that further experiments should be made to discover how specific heat at constant temperature depends on temperature. He calculated values for hydrogen were too few to be taken as evidence of the validity of the rule.

Mr. ROSE-INNES, in reply, said that from what was known of hydrogen, it might be expected to behave at ordinary temperatures as air behaves at higher temperatures. His object was, if possible, to include in one formula the case of the three investigated gases. This was better than having a separate formula for each gas. Whether or not hydrogen was confirmatory with air and carbonic acid might be considered as *sub judice* ; it required futher experimental data to test the formula in that case.

The PRESIDENT proposed a vote of thanks to the authors, and the meeting was adjourned until January 21, 1898.

THE TELEPHONES OF THE WORLD.

Electrical Engineering of Chicago publishes the following list of the number of telephones in use in various countries. It is compiled, says our contemporary, from the latest statistics :—

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Austria	20,000	Italy	14,000
Australia	2,000	Japan	3,500
Bavaria	15,000	Luxemburg	2,000
Belgium	11,000	Norway	16,000
British India	2,000	Portugal	2,000
Bulgaria	300	Roumania	400
Cape of Good Hope	600	Russia	18,000
Cochin China	200	Senegal	100
Cuba	2,500	Spain	12,000
Denmark	15,000	Sweden	50,000
England	75,000	Switzerland	30,000
Finland	6,000	Tunis	300
France	35,000	United States	900,000
Germany	140,000	Wurtemberg	7,000
Holland	12,000		

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THE COLONIES AND ELECTRICAL DEVELOPMENT.

Our attention has been recently directed by a colonial correspondent to the relationship existing between Great Britain and her colonies in regard to the development of electrical engineering. The subject lies on the fringe of the very much larger question: as to the position which the British electrical manufacturer will occupy when the struggle of the nations for the engineering trade of the world begins in real earnest. Into the details of that vast question we do not now purpose to enter; but, were we to do so, we think there would be no great difficulty in showing that Great Britain still possesses abundant opportunities to retain that premier position which she has long held as an engineering nation. It would, of course, be idle to expect that in the growth and development of foreign peoples there should be no tendency to acquire some share in the world's engineering trade; and since it is inevitable that expanding nations, like the United States and Germany, will develop an increasing trade of their own, it would be foolish to betray unwarrantable alarm at the phenomenon. That their newly-developed engineering industry should increase is no argument that ours must, or will, decrease; nor is it logical to compare the percentage increase of their smaller trade with that of our very much larger bulk of trade in engineering manufactures. The engineering manufacturers of Britain may, indeed, have ceased to have things all their own way; they may be compelled to realise that rivals have sprung up where formerly the monopoly went unchallenged, and thus their energies must be nerved to a more active pitch than heretofore; but, given a fair field and no favour, our British manufacturers can still not only hold their own but also make headway abroad. What is certainly true of the aggregate of British engineering trade is, however, unfortunately not true of every one of the individual firms that contribute to it. There are certain instances where British firms have lamentably failed to "catch

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on " in colonial and foreign work, to say nothing of some few instances where they have been outrun by foreign firms on English soil. To these especially, and to British electrical manufacturers in general, it may be useful to consider the case as presented from a colonial point of view.

It is pointed out by our correspondent that in the extension of electrical business to our colonies due allowance should be made for the divergence from English conditions; for it must be remembered that our kith and kin are developing many new traits, the result of their natural adaptation to their circumstances. At the outset one prominent fact should not go unnoticed. Each of the colonies places great weight upon the encouragement of manufacturing within its borders. It is but a question of sufficient population, and therefore demand, to enable new local industries to be founded. At present, with one or two exceptions, such as Canada, none of the colonies can be said to possess the requisite population to warrant local manufacture of electrical plant; but as time goes on this feature of colonial life will disappear, and the great problem for the British electrical manufacturer will then be the establishment of branch works in certain of those colonies—a policy, in fact, similar to the one now being adopted by some firms in regard to the United States.

Our colonial possessions are best considered as being grouped in three distinct classes—those of recent establishment, those having already attained some few years of organised colonial life, and those which have a history of, perhaps, a century or more to look back upon. The countries comprised in the first class possess, as a rule, in their populations a large majority of English-born colonists, whereas those in the other two divisions have from about 45 to 80 per cent. of locally-born inhabitants. At first sight it may appear improbable that the approximate proportion of English and native born colonials should have any bearing upon electrical development. That it does so, however, seems undoubtedly to be the case. Wherever a majority of the adult population are of colonial birth and education, a much greater advance in this direction will almost always be found than in those instances where the English-born predominate; and it does not appear to be an unjust inference that in the latter case the characteristic conservatism of the old land cannot be quite eradicated, even in those who have bound up their lives and interests in the new lands. The prospects of each of the three classes of colonies in relation to electrical enterprise are fairly well defined. Those in the youngest group offer a good field; they are obliged to adopt modern devices to enable them to cope with the difficulties always found in quite new countries—difficulties of distance, means of transit, development of natural wealth and resources—in a word, the difficulties of self-support. There is also lacking in these one great deterrent to progress, in that they are too young for vested interests to have arisen. Any country that is to-day being opened up must, no matter what the private prejudices of any section of its people, enlist all the aid that can be obtained from the use of thoroughly modern appliances. The second class present certain features peculiar to themselves. While old enough to have acquired various interests that are to some extent antagonistic to the newer methods involved in the adoption of electricity, they at the same time possess that conservative strain in their populations which has already been referred to. The result is, that before the valuable openings for electrical enterprise lying latent can be made available to any great degree, a certain amount of what our correspondent calls "missionary work" is necessary. And as in the teaching of children no method appeals so forcibly as the object lesson, so here no argument carries half so much weight to these doubting Thomases as practical demonstration Confidence begets confidence, and what is most urgently required at the present time in these colonies is not so much presentation of unanswerable arguments and statistics as a straightforward, practical display of well-founded confidence on the spot. One such illustration will bear more fruit than years of moral suasion at a distance. There are no great difficulties in the way of carrying this out; the local legislation is not harassing, and the people when once convinced become staunch admirers and supporters. A close knowledge of these places and of their inhabitants points to this policy as the one that will be eminently satisfactory, both in its immediate outcome and future results. In regard to the third class, embodying the older colonies, the electrical firms of not a few countries have already taken advantage of their growing needs to set up within them permanent branch establishments, and from these branch centres they extend their operations to quite considerable distances. A few years ago it was hard to find any other than British concerns thus represented; to-day the ubiquitous American and German are there, and seemingly there to stay. This, however, should but serve as a greater incentive to manufacturers in the mother country to extend their ramifications into the many parts of the empire still awaiting occupation.

MORE REJECTED ABSTRACTS.

It is presumed that the following abstracts have reached us from the same quarter as those we published at Christmas, 1894. We are unable to make out from the maze of cross-writing on the envelope to which of the scientific societies they were originally sent, while the superposition of the names of the numerous societies that appear to have rejected them makes it impossible to decipher the several places to which the MS. has apparently travelled. Doubtless by their publication in our columns the author of these abstracts will receive intimation of their whereabouts:—

1. *On a Totally New Kind of Rays.* Prof. S. P. Th*mps*n.—These rays are called Y-rays because they come after the X-rays. They are produced by reflecting X-rays from an antikathode of paraketonitrodiphenylamylsulphate upon a screen painted with an alcoholic solution of trihardtogetthethingtofunctionphosphate, crystallised out in four dimensions by evaporation to dryness over a lucifer match. When passed through an empty leather purse and allowed to fall on a balance sheet these rays show how much money the owner ought to possess.

2. *On a Nickel Prism.* By Messrs. Kid and Simpleton.—Two young students at —— College have concluded some researches on the effect of a huge nickel prism on hyperbolically polarised light. The results are entirely negative, and the Paper is published as a warning.

3. *The Masslessness of Matter.* Prof. F*tzg*r*ld.—A continuation of the researches mentioned in the 1894 abstracts. An infinitely extended spaceless ether is made to revolve in opposite directions at the same time around a massless countershaft. Finds that the horse-power is not transmitted through the shaft and that all the heat is generated in the bearings. Is about to repeat the investigations with the value of μ in the equations changed sufficiently to allow of ninepennyworth of oil *per diem*. Hopes to simplify the mathematics and get the countershaft to rotate, but is not yet sure in which direction. Matter cannot possess mass, because if it did it would be no matter.

4. *On Purring Dynamoes.* W. M. M*rd*y.—Two dynamoes were coupled together by leather belts between their terminals and tested by the H*pk*ns*n method. Their combined efficiency was found to be higher than that of either, and was 110 per cent. per annum. Reckoned at par, this is equal to 10s. per share on allotment, or £1 per share if applied for at the Reichsanstalt before Monday. The dynamoes purr when

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Kipling is recited anywhere within a radius of 4π kilometres, an effect which is attributed to resonance and may be due to resin on the belts. Another theory is that the radius of 4π arises from the heavy side of the flywheels.

5. *On a Massless Flywheel for Traction Engines.* J. S. R*w*rth.—Tried a heavy flywheel on a traction engine and was fined as heavily for scarifying common roads without the use of a red flag. Decided to make the flywheel massless, and, if allowed by the County Council, invisible. By reducing the mass to zero you could have your flywheel, without any harm being done on short circuits through back streets. Advises that the flywheel be made of plain, unvarnished ether, which is massless to the fiftieth place of decimals. This figure has been verified by the Astr*n*m*r R*y*l, with a Universal engine and the Lick telescope. Allowance has been made for refraction in the engine. Proposes to use his traction engine for starting trolley cars on a heavy gradient.

6. *A Ruined Thermopile in Greece.* Prof. H**t*n.—Ruins of an ancient thermopile have been discovered in Greece, and are believed to have been used in the orientation of the temples. It is supposed that the current from the thermopile (spelled "Thermopylæ" in the *Proceedings* of the Greek Physical Society) was used in the determination of the magnetic axis, the correction of the "true north" being obtained from S. P. Th*mps*n's "little book". It is also supposed that the magnetic axis thus obtained was broken up into little bits and used as dynamo poles. Other authorities allege that as there was no H in the Greek language there cannot possibly have been any earth's magnetic field at that time; but the author states that this only indicates a perfectly vertical field—a statement that is borne out by the fact of Etruscan vases being *open* at the *top*. By baking these vases in a certain position the lines of force are cemented into the plane of cleavage, and may actually be seen sticking out of some broken vases now deposited in the British Museum at Colney Hatch.

7. *Platinum Temperature.* Prof. Fl*m*ng.—By mixing absolute temperature with solid air the platinum is found to crystallise out in rhombohedral cubes. The crystals have been collected and measured by means of callipers and a two-foot rule, and as soon as the constants of the callipers have been evaluated and the two-foot rule has been paid for and reduced to centimetres, it is hoped to be able to determine the absolute dimensions of temperature. *Time* is one of the fundamental elements of this research, and the author asks for seven years, and seems likely to get it. The other fundamental quantities may be expressed in terms of time, though the term would then be longer.

8. *A Polyphase Battery.* Profs. Ayrt*n and R. Arn*.—Experiments have been carried out on a 250-H.P. polyphase storage battery, made by Messrs. Brown Bovril et Cie., with a view to see if there was anything in it. A great deal of sediment was found in it, which one of the authors alleges to be paste, the other stating it to be merely diamond. It is proposed to construct a polyphase motor car, using this battery, the advantages being that this would be able to go in three directions at the same time, if three-phase were used; but only in two directions with two-phase currents; hence the superiority of the three-phase system. It is supposed that the superiority will not be admitted by the police, as it might affect the continuous current of the foot-passengers; but this is where the diamonds may be useful.

9. *The Clark Sell.* Messrs. F*sh*r and T*yl*r.—The authors have investigated the regular sell as well as the irregular pattern. The former is called the "Bot." which is short for "bottle." One of the authors has kept a bot. for many years without it running dry, which speaks well either for the sell or the author in question. By calibrating one of the authors on a Crompton potentiometer it has been found that he might be used as a demand indicator, the only objection being there is not enough of him.

10. *The Alternating Arc.* Mrs. Ayrt*n.—An alternating arc goes out half the time, and the problem is to arrange for it to go out only in daytime and come in at night. This is called good regulation; it is also called "low frequency" because the arc often frequents low places like public houses. The reason why an alternating arc is worked at low frequency is to save matches, as the arc has to be rekindled every time.

11. *A Unit of Hysteresis.* Prof. Ew*ng.—As an absolutely invariable unit of hysteresis the frequency of magnetisation necessary to raise chemically pure iron to its melting point is proposed. As this unit has no practical value it has been accepted internationally by scientists. To eliminate π the crust is taken off the iron first, the π being raised to the tth power. The formulæ are irrational and all the terms involve surds. These are immense advantages.

12. *An Unmistakable Bicycle.* M. H**lm*nn.—Some excitement has been created in the streets of Paris by the appearance of a new form of bicycle, the invention of M. H**lm*nn, who has applied the principles of his electric locomotive to produce a variable speed gearing for bicycles. The bicycle, which is somewhat heavier than an ordinary roadster, is fitted with a three-pole iron-clad dynamo, of the three-phase continuous current type which is so common on the continent, though, for some unexplained reason, it has found but little favour in England. This machine is driven directly from the pedals, and is excited by a small rotary converter mounted under the saddle. A continuous current non-synchronous motor is mounted directly on each hub, thus making both wheels driving wheels and largely increasing the mechanical efficiency of the arrangement. Since the motor on the front wheel takes a leading, and that on the back wheel a lagging current, the total current to be given by the dynamo is practically in phase, though in the case of racing machines it is proposed to add a condenser, so as to give them a distinct lead over their competitors. The field regulator of the generator is controlled from the handle bars, which are highly insulated to prevent any danger from shocks. By decreasing the excitation when ascending a hill, the pedals may be worked quickly, while the motors, and consequently the wheels, revolve comparatively slowly. The generator works at a maximum voltage of 50, while the high frequency employed—130 $\sim$ per second—is expected to cause great activity in the cycle trade. The weight of the whole bicycle, including the accumulators, which are carried as a reserve, is only 250 kilogrammes. The marked success which attended the first tests of the machine has led to the suggestion that it should be used as a road roller, and we understand that several local boards have already made overtures to M. H**lm*nn with this object in view.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Dec. 3, 1897.*

The Suit of the Western Union Telegraph Company against the Government.—Reference was made in a recent letter to a claim against the Government by the Western Union Telegraph Company for the recovery of a large amount of money due for telegraph service performed during the term of Postmaster-General Wanamaker, some years ago. Mr. Wanamaker, acting under constitutional authority, fixed the rate to be paid by the Government for the transmission of telegraphic messages at 0·1 cent per word. The Western Union Telegraph Company protested against this rate, and refused to accept any money in payment for its services, preferring to carry its case to the Court for adjudication at some future time. At the close of Mr. Wanamaker's term of office the Company sued the Government in the Court of Claims to recover the amount of money to which it thought it was entitled for the business transacted during the existence of the order above referred to. The matter was referred to First Assistant Postmaster-General Heath, as Master, for examination. He reported that the Telegraph Company was entitled to recover $258,869.84. This report was confirmed by the Court of Claims on November 22nd.

Enlarging the Niagara-Buffalo Transmission Line.—The increased demand for power in Buffalo has necessitated the installation of more copper on the transmission line carrying power from the Niagara Falls Power Company's plant to the points of distribution in Buffalo. Three new wires of 350,000 circular mils each have been strung on the

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existing pole-line. These, together with the three original wires, make a total of six wires. Each is placed on the six-pin cross arm, the two circuits being symmetrically placed on opposite sides of the pole. The wire is transposed five times between terminals, the transposition being effected by the aid of a second cross arm and a simple spiralling. The new wire was raised without turning off the current from the old line, which is operated at 11,000 volts. Special care was necessary, of course, when the woodwork was wet, and rollers were placed on the cross arms, so that in hauling the wire over the arms there would be no tendency to disturb the line already in place. The underground section within the city of Buffalo has been laid with cable, the insulation of which is of the best quality rubber compound. The three lines instead of being in separate lead sheathings are laid up together and covered with one lead sheath, the outside diameter of the whole being 2⅛in. This is drawn into 3in. tile ducts. The cable now in use is giving no trouble at all on straight work, but it has been found somewhat difficult to make all the joints sufficiently perfect and dry to prevent an occasional breakdown. The transformer plant will be augmented by seven new transformers of the size of those now in use, making a total of ten transformers, each with a capacity of 1,250 H.P., or a total step-up transforming capacity of 12,500 H.P. These transformers are of the air-blast type. It is intended eventually to raise the line pressure to 22,000 volts in place of the present 11,000. At the Buffalo end of the line new step-down transformers will be installed to reduce the pressure to various voltages for distribution over the city network for motor uses. Several step-down transformers will also be placed in the station of the Buffalo General Electric Company to supply current to rotary converters from which direct current will be taken for lighting and small motor service. The Buffalo Railway Company is also increasing its step-down transformer and rotary converter capacity in the Niagara Street power house. Three additional step-down voltage transformers similar to the three already in use are being installed. Each has a capacity of 275 kilowatts, stepping the current down from 10,500 to 375 volts three-phase for delivery to the alternating current side of the rotaries. On the completion of all the improvements the total converter capacity in the station will be brought up to 2,000 H.P.

Telephone Competition in New York City.—The telephone service in New York City, as in most large cities in this country, is controlled exclusively by lessees of the Bell Telephone Company. In the western part of the United States many independent or opposition telephone companies have come into existence in recent years, and the movement seems to be now spreading to the larger cities, including New York. It was given out a few days ago that New York City was to be made the scene of a telephone war in the near future, for the conduct of which a Company, named the Citizens Telephone Company of New York and New Jersey, has been organised. It is stated that the new Company will establish a large telephone exchange, and cut deeply into the rates charged by the Bell Company. The proposed rates by the rival concern for the service which it intends to render in Greater New York are $24 a year for house instruments and $48 for business instruments. It is reported that the new Company will operate 50,000 telephones in this city, and it is contemplated to establish toll stations in every city in New York State. Whether this opposition will amount to anything it is yet too early to say, but there are a great many difficulties in the way of the new company getting established in New York City. The principal obstacle is securing right of way in the underground conduits, the building of overhead lines in the city not being permissible. It is stated that the new company is prepared to invest $15,000,000 in the enterprise.

Cable-laying in New York Harbour.—On November 26th a party of prominent telegraph officials and electricians witnessed the operation of submarine cable-laying from on board the Commercial Cable Company's steamer "Mackay-Bennett." Such an opportunity does not often present itself in these waters, and the guests of the Postal Telegraph Company on this occasion were delighted with the treat. The cable in question was laid from the Commercial Cable Company's station at Coney Island to Sandy Hook, a distance of ten or twelve miles. This cable is to connect the Sandy Hook marine signal station of the Postal Company with the Commercial Cable Company's land line system at Coney Island, thus enabling the Postal Telegraph Company to report the arrival of vessels at the earliest possible moment. There is likely to be some rivalry in this particular field between the Western Union Telegraph Company and the Postal Telegraph Company, and the former does not relish the idea of having an opponent in what is one of the most remunerative branches of the Company's business, in proportion to the length of line operated. The laying and splicing of the cable occupied the entire day.

Telegraph Line to the Klondyke Gold Fields.—Mr. C. R. Hosmer, general manager of the Canadian Pacific telegraph lines, was in San Francisco recently conferring with Mr. John W. Mackay. Mr. Hosmer expressed his belief that a telegraph line will be built next spring from Ashcroft, on the Canadian Pacific Railroad, to Dawson—a distance of 1,400 miles. The projected line will be stretched along the same route that was surveyed and partly wired in 1866-67 in an attempt to secure telegraphic communication around the world, *viâ* Siberia, but which was abandoned when the success of the Atlantic cable was announced. The proposed new line will be built by the Dominion Government at an estimated cost of between $300,000 and $400,000, and operated by the Canadian Pacific Telegraph Company. Branches to Juneau and other points may be built.

The Annual Meeting of the Mechanical Engineers' Society.—The American Society of Mechanical Engineers held its eighteenth annual convention in this city this week. Several Papers were read, among which the following were of particular interest: "Notes on Rating of Electric Power Plants upon the Heat Unit Standard," by William S. Aldrich, describing the many different ratios by which the economy of electric generating stations is expressed. The ratios of kilowatt-hours per pound of coal and pounds of coal per kilowatt-hour, and various other ratios involving the amount of water evaporated in the boilers, are common. The author advocates the uniform use of a ratio expressing the British thermal units of coal supplied per unit output. The standard practice of rating pumping plants in foot-pounds per million B.T.U. is mentioned, and the specification of a certain duty and the rigid test to determine the duty obtained are given as causes of the high efficiencies realised in pumping systems. The figures of 100 and 150 watt hours per pound of coal given by tests on representative stations are cited as surprisingly low when compared with recorded steam-engine attainments. The test of a certain mill engine showing a coal consumption of less than 1½lb. per indicated horse-power hour, with the load varying from 495 to 765 H.P., is cited with the remark that a similar economy in electrical generating stations should give 400 watt hours per pound of coal, allowing for a 10 per cent. loss in the dynamo. A Paper on "Multiple Cylinder Steam Engines," presented by Prof. Robert H. Thurston, described tests made on the triple expansion experimental engines at Sibley College to determine the effect of a change of the ratio of cylinder volumes in multiple expansion engines. Three combinations of the three cylinders of a triple expansion unit were made, the first being a combination of the triple expansion engine in its usual form; the second, the intermediate and high-pressure elements combined to make a compound with cylinder volumes in the ratio of 8:1; and the third, the low and the high-pressure elements making a compound with cylinder volume 7:1. Careful tests of steam consumption per horse-power hour showed a minimum of 1·3lb. with a triple expansion at 110 H.P. The 8:1 compound used a minimum of 18lb. of steam per horse-power hour when loaded to 75 H.P., while the 7:1 compound used less than 16lb. of water per horse-power hour with a load of 125 H.P. The conclusion was drawn that when, for purposes of expediency, compound engines were used instead of triple expansion, the economy of steam, especially on variable loads, would be increased by a considerable reduction in the size of the high-pressure cylinder. Considerable discussion was elicited by this Paper, tending to account for the economy effected by a divergence from the thermo-dynamic theory of the best expansion.

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CORRESPONDENCE.

THE ACCURACY OF MOTOR METERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I understand that there is a belief among electrical engineers that the ordinary electric motor meter does not record correctly if the current alters considerably. The question first came up in connection with the working of elevators and trolley tramlines.

Mr. Holden, of the Thomson-Houston Company, has drawn interesting curves, which, for particular cases, show that there is no error; but it is easy to show that in any case the meter will make correct records. Let it be one where field is proportional to the voltage V, the current being C, so that the power VC being integrated gives the electric energy supplied. The torque is aVC, where a is some constant. Resistance to motion is bn, where b is some constant and n the speed in revolutions per second.

Because the speed n is altering at the rate $\frac{dn}{dt}$, if h is a constant which depends upon the moment of inertia of the armature we have the general equation $a\text{VC} - bn = h\frac{dn}{dt}$. Integrating this equation we see that from the time when the meter is at any speed n_0 until it reaches that speed again, the record is the same as if we neglect the acceleration term, or assume $h = 0$; for the excess of the integral of aVC over that of bn (this represents any error that there may be) is evidently $h(n_0 - n_0) = 0$. Of course, there is an error in any time if the speed is not the same at the beginning and end of the time and it is proportional to the difference of the terminal speeds.—

Yours, &c.,

JOHN PERRY.

Royal College of Science, Dec. 15, 1897.

THE MEASUREMENT OF LOW RESISTANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The article by Prof. Ayrton in *The Electrician* for November 26th, on "Our Knowledge of the Value of a Resistance," makes it apparent that there is a generally recognised difficulty in measuring low resistances such as are required for the measurement of current. The writer, however, has found the measurement of such resistances in two stages, by means of an intermediate resistance, not only feasible but by no means lengthy, and during the last three years, in the physical and electro-technical laboratories at Mason College, has measured resistances between $\frac{1}{1000}$th and $\frac{1}{10000}$th of an ohm to about $\frac{1}{10}$th of a microhm, with an ordinary Wheatstone Bridge and a D'Arsonval galvanometer of fairly high sensibility (about 1mm. per microvolt), the resistances being measured between "potential points" on a bar or strip. The method employed is as follows:—

The secondary standard with which the resistances are compared consists of about 9ft. of No. 18 manganin wire adjusted to very nearly 1 ohm by comparison with a platinum silver B.A. unit. Measurements at intervals of a week generally agree to 1 in 30,000, though the value is slowly changing.

In making this comparison the resistance of the strip of copper* connecting the two standards is eliminated as follows. First measure the ratio of the manganin ohm (S) to the sum of the manganin ohm + the connecting strip and contacts (r) + the B.A. unit (B). Let $\frac{S}{S+r+B} = a$.

Next measure the ratio of the B.A. unit to the sum of the three, as above, and let $\frac{B}{S+r+B} = b$. Then $\frac{S}{B} = \frac{a}{b}$.

This method may be used for comparing two low resistances with great accuracy, as it eliminates all uncertainty as to contact and connections.

* No mercury cups are used; the current is carried by copper strips clamped on the end of the legs of B.A. unit, the bridge and galvanometer connections being a little higher up.

The manganin ohm, which is capable of carrying two amperes for some seconds without appreciable change of resistance, is connected to the low resistance to be measured (say $\frac{1}{10000}$th ohm) by a strip of manganin of about $\frac{1}{100}$th ohm resistance and capable of carrying 50 amperes.

The first stage of the process is to measure the ratio of the resistance of the manganin $\frac{1}{100}$th ohm strip with contacts and connections (R_1) + the resistance to be measured (R_2), to the manganin ohm (S). Let $\frac{R_1+R_2}{S} = a$ (as measured by the bridge).

The connections are shown in Fig. 1. The manganin standard S is provided with double terminals, the inner contacts of which serve as potential points for connections to bridge and galvanometer in the first stage. The bridge is used merely

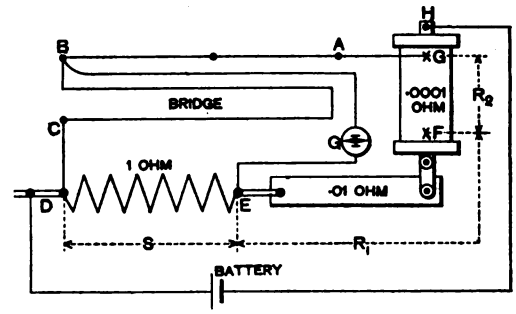

FIG. 1.—First Stage.

as a potentiometer, the two ratio arms being treated as one arm, so that $\frac{R_1+R_2}{S} = \frac{\text{A B arm}}{\text{B C arm}}$. A single storage cell is connected from D to H, and sends a current of about 2 amperes through S, R_1 and R_2. The ratio $\frac{R_1+R_2}{S}$ is easily determined to 1 in 10,000.

The second stage of the process is to determine the ratio $\frac{R_2}{R_1+R_2}$. This is done by shifting the galvanometer wire from E to F and the battery from D to E, so that S is now included in the variable arm of the bridge. *No contact which was included in the measurement of Stage I. is altered.* A current of about 50 amperes is now sent through R_1 and R_2, producing a P.D. of about $\frac{1}{200}$th volt between F and G. If R_2 is varied by 1 in 10,000 from absolute balance, there will be an un-

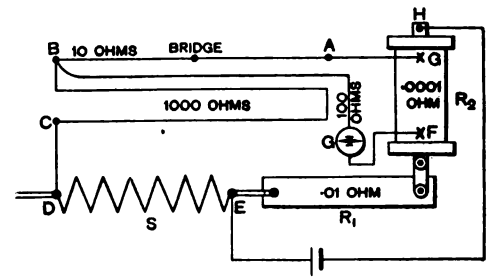

FIG. 2.—Second Stage.

balanced E.M.F. of about $\frac{1}{2000000}$th volt in that arm, and a P.D. of about $\frac{1}{2000000}$th volt at the galvanometer terminals, the resistance of bridge and galvanometer being as in Fig. 2. There is, therefore, no difficulty in measuring $\frac{R_2}{R_1+R_2}$ to 1 in 10,000, with a 100-ohm galvanometer giving 1mm. deflection with 1 microvolt.

Combining the results of Stages I. and II., we have

$$\frac{\quad}{S} = a \text{ and } \frac{R_2}{R_1+R_2} = b. \quad \text{Hence } R_2 = abS.$$

It will be noticed that the small resistance is always placed opposite the variable arm of the bridge, so as to make that as large as possible, and give a fine adjustment without the use of shunts.

The connections of the bridge to the resistances should not exceed $\frac{1}{10000}$th of the resistance of the adjacent arm, or say

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$\frac{1}{10}$th ohm from C to D in Fig. 2, and $\frac{1}{10\,0}$th ohm from A to G. They may be made to balance one another approximately, or that from A to G may be measured in Stage I. by taking the direct deflection of the galvanometer connected from A to G with 200 ohms in the bridge, giving $\frac{1}{100}$th ampere through the connection. The resistance so found is added to that in the AB arm of the bridge. The time taken for the double measurement is certainly less than that taken to measure two ordinary resistances, and the working out presents no difficulties.

It is clear that, as the galvanometer used with the bridge may easily be made some hundred times more sensitive than the D'Arsonval used for the commercial measurement of current by the shunt method, the resistance of any of these shunts may be measured with a current of $\frac{1}{100}$th of that used in practice with greater accuracy than the deflection of any galvanometer can be read. There seems to be no reason why resistances down to $\frac{1}{100\,00}$th ohm should not be measured to at least 1 part in 1,000.

In making these measurements the galvanometer circuit is always kept closed to avoid the effects of thermoelectric current, and any slight inductive kick which may be noticed when using a large current in the second stage can be eliminated by keeping the galvanometer wire close to the lower resistance, so as to make the inductances approximately in the ratio of R_1 to R_2.

The following are determinations of resistance of a platinoid strip used at Mason College for current measurements. When first made in September, 1894, it was found to have a resistance of 0·0004408 ohm at 16°C. Subsequent measurements show a slight diminution of resistance.

March 13, 1897.	R = 0·00044059	ohm at 16°C.
Nov. 20, 1897.	R = 0·00044053	,, ,,
Dec. 1, 1897.	R = 0·00044055	,, ,,

showing a variation from the mean of about 1 in 15,000.

It is thus apparent that a resistance of the order of $\frac{1}{10\,000}$th ohm can be compared with a material standard more exactly than it can be measured absolutely, except by specially skilled observers who have devoted themselves particularly to the work.—Yours, &c.,

Mason College, Birmingham. R. H. Housman.

THE SCHAEFER METHOD OF LOCALISING TOTAL BREAKS IN SUBMARINE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Before entering into matters of abstract interest connected with the new laws relating to exposures Mr. Schaefer has enunciated, I must express my thorough appreciation of the practical value and importance of the method of localisation he has based upon them. Almost daily practical application for over a year has shown his test to be perfectly reliable and accurate, and there can be no doubt that it is, within the range of its proper application, the most powerful of the methods of break testing we possess, combining, as it does, the attributes of Kennelly's two-current test and those of Mance's method of eliminating the effect of disturbing cable currents from bridge-test results.

But although at one with Mr. Schaefer as to the practical outcome of his experiments I cannot acquiesce with his view of the theoretical inferences to be drawn from them. He says (*The Electrician* Vol. XXXIX., p. 817), "I regard the variation of the *true* break resistance as being in accordance with the new laws." The items which make up the total apparent resistance of a broken cable are, generally, these

$$R = x + f + s \pm e - p.$$

Where x = resistance of the conductor,
f = resistance of the fault.
s = apparent resistance due to E.M.F. of polarisation (secondary).
p = apparent resistance due to E.M.F. of exposure (primary couple).
e = apparent resistance due to earth potential difference.

Kennelly has proved conclusively by a series of most careful experiments that the resistance of an exposure varies inversely as the square root of the current strength. He obtained his results by balancing to the deflection produced by the combined effects of s, p and e, and took special precautions to ensure accuracy in this respect.

Schaefer's method is to balance to scale zero. Consequently the results of his observations of the exposure differ from Kennelly's by an amount which is the ohmic equivalent of $+s \pm e - p$ in terms of the testing current, which difference is additive or subtractive, according to the resultant sign of their algebraical sum. But he observes and corrects for $\pm e - p$ separately, so that his net result is the value of $x + f + s$, while Kennelly's is that of $x + f$. The reason of the difference of their laws is therefore the presence of s in Schaefer's corrected results, Kennelly's law giving the rate $\frac{1}{\sqrt{n}}$ for the change of *true* fault resistance, while Schaefer's gives $\frac{1}{\sqrt[3]{n}}$ as the change of resistance and polarisation combined. That Mr. Schaefer has found it possible to bracket the resistance and polarisation together in this way is the most interesting result of his discovery. If what I have advanced is correct, it is evident a new view must be taken of the polarisation which goes on at an exposure, and perhaps also of polarisation in general, since the laws taken together seem to show that the polarisation varies as the square root of the resistance! It is difficult to imagine how this can be, although it seems reasonable to imagine that the back E.M.F. of polarisation, being a reaction, should be in some proportion to the causing current.

The matter is full of interest and will repay further investigation. Some experiments I made in 1894 confirm Schaefer's in showing the principal seat of the resistance is at the anode. But it remains to be shown what part the water and the cathode play in the matter. I am repeating my experiments with this object in view, and that of obtaining evidence for or against the $p \propto \frac{1}{\sqrt{f}}$ idea.—Yours, &c., Walter J. Murphy.

Aden, Dec. 5, 1897.

CALCIC CARBIDE FURNACES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to the "Note" in your issue of the 10th inst. on the calcic carbide question, you are mistaken in saying there are no furnaces working continuously. Last November twelvemonth I was asked to examine a system working on rather a large scale at Puteaux, near Paris. The inventor of this system, M. Patin, has succeeded in designing a very practical electro-carbide and highly efficient furnace plant which works quite continuously.—Yours, &c.,

B. H. Thwaite.

London, S.W., Dec. 20, 1897.

LEGAL INTELLIGENCE.

Levy v. The National Telephone Company (Limited).

This case came before the Court of Appeal on Friday last, on the appeal of the defendants from an order of Mr. Justice Day in November, granting a mandatory injunction against the defendants, commanding them to remove their telephone wires erected over and above the plaintiff's premises in the Whitechapel-road within two months from the date of the order.

Mr. ASQUITH, Q.C., M.P., in support of the appeal, said that the action was brought by the plaintiff, as lessee of the premises, for trespass, her complaint being with regard to certain wires and cables, which were admittedly vested in the defendant Company, and which passed over the roof of her premises, in respect of which she alleged she was entitled to damages and to an injunction. The defendants were a Company incorporated for the supply of telephonic communication, and since 1884 had been acting under licence from the Postmaster-General, but this licence had in some respects been modified and amplified by an agreement made with the Postmaster-General in 1886. The Company, however, had not been acting under statutory powers. They carried their wires overhead by poles and standards, some of which were fixed in the streets and some on the roofs of houses. In some, and indeed in many cases, as in the case now in question, there was no head post or standard raised upon the roof of the house, and the trespass complained of was the existence of the wires through the air at certain heights over the houses.

Lord Justice SMITH: Do you say it is no trespass?

Mr. ASQUITH: It is not necessary for me to contend it is not a trespass.

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Mr. UPJOHN, Q.C. (for the respondent), said that that was not the only trespass of which the plaintiff complained, because the defendants' men had to go on the plaintiff's roof and had damaged it.

Mr. ASQUITH said the question was not whether at the trial of the action the plaintiff would be entitled to damages, but whether an interlocutory injunction ought to be granted.

Lord Justice SMITH: Do you mean to say if a man puts a wire in front of my house I am not entitled to have it pulled down.

Mr. ASQUITH: Perhaps; but these wires have been in this position for about 13 years.

Mr. UPJOHN said that he could not agree with that statement.

Mr. ASQUITH said that according to the views of the defendants' witnesses the wires were not causing the slightest danger or inconvenience to the plaintiff.

Lord Justice SMITH: Could the plaintiff get an injunction at the trial?

Mr. ASQUITH: I am not at all certain whether the plaintiff could get an injunction to restrain a thing which has been acquiesced in so long.

Lord Justice RIGBY: If a Statute of Limitations has any application, I daresay you are right.

Mr. ASQUITH: There is no Statute of Limitations, of course, which would apply in this case. There is another question which will arise at the trial which is, although the defendants have not put up these wires under statutory powers, they say they are in a position to petition the statutory authority for that now.

Lord Justice SMITH: They ought to have done that first. What I mean is, it is a very high-handed proceeding to go on to a person's house to look after their wires.

Mr. ASQUITH: The point which might be raised at the trial is that between now and then the defendants could call upon the Local Authority for authority to do this very thing, and a wrongful act now would become a perfectly legal act then.

Mr. UPJOHN said that the evidence was that all the wires had not been in the position in question for 13 years. The evidence was that several of the wires had not been there for anything like that time.

Mr. ASQUITH, continuing, said that although the defendants were not in a position to say they had obtained the necessary consent they did say they were in a position to obtain it.

Lord Justice RIGBY: Without compensation?

Mr. ASQUITH replied he did not say that, and the Act made provision for that. If the defendants had to take the wires away it would dislocate the whole service.

Mr. UPJOHN said that he was quite prepared to treat the motion as the trial of the action.

Mr. ASQUITH: I daresay you are.

Lord Justice RIGBY (to Mr. Asquith): What you say is, that although you have done a wrongful act, for which there is no defence at all, if the plaintiff gives you plenty of time you will get the necessary consent?

Mr. ASQUITH: If your Lordships believe the affidavits, it is impossible to remove the wires in two months. Again, I have broken the law for a great number of years without remonstrance.

Lord Justice SMITH: I do not see that proved.

Mr. ASQUITH: Substantially the wires have been there for a considerable length of time, and although I am not able to justify their being there at the present moment is it a resonable thing to order them to be removed within two months?

Lord Justice RIGBY said that nobody had ever laid it down yet that an arbitrary trespass might be justified by a man saying "I will compensate you."

Mr. UPJOHN said that Mr. Justice Day thought it was an absolutely undefended action, and so it was. The learned counsel stated that there were 250 wires over his client's house, including eight cables. The wires were about 3ft. above the roof, but, of course, below the top of the chimneys. He read affidavits that the wires were a great annoyance to persons sleeping in rooms immediately beneath the roof, and that they were a great source of danger in gales and snowstorms.

Lord Justice SMITH, in giving judgment, said that he was of opinion that Mr. Justice Day had come to a right decision on the matter. Mr. Justice Day had decided that the plaintiff might have cut the defendants' wires, but the plaintiff, instead of doing that, had come to the Court to ask for an injunction to compel the defendants to take them down themselves. He accordingly thought that Mr. Justice Day's order ought to be affirmed, and the appeal dismissed with costs.

The other Lords Justices concurred, and the appeal was accordingly dismisse with costs.

Lord Justice SMITH said that the Court thought, as the appeal had been hanging up for a month, the defendants ought to have two months from that date within which to remove their wires.

Order accordingly.

The City Commission of Sewers v. the City of London Electric Lighting Company.

In the Appeal Court, on Monday last, an appeal of the City Commission of Sewers against an order made by Mr. Justice Day in chambers was heard. The order appealed against reversed an order of Master Pollock giving the defendants unconditional leave to defend an action for a sum of £1,142. 2s. 7d. out of a total claim of £6,439 odd, and signing summary judgment for the plaintiffs as to the balance which was in dispute between the parties.

COUNSEL for appellant said the plaintiffs undertook to light the City by electricity, under a Provisional Order sanctioned by Parliament, which gave authority to the local authority to appoint from time to time electric inspectors under the Board of Trade, and prescribed the duties and fees to be taken. This action had been brought in respect of these matters, and there was a counter-claim made out, the contention being that under Clause 47 of the Order the fees, unless they could be agreed upon, should be ascertained by a court of summary jurisdiction or by the Board of Trade and be paid by the Company. What took place was that under the provisions of the Order the commission appointed an electric inspector, and their clerk wrote to the Company forwarding an account of the electrical inspection. and asking that the Company might reimburse the amount. The Company wrote that it was a condition precedent that the amount should be ascertained between the parties. The eventual answer was, in short, that they owed nothing. They raised no question as to amount, but simply said that they did not recognise the claim of the Commission. The correspondence showed that the Company had not been altogether consistent in their action, as they offered to pay the Commissioners £2,200 out of the £6,000. In other words, they deducted from the total certain amounts they disputed.

Lord Justice SMITH asked: Was not the true meaning of clause 47 that the parties were not to go into a court of law at all?

COUNSEL stated that their liability being admitted, a court of Summary Jurisdiction would settle any differences, but what was said by the Company was that they owed nothing and that the defendants ought not to be refused a hearing of their case. This was the effect of Mr. Justice Day's order. The respondents admitted liability for some items and denied others, the appellants understanding that now the respondents' case was a total denial.

Lord Justice SMITH expressed the opinion that it was a miserable squabble between two large constituted bodies. Why not pay the whole amount and bring a cross action?

Appellant's counsel said that liability was denied.

Lord Justice SMITH: Why should not judgment be signed against appellants for £6,000, and the execution be stayed as to the £1,142 for them to settle the matter?

COUNSEL said he had no objection, but there was no reason why the other side should have £1,100 of their money in the pockets pending what they themselves in their correspondence called a *bona fide* dispute as to liability. They offered to bring the whole amount into Court, but the Master gave them an opportunity of having the case tried before the ordinary tribunals. Mr. Justice Day, however, upset that order.

COUNSEL for the Company contended that the judge's order was perfectly correct, which view the Court of Appeal now took, and the appeal was dismissed with costs.

Thorpe v. Dublin Corporation.

This action, which was for the recovery of damages for injury alleged to have been sustained from an electric shock received while crossing at the corner of Grafton-street, came before the Dublin Recorder on Tuesday. Plaintiff stated that on Oct. 30 he was passing near an electric lamp, and stepping on a plate on the ground he got a terrific shock, and he fell to the ground. A bystander, who gave evidence, stated that plaintiff was shaking all over. The Corporation produced medical evidence to prove that, although the plaintiff might have had a nervous shock, he had sustained no permanent injury. The plaintiff was awarded £25.

North Staffordshire Tramways Company v. the British Electric Traction Company.

This case came before the Court of Appeal last week on the appeal of the defendants from an order of Mr. Justice Day in Chambers restraining the defendants from interfering with the plaintiffs' tramways at Burslem. The acts of which the plaintiffs complained were being done while the defendants were acting in the exercise of their statutory rights, the defendants being the transferrees of certain rights and authority granted by the Potteries Extension Tramways Order, 1896, as confirmed by the Tramways Order Confirmation No. 2 Act, 1896. The Order in question authorised the construction and maintenance of certain tramways. The defendants commenced an action for damages for trespass and for an injunction, and Mr. Justice Day made an order granting an interim injunction till the trial of the action.

Before the arguments of counsel had concluded a settlement was arrived at, the injunction which had been granted being dissolved on the defendants undertaking to let matters remain as they were till Jan. 1, to proceed with their works as expeditiously as possible after that date, and to grant the plaintiffs certain facilities for working their tramway.

THE NORTHAMPTON ARBITRATION.

In July last the Northampton Electric Light and Power Company (Limited) gave notice to the local gas company of their intention, under the general powers given by their Provisional Order, to alter the position of certain public supply gas pipes, in order to facilitate the laying of electric mains, with the primary object of protecting such electric mains from the danger of gas accumulations. The reply of the gas company was a demand that the whole subject should be submitted to an arbitrator, under the provisions of an Act in that case provided. The Board of Trade appointed Major-General Alex. deC. Scott to investigate the matter, and public inquiries were held in September and November last, when expert evidence was presented by both parties. This is, we believe, the first arbitration of the kind undertaken by the Board of Trade. The decision of the arbitrator has now been given, and is to the effect generally that the alterations required by the Electric Lighting Company may be made, subject to certain modifications and conditions as follow:

(*a*) If the level of the centre of the gas main at or opposite the point of connection of any gas service pipe with such main is 2ft. or more below the

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level of the surface of the pavement of the footway, at the point vertically above the point where the longitudinal axis of such pipe crosses the longitudinal axis of the culvert laid down, or proposed to be laid down, by the Electric Company, then the Electric Company may lower such pipe.

(*b*) If the level of the centre of the gas main at or opposite the point of connection of any gas service pipe with such main is less than 2ft. below the level of the surface of the pavement of the footway, vertically above the point of crossing above mentioned, then the Electric Company may raise such pipe.

(*c*) The inclination or fall of every gas service pipe which shall be lowered or raised shall be in the same direction as before the same shall be lowered or raised.

(*d*) The rate of inclination or fall of every gas service pipe which shall be lowered or raised shall not, after the same shall be lowered or raised, be at any part less than 1in. vertical in a horizontal distance of 8ft.

(*e*) No gas service pipe shall be lowered so that the highest point of the pipe at the point of crossing above mentioned shall be more than 1ft. 10in. below the surface of the pavement of the footway vertically above such point.

(*f*) No gas service pipe shall be raised so that its longitudinal axis at the point of crossing above mentioned shall be less than 11in. below the surface of the pavement of the footway vertically above such point.

(*g*) In order to conform to the foregoing modifications or conditions any gas service pipe may be disconnected from the gas main to which such pipe may be at the time connected, but if disconnected shall be reconnected with such mains, and in making such reconnection no hole shall be made in such main in such a position that the centre of such hole shall be below any point midway between the highest and lowest part of such main.

(*h*) The culvert proposed to be laid down by the Electric Company shall not be placed over any gas service pipe unless and until such pipe is protected so as not to come into contact with or be injured by the base of such culvert, and in every case in which a gas service pipe is lowered a free passage shall be provided for such pipe beneath such culvert, so that it can be withdrawn from under such culvert without difficulty.

The arbitrator further awards that if, in order to comply with the provisions hereof, it shall be necessary to make in any gas main a new hole or new holes, the centre of which shall be below the highest point of the surface of such main at the point of connection of the gas service pipe with such main, then for each hole so made the Electric Company shall within one month after such hole shall be made pay to the Gas Company the sum of 4s. 6d. as compensation, in addition to all expenses properly incurred by the Gas Company in complying with any notification of the Electric Company under the 16th section of the Order.

The notices and plans served by the Electric Lighting Company on the Gas Company are stated to have fully complied with the terms of the section. Each Company is to bear its own costs, and is to pay one-half of the expenses of the arbitration, the amount payable by each party being £22. 3s. 7d.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

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"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced, and all the usual important articles, &c., which have made the book indispensable to the industry, will be brought up to date and amplified where necessary.

Tenders Invited.—The Electric Light Committee of the County Borough of Salford invite tenders for high-tension service cable. Some particulars appear in our advertisement columns, and specifications, &c., may be obtained from the electrical engineer (Mr. C. Turner), Wallness-road, Broughton. Tenders (addressed to the Chairman of the Electric Light Committee) must be delivered at the office of the town clerk (Mr. Samuel Brown), Town Hall, Salford, by noon of Thursday, the 30th inst.

——— The Electricity Supply Committee of the City of Gloucester invite tenders for the supply and erection of (*a*) Lancashire boilers and accessories, mechanical stokers, feed-pump, injector, economiser and electric motor; (*b*) steam dynamos and accessories; (*c*) overhead travelling crane; (*d*) switchboard and instruments; (*e*) accumulators; (*f*) insulated cables and trenching; (*g*) arc and incandescent lamps and lamp-posts; and (*h*) meters. Tenders to Town Clerk, Guildhall, Gloucester, by Jan. 18.

Tenders Invited.—The Corporation of Bootle invite tenders for the supply and erection of (1) Lancashire boilers and Green's economisers ; (2) engines, dynamos, switchboard, condensers, condensing and feed-water pumps, &c., wiring of electricity works and alterations and additions to wiring at Town Hall ; (3) secondary batteries and accessories ; (4) feeder and distributing mains, &c. ; and (5) running of the electricity supply works for a period not exceeding three years. Tenders to Chairman of Watch Committee, by noon, Jan. 10.

——— The Electric Lighting Committee of the Borough of Bedford require tenders for the supply and erection of a 420 B.H.P. double-acting compound enclosed engine, and a 250 unit alternator, with stationary armature. Tenders to Town Clerk by Jan. 10.

——— The Vestry of St. Pancras (London) invite tenders for the supply and erection of electric lamps, posts, and circuit complete ; also fitting and distributing mains. Tenders to Mr. C. H. F. Barrett, Vestry Hall, Pancras-road, N.W., by noon, 28th inst.

——— The Morley (Yorks) School Board require tenders for the supply and fixing of lightning conductors to the various buildings at Bridge-street Board Schools. Tenders to the clerk by 31st inst.

——— The trustees of the Heaton-road (Newcastle-on-Tyne) Wesleyan Church invite tenders for an electric light installation in the church, lecture hall, &c. Tenders to Mr. J. W. Hunter, 170, Shields-road, Newcastle, by 27th inst.

——— The Bedford Town Council require tenders for the erection of offices and store rooms at the electricity works. Tenders to the town clerk (Mr. T. S. Porter), Town Hall, Bedford, by Jan. 10.

——— Tenders are invited for the extension of the Huddersfield electricity supply station. Tenders to the Town Clerk, Town Hall, Huddersfield, by Jan. 4.

——— The Foreign Office has received a despatch from the Chargé d'Affaires in Madrid notifying that tenders are being invited for the construction and working for a number of years of a telephone system in the City of Tarragona. Sealed tenders (on forms which can be obtained from the Civil Governor of Tarragona, or at the Registry of the Direccion Generale de Correos y Telegrafos, Calle de Carretas 10, Tarragona), from whom full particulars and conditions may also be obtained), must be sent in by Jan. 11 to the Civil Governor of Tarragona. The telephone poles must be of the pattern used by the Telegraph service ; the insulators must be hard burnt porcelain of the double-petticoat type, and the supports must be of galvanised iron. The wire is to be of bronze, and of at least 11/10mm. diameter, and have an electrical resistance of 54 ohms per kilometre and a mechanical resistance of 70 kilogrammes per square millimetre. Iron or steel wire may also be employed. The microphones and telephones must conform to the same conditions as those usual with the Ader No. 3. Some further particulars of the conditions of tendering can be seen (in Spanish) at the commercial department of the Foreign Office between the hours of 11 and 5. A sum of 2,000 pesetas (about £75) must be lodged with the tender, and this must be increased to 4,000 pesetas on the acceptance of the tender.

——— The Secretary for Foreign Affairs has received a dispatch from H.M. Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tenders for the construction and equipment of the line, which, with branch, is 30 miles in length. Further particulars of the conditions of the tender may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6. Tenders must be sent in by Feb. 28, 1898. Full particulars can be had of Señor Alcalde Azpeitia, Guipuzcoa, Spain.

——— The Municipal authorities of Torrente (Valencia) invite tenders for the concession for the electric lighting of the streets for 17 years. Tenders to El Secretario del Ayuntamiento de Torrente (Valencia), Spain, by Jan. 9.

——— The General Direction of the Roumanian Posts and Telegraphs, Bucharest, invites tenders for the supply of 56,000 metres of galvanised iron and steel wire. Tenders by March 15.

——— Tenders are invited until the 30th inst. by the authorities of the Minho and Douro Railway, at Oporto, for an electric lighting installation at the railway station of Campanha.

Tenders Accepted.—We learn that the contract for the electric lighting of the new Hotel Victoria, at Newquay, Cornwall, has been entrusted to Messrs. Drake and Gorham. The installation will consist of two large gas engines and a central station type battery of D.P. cells. Over 400 lamps will be installed.

Tenders Received.—The Hammersmith Vestry have received the following tenders for the supply and erection of two 375-H.P. low-speed vertical engines and two 300-kilowatt flywheel alternator:

Brush Company.....	£6,522	18	*Engines only.*		
S. Z. de Ferranti (Ltd.)	7,014	0	Fairbank Brearley.....	£3,486	0
Siemens Bros. and Co. ...	7,926	0	Robey and Co.	4,610	0
Electric Construction Co.	8,560	0	J. and H. McLaren	5,400	0

Appointments Vacant.—The Council for the Foreign Community of Shanghai require a chief municipal electrical engineer. Salary (at present rate of exchange) about £460 per annum, with quarters, coal, &c. Some particulars are given in our advertisement columns, and further information may be obtained from Messrs. John Pook and Co., 6, Jeffrey's-square, St. Mary Axe, E.C., to whom applications should be sent before Jan. 15 next.

——— The Government of Trinidad require an electrical engineer to examine and report upon the various electricity supply and telephone undertakings in and adjacent to the Port of Spain. Engagement three months, with option to the Government to extend to any period not exceeding twelve months. Salary, £25 per month, and half salary during voyage out, with free first-class passage out and home again on satisfactory termination of engagement. Some further particulars appear in our advertisement columns, and applications should be sent in to the Crown Agents for the Colonies, Downing-street, S.W., by Jan. 6th.

Vacancies.—The National Electric Free Wiring Company require a wiring superintendent, at a salary of £100 per annum and commission. See advertisement.

——— There is a vacancy for an assistant electrician at the Coventry Corporation Electricity Works. Salary £2 per week. Applications to the manager. See advertisement.

——— An engineer is required for the District Lunatic Asylum, Queen's County, Ireland. Salary £100, with allowance valued at £30 per annum. Applications to resident medical superintendent by 29th inst.

——— The Hull Corporation require a working electrician to attend to the lighting of the town hall, market hall, and other public buildings. Applications to city engineer by 1st prox.

Appointments.—Mr. Ross, of Sunderland, has been appointed assistant engineer at the Hampstead Vestry Electricity Supply Station vice Mr. T. Hesketh, who has been appointed to take charge of the new station of the Folkestone Electricity Supply Company. Mr. Seabrook, assistant engineer at Yarmouth, is to take the position about to be vacated by Mr. H. Morton, who is going to Llandudno as resident engineer.

——— Mr. A. L. C. Fell, M.I.E.E., who has represented the British Thomson-Houston Company as resident engineer in connection with the Cork Tramways and Lighting scheme, has been appointed by the Tramways Committee of the Sheffield Corporation resident electrical engineer to the Sheffield Tramways, some portions of which are undergoing conversion to overhead electric lines. The salary attached to the office is £400, increasing by annual increments of £25 to £500 per annum. There were 40 applicants for the post, but this number was reduced to five, viz. : Mr. F. Ayton, Blackheath (with Siemens Bros. and Co.) ; Mr. E. A. Browning, Wolverhampton (with the Electric Construction Company) ; Mr. C. Taylor, who has been superintending the cabling of the Leeds lines ; Mr. H. Yerburgh, Bristol (assistant engineer for the Bristol tramways), and Mr. Fell.

——— Mr. Harold A. Howie, formerly assistant engineer at the Bolton Corporation Electricity Works, has been appointed junior assistant at Wolverhampton.

Business Notice.—Mr. W. Vinter, mathematical divider and general engraver to the trade, has removed from No. 3 to Nos. 10 and 11, Dyer's-buildings, Holborn, London, E.C.

Bankruptcies.—The public examination of John Orme, electrical and scientific apparatus manufacturer, 6, Cross-street, Finsbury, and 62, Compton-street, Clerkenwell, E.C., was held on Friday at the London Bankruptcy Court. The liabilities were returned at £2,453. 13s. 9d., of which £1,744. 16s. 3d. was expected to rank, against assets £118. 18s. 1d. Bankrupt promoted Orme's Electric Signal Company (Limited) in 1893, with a nominal capital of £7,500, to exploit a patent for an electric fog signal. He received £6,000 in shares, but in 1895 the Company went into liquidation. Failure was attributed to the excessive amount paid to his partner in 1881, to insufficiency of capital, and other causes. Examination concluded.

——— The following are the principal creditors in the failure of S. Bousfield Tatham, electrical engineer, 26, Thurloe-place, South Kensington, London, S.W. :—W. Alwright, £498 ; J. W. Acherson Gray, £429 ; A. J. Tatham, £373 ; Electrical Company, £115 ; W. T. Henley's Telegraph Works Co., £50 ; W. H. Willcox and Co., £48 ; Edison and Swan Company, £35 ; H. Lancaster, £25 ; W. McGeoch and Co., £23 ; J. Bolding and Sons, £22 ; G. Braulik, £21 ; D. Hulett and Co., £20 ; General Electric Co., £12 ; C. W. Carter, £10 ; Nalder Bros. and Co., £10 ; W. H. Reed and Sons, £10 ; G. Straus and Co., £10 (all of London) ; and A. and R. Cochran (of Glasgow) £12. The liabilities are returned at £2,510. 8s. 1d., assets £41. 2s. 1d.

Liquidation.—At a meeting of the members of the Electrical Traffic Syndicate (Limited) on Nov. 26 it was resolved to wind up the Company voluntarily, and to appoint Mr. M. Jenks, 6, Old Jewry, E.C., as liquidator. This resolution was confirmed on the 13th inst

Liquidation.—It has been resolved to wind up the Salt Lake and Ogden Gas and Electric Light Company (Limited) voluntarily. Mr. King has been appointed liquidator. The business of the company has been taken over by a local corporation.

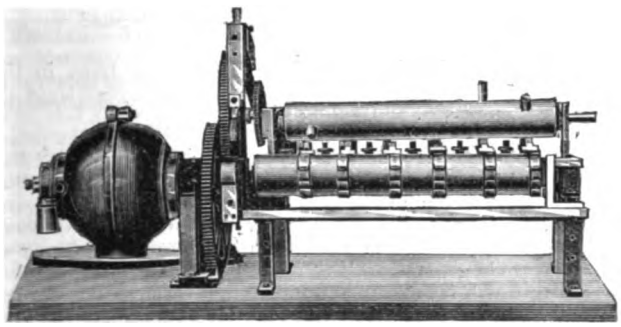
Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 15 to Dec. 21, with the ports of destination :—

Argentina—Buenos Ayres, £266 (including £156 telegraph material. *Australasia*—Adelaide, £17; Fremantle, £1,484 (including £1,145 telegraph material); Geraldton, £60; Hobart, £49; Melbourne, £49: Sydney, £423; Townsville, £140; Wellington, £1,808 (telegraph material). *Belgium*—Antwerp, £173; Brussels, £210. *Ceylon*—Colombo, £62. *Chili*—Boca, £189 (telegraph material). *China*—Shanghai, £793 (including £137 telegraph material). *Egypt*—Alexandria, £190. *Germany*—Bremen, £16. *Gibraltar*—£2,527. *Holland*—Amsterdam, £45; Flushing, £65; Rotterdam, £11. *Hong Kong*—£32. *India*—Calcutta, £211; Madras, £196. *Japan*—Hiogo, £35; Nagasaki, £9,000; Yokohama, £799. *Norway*—Christiania, £95. *Portugal*—Beira, £122 (telegraph material). *Russia*—Odessa, £263 (including £83 telegraph material); St. Petersburg, £382 (telegraph material). *Siam*—Bangkok, £413. *South Africa*—Cape Town, £239; Delagoa Bay, £180 (telegraph material); Durban, £226 (including £670 telegraph material); Port Elizabeth, £171 (telegraph material). *Spain*—Pasages, £314. *Straits Settlements*—Singapore, £95 (including £25 telegraph material). *Sweden*—Gothenburg, £43. Total, £21,433, against £46,258 in the corresponding week last year (Dec. 16 to Dec. 22).

The Hiring of Heating and Cooking Apparatus.—The Gas Light and Coke Company, in order to advertise the advantages of gas-cooking stoves, &c., have taken extensive premises in North London, where these goods are on show. This is a new departure on the part of the Company, and should be duly noted by manufacturers of electric heating and cooking apparatus and by electricity supply undertakings. The public should be kept well posted in the many advantages offered by the latest kinds of electric cooking and heating appliances.

Christmas Arrangements.—On Christmas Day telegraphic and trunk telephone business will be conducted the same as on Sunday in England and Ireland, and in Scotland the same as on week days. On Bank Holiday (Monday, 27th inst.) telegraphic and trunk telephone business will be transacted as on ordinary week days.

Illuminated Advertising.—The apparatus shown in the illustration has been patented by Mr. J. T. Gent, and is designed to render illuminated signs or parts of illuminated devices, or a series of separate illuminated advertisements, more attractive by causing the letters or other parts of such devices to appear and disappear in varying order. The ordinary illuminated sign has its different



"Allaxic" Apparatus for Electric Light, with Motor.

letters or parts brought into view or change colour consecutively, and, after the whole is illuminated, is extinguished, to reappear in the same order. Mr. Gent's arrangement, however, causes the letters or parts to appear in a non-consecutive order, and when complete to be extinguished and reappear in different order, and has so been termed "Allaxic." The system is applicable for illumination by electric light or gas. In either case a motor is employed to actuate a series of switches or valves. The motor must be fitted with a train of wheels for reducing the speed to that required by the apparatus; the last wheel of the train being attached to a revolving spindle or barrel having the requisite number of cams or pins (according to the number of letters or devices to be illuminated) at equal distances circumferentially, which, as the spindle revolves, come into contact with hinged levers connected to the electric light switches, or valves, and lift them into the on or off position for allowing the current to flow to the lamps, in which position they are retained by catches until released by the falling of a weighted lever actuated by the revolving of a second spindle and releasing cams. It is in the varying order of releasing the weighted lever, and allowing the switches or valves to return to their original positions, that this system is claimed to differ from others on the market.

"Hansen" Arc Lamps.—Messrs. Gülich and McIntyre forward circular particulars of "Hansen" continuous and alternating current arcs for parallel or series lighting. The list includes prices and illustrations of a large number of lamps of various types.

Street-Car Controller.—The Walker Company, of Cleveland, Ohio, are issuing a pamphlet, descriptive of their type "'S' Solenoid Blow-out Controller." Among the distinguishing features of this controller are the means of extinguishing the destructive arcs consequent on the passage of the various contact pieces from the fingers. In the older forms of magnetic blow-out the magnetic field is directed on the parts where the arcs form, and in such a manner that before it is extinguished it is directed against the insulating partitions of the controller, thus causing damage. With short-circuits carrying large currents the iron-cored magnet often failed to extinguish the arc in consequence of magnetic saturation in the iron core. In the Walker controller a solenoid with no iron core is used, and the blowing-out field is parallel to the axis of the controller, thus blowing out the arc radially; the field being also always proportional to the current. Violet arcs are also certain of being extinguished. The solenoids are formed of copper strip insulated with pure asbestos, and wound between each set of controller contact-fingers. Other features are the contacts, in addition to the usual ones, by which either of the two motors can be run alone, backwards or forwards, without cut-out switches in the controller case; and the seventh or "emergency" notch for applying a braking effect by short-circuiting the motors through a portion of the rheostat. This takes the place of reversing the motors in case of accident and accomplishes the rapid braking of the car without risking the destruction of the motors. This brake cannot be released until the car has come to a standstill because of a magnetic locking device which will not release till all current through the motor circuits ceases. Each controller for a 25 H.P. equipment weighs 200lb. and the rheostat 90lb., making the total weight for the double equipment 490lb.

Catalogues and Trade Lists.—An excellent catalogue is to hand from Messrs. W. M. Still and Co., 24, Charles-street, Hatton-garden, London, manufacturers of the "Still" incandescent lamp, and makers of reflectors, and spun, stamped, and pierced metal work for all descriptions of electrical fittings, &c. The catalogue illustrates a large variety of metal bases suitable for electrical work, counter-weights and pulleys for suspended lights, rosettes and leaves in a very large variety of designs, and general metal work in copper and brass; electric globe carriers; a fine show of reflectors, both plain and ornamental; electrical switch covers, bell pushes, and a large assortment of electrical accessories in stamped and shaped metal and a variety of excellent designs.

Catalogues Wanted.—Makers of engines and combined engines and dynamos for three-wire continuous-current working are requested to forward on their catalogues and price lists to Mr. Norman Selfe, M.Inst.C.E., M.Inst.M.E., &c., 279, George-street, Sydney, N.S.W.

Calendars.—We have received from the Eastern Telegraph Company a handy sealed glass ruler, in which is neatly rolled a map showing the submarine cable routes of the world. This well-made ruler is the work of Mr. J. J. Hicks, of Hatton-garden. The Eastern Company are also issuing the very useful map-covered paper-cutter which has now become a regular and acceptable annual for office use.

Mr. Robert W. Paul, of 44, Hatton-garden, London, E.C., issues a neat hanging sheet, with not too much calendar, but just calendar enough, and upon which is very clearly printed a number of the well-known instruments manufactured by Mr. Paul.

Messrs. Croggon and Co. issue a handy hanging tear-off pad, upon which opportunity is taken for illustrating types of apparatus manufactured by the firm.

The Brush Electrical Engineering Company's contribution takes the form of a handy pocket calendar and diary, which is provided with a pencil, and is likely to prove as useful and enduring as any of the calendars to hand.

The Magnolia Anti-Friction Metal Company of Great Britian forward a table calendar, very well made "in the United States," and as useful a desk calendar as could be found—wherever made. The facing is of celluloid and shows how easily manipulated is this material. This is a good advertisement.

Turin Exhibition.—The German Minister of Trade and Commerce notifies that makers of material for house installations would do well to exhibit in the electrical section of the Italian International Exhibition at Turin next year. The electric light works which are being erected in Turin will soon be completed, and there will, no doubt, be a considerable demand for various fittings and wiring material for private lighting. English manufacturers (as well as German) may be advised to take note of this fact.

New Journals.—A new journal is announced, and the first number published, entitled the *Journal of Acetylene Gas Lighting and Carbide of Calcium Review*, the pioneer journal of a New industry. The published price is 6d.—Another new journal is entitled the *Model Engineer*, published monthly, price 2d.

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Ayr.—The Town Council have offered to supply electric current to the Harbour Trust for lighting the harbour at 6d. per unit for the first hour and 2d. per unit after. The charge for current to incandescent lamps for street lighting has been fixed at £2. 10s. per 16 c.p. lamp per annum.

Beckenham (Kent).—The District Council recently called upon the National Telephone Company to remove the overhead telephone posts and wires in the district but the Company refused, and it is stated that a writ has now been served, and an injunction is to be applied for to restrain the Company from continuing to trespass in the Council's district.

Belfast.—The Electric Committee recommend the Corporation to adopt the maximum demand system of charging for electric current.

Brighton.—The minutes of the Lighting Committee presented at the last meeting of the Town Council stated that, according to a report from the electrical engineer (Mr. Arthur Wright), the loans for electrical street lighting are overspent to the amount of £1,808. Of this amount £1,070 was for 17 additional arc lamps and 66 incandescents, £250 for lighting Madeira-road, and £670 for the purchase of spare lamp pillars and lamps and fittings not yet used. Mr. Wright also reported that the expenditure necessary when the further 13 arc lamp pillars in stock were erected would be £325. The Committee recommended that application be made to the Local Government Board to borrow a further sum of £2,130 for street lighting. This was agreed to.

Carlisle.—Col. Durnford held a Local Government Board inquiry at Carlisle, this week, into the application of the Corporation for sanction to borrow £30,000 for the purpose of establishing electricity supply works. Prof. Kennedy submitted plans and particulars of the scheme, and said that the Corporation would themselves erect the arc lamps in the streets, but would not supply lamps for private consumers. They would only take the mains to the doors of the consumers. The Town Clerk said a number of people were ready to take current, and the Corporation would light the public buildings electrically. The estimated capital expenditure was £26,300, leaving a balance of £3,700 for contingencies, extension of mains, and road work.

The contract for the supply of the electric lighting plant has been sealed, and the Council have approved a recommendation that their consulting engineer (Prof. A. B. W. Kennedy) should have certain alterations made in the generating plant and switchboard, so as to enable them to supply current for tramway working.

Castleford.—The Market Committee of the Urban District Council have decided to ask a local firm of electrical engineers to submit estimates of the cost of lighting the market hall and its approaches electrically.

Colwyn Bay.—At the last meeting of the District Council a communication was received from the Local Government Board as to the proposed loan for electricity supply works at Groes, and asking for plans and details of the works. The Surveyor is to prepare and submit these, and the opinion of Messrs. Fawcus and Clirehugh is to be taken on the scheme prepared by the Surveyor.

Country House Lighting.—York House, Twickenham, the English residence of the Duc d'Orleans, has been entirely redecorated, and the electric light fittings are stated to be on a very lavish scale.

Crewe.—The Town Council have unanimously resolved to proceed with their application for a Provisional Order.

"Electric Avenue."—This avenue, which for many years has attracted large crowds of South London residents as a brilliant "shopping" centre, is again being elaborately illuminated by the electric light to set off the displays of Christmas goods offered by tradesmen. Huge masses of foliage are utilised in the decorations, amidst which a large number of electric incandescent lamps of all colours are plunged. The illumination is extremely attractive, and makes the avenue one of the sights of London, and a credit to Brixton, an extensive suburb not over burdened with attractions.

Electric Motor Vans.—The Clerkenwell Vestry are to be asked at the next sitting to instruct the Clerk to ascertain the cost of purchasing and maintaining an electrically-propelled water van. A feature of the meeting of the Royal Agricultural Society at Birmingham next June will, it is announced, be the trials of self-propelled vehicles for light and heavy loads.

Electric Traction in Argentina.—It is reported that a Berlin syndicate connected with the Union Elektricitäts Gesellschaft of Berlin have acquired a considerable block of shares in the Anglo-Argentine Tramway Company, which were last week purchased from the Baring Estates Company by a London syndicate. The shares will confer strong voting power in connection with the proposal for working the line electrically, a step which has virtually been decided upon. The change of motive power will, it is estimated, effect a saving of from 35 to 40 per cent. in the working, and lead to a considerable increase in the traffic. In the event of the proposed amalgamation with the Buenos Ayres Grand National Tramways Company being brought about, the combined system will be worked by electricity.

Electric Traction in Kent.—A meeting of residents has been held at New Brompton to discuss the proposal to construct a network of electric tramways in Chatham, Rochester, New Brompton, Gillingham, &c. Mr. Fraser, who represented the promoters, gave details of the scheme, and particulars of the system of traction proposed to be adopted. The cost of the whole scheme, he said, would amount to about £200,000. A resolution in favour of the project was passed unanimously.

Folkestone.—The Folkestone Electricity Supply Company have submitted plans of the positions of the arc lamps proposed to be erected in certain streets. At present it is proposed to replace 200 gas standards, but the Company suggest that further streets should be lighted electrically. The Borough Engineer has been instructed to submit a report.

Glasgow.—At the last meeting of the Electricity Committee of the Corporation a notification was made by the proprietors of the *Glasgow Mail* that electricity is to take the place of steam as the motive power employed in the printing works, the condition being that current shall be supplied at a cheap rate from the Corporation supply. The subject is being considered by the Works Sub-Committee.

The receipts of the electricity department from June 1 last to date amount to £6,897. 11s. 11d., against £6,404. 4s. 3d. at the corresponding period last year.

The joint Tramways and Watching Sub-Committees of the Corporation having agreed that the whole of the Springburn tramway route should be lighted electrically, the Electricity Committee, to whom the matter was submitted, have approved.

An important project for the electric lighting of the docks and harbour is at present under the consideration of the Clyde Trust. Though a detailed scheme has not yet been submitted, it is proposed to erect between 30 and 40 arcs for the lighting of the north wall of the Queen's Dock. A consultation has taken place between the Trust and the Electric Lighting Committee of the Corporation as to terms and conditions for taking current from the Corporation, and the latter have agreed to supply at 2½d. per unit, the Trust providing its own lamps, carbons, poles, &c., and the necessary staff to look after the installation. The Trust has, however, instructed its engineers to prepare and submit a detailed report as to the cost of putting down an independent installation. This report has just been presented and states that the Trust could produce current at a cost of about 1½d. per unit from its own plant.

Hastings.—A special meeting of the Town Council was held on Friday last, when a resolution in favour of proceeding with the application for a Provisional Order for the purchase of the undertaking of the Hastings and St. Leonards-on-Sea Electric Light Company was passed. At the same time it was decided to enter opposition to the electric tramway scheme.

Iron and Steel Trades.—Messrs. Bolling and Lowe in their review of the iron and steel trades for the past year state that exports have increased, and ruling prices have given a fair return to both employers and workmen. Up to the middle of the present year works were full of orders, many of which have since had to be cancelled owing to the engineering strike. Trade wth India is stated to have been satisfactory, notwithstanding the special drawbacks which the past year has presented in regard to this dependency. Large orders have been filled for both China and Japan, and trade generally with the far East has been satisfactory. The return, which is lengthy and interesting throughout, strangely makes no reference to the very considerable extension of the applications of electricity to railway and tramway work throughout the world.

Kettering.—Communications from two electricity supply companies offering to take a transfer of the Council's Provisional Order have been referred to the Lighting Committee for consideration and report.

Kirkcaldy.—Some time ago the Town Council received proposals relative to the construction of electric tramways in this town and extending to Dysart. A committee, which was appointed to consider the matter, has now unanimously endorsed the scheme, and approves the adoption of the overhead trolley system. An electrical expert is to be consulted as to the desirability of carrying out a combined electric lighting and traction scheme.

Lectures.—Mr. David Urquhart delivered a lecture last week at Dundee, under the auspices of the Dundee Institute of Engineers, on "Electric Traction for Tramways."

Leeds.—The Corporation's first experiment in street lighting by electricity was inaugurated on Wednesday. Altogether 40 arc lamps have been erected in Wellington-street, Briggate and North-street. The lamps are fixed on an extension of the electric tramway poles, and current is supplied from the Corporation generating station at Crown Point Bridge. The work has been executed by a local electrical engineer, Mr. W. Wharam, under the super-

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vision of Dr. J. Hopkinson. It is anticipated that extensions of the system will be shortly required.

The Parliamentary Committee recommend the City Council to apply to the Local Government Board for an Order to enable the Corporation to issue 5 per cent. Debenture Stock with a view to the purchase of the undertaking of the Yorkshire House-to-House Electricity Company.

Madagascar.—An export duty of 25fr. per 100 kilos on rubber has been imposed by the French authorities on Madagascar exports.

Manchester.—The Special Tramways Committee recommend the City Council to oppose the Bill of the Manchester Carriage and Tramways Company for power to use electric traction on the tramways owned or leased by the Company. The Moss Side District Council have also decided to formally oppose the Bill in order to secure a *locus standi* before Parliament.

Margam.—A report on the electric lighting of this district was considered by the District Council last week. Messrs. Lewis and Fletcher, who prepared the report, estimated the cost of an installation for public lighting at £10,000, and the annual cost of 122 street lamps at about £900, or £7. 10s. per lamp per annum. No provision is made for the supply of current for private lighting. The Council decided to proceed with their application for a Provisional Order, but a deputation has also been appointed to wait upon the Aberavon Council with a view to obtaining a reduction in the charge for gas lighting.

Newspaper Office Lighting.—The printing and publishing offices of the London *Financial Times* are to be lighted electrically, and electric motive power is to be used for the printing machinery, electric fans, &c. About 600 lights will be required. The plant is being put in by Messrs. Siemens Bros. and Co., and the wiring is to be carried out by Messrs. Vaughan and Brown. Mr. Morgan Williams is the consulting engineer for the work.

Personal.—Mr. Justus Eck, M.A., M.I.E.E., managing director of Laing, Wharton and Down (Limited), who has been about two months in the United States studying the latest developments in electric traction and street railway work on behalf of the Company, returns to England next week.

Portsmouth.—Col. J. T. Marsh, R.E., held a Local Government Board inquiry, on Tuesday, into the application of the Town Council for sanction to borrow £21,000 for electric lighting extension purposes. The Chairman of the Electric Light Committee stated that the demand for current from ratepayers in the streets where the mains had been laid was so great that their station plant was already overtaxed. The engineers' strike had prevented the erection of new engines, and consequentiy there would be a loss of revenue, but the profits last year were within a fraction of 8 per cent. on the capital expenditure. He claimed that the Portsmouth electric lighting undertaking was one of the most successful in the country.

Preston.—The Rural District Council have decided to allow the National Electric Supply Company to extend the electric light mains in their district on the usual conditions as to repair and maintenance of the roads by the Company.

Private Bill Legislation.—The Metropolitan Railway Company have deposited their Bill, in which powers are being sought by the Company to work by electricity the whole of the traffic on their railway or on any part of their system, including the lines owned jointly by them and the Metropolitan District Company. It is proposed to erect a generating station on land adjoining the Edgware-road Station, and power is also sought to enter into agreements with the District Company with reference to the working of both systems by electric traction.

Rumoured Railway Amalgamation.—A prompt denial has been given to the absurd rumour that the City and South London Railway Company's undertaking was to be at once acquired by the London, Brighton and South Coast Railway Company.

Salford.—Col. W. Langton Coke, M.I.C.E., held an inquiry on Wednesday into the application of the Town Council to borrow £13,000 for electric light extension purposes. The town clerk (Mr. Samuel Brown), who supported the application, said that the sum of £44,770 had already been expended by the Corporation on their electric lighting undertaking, and it was now proposed to construct a battery sub-station under the Regent-road Public Baths. The electric light mains would be extended along the Regent-road district, and other steps would be taken in order to meet the now largely-increasing public demand. There was no opposition.

School Lighting.—Mr. Morgan Williams is reporting to the Governors of the Stepney and Bow Foundation on the question of the introduction of the electric light at the large new schools now in course of erection for this Foundation.

Sheffield.—A special meeting of the City Council was held on Wednesday to consider the recent judgment in the action against the Sheffield Electric Light and Power Company and the present aspect of matters relating to the purchase of the Company's undertaking. Ultimately it was decided to authorise the Parliamentary Committee to apply to the Local Government Board for powers to amend so much of the Local Government Board's Provisional Orders Confirmation (No. 9) Act of 1892 so as to enable the Corporation to issue irredeemable stock to an amount sufficient to purchase the undertaking, and to authorise the issue of redeemable stock sufficient to pay a dividend of 5 per cent. on the capital expenditure of the Company, less the aggregate amount of the dividends declared from the date of the expenditure to the date of purchase by the Corporation.

Shrewsbury.—A special meeting of the Town Council was held last week to consider the Council's application for a Provisional Order, and the proposed purchase of the Shropshire Electric Light and Power Company's undertaking. It was decided to proceed with the application and also to pay interest on the purchase money, and the cost of the extensions made after the agreement to purchase, at the rate of 4 per cent. to the date of completion, the interest not to exceed in all £350.

Sowerby Bridge.—A ratepayers' meeting was held on Thursday last to consider an electric lighting scheme for the district. A representative of Messrs. J. E. Preston and Co. attended, and offered, on behalf of his firm, to put down an electric lighting plant, provided two-thirds of the shopkeepers would agree to take current at 4d. per unit. The meeting appointed a deputation to wait upon the Council and urge them to start municipal electricity works.

Swansea.—Though the order for wiring the Swansea Market was only given about a week ago to Mr. J. S. Brown, the Christmas market was lighted electrically yesterday (Thursday). Current is supplied by the United Brewery Company; 24 arcs of 2,000 c.p. each are employed.

Theatre Lighting.—The reconstructed Standard Theatre, Shoreditch, London, has been wired for the electric light. Current is to be taken from the mains of the Shoreditch Vestry.

The Strike.—Early on Friday last the representatives of both sides in the engineering dispute again assembled at the Westminster Palace Hotel and continued the discussion of the points of difference with a view to a satisfactory basis of arrangement being arrived at. This discussion proceeded throughout the day. The absence of any official report on the day's proceedings gave rise to anxiety in engineering circles, being taken to indicate that no satisfactory understanding was probable. This did not, however, prove to be the case, as on Saturday it was announced that an arrangement had been come to between the joint committee of the Employers' Federation and the Amalgamated Society of Engineers which only required ratification by a ballot of the men. Mutual concessions resulted in a provisional understanding being arrived at, which only left open for consideration the question of the 48-hours week. Upon this important point the employers' representatives remained firm, refusing to discuss the matter or to entertain a suggested compromise of a 51-hour week. It was therefore left for the men's representatives to place the final outcome of the labours of the conference before the men, and the result of the ballot is expected to be announced early next week. The proposals upon which the men are asked to express their views may be briefly given as under:—

1. The masters' original proposal was that every workman should undertake to work peaceably and harmoniously with his fellow workmen, whether he or they were trade union members or not. The latest modification of this proposal is that "he shall also be free to leave such employment, but no collective action shall be taken until the matter has been dealt with under the provisions for avoiding disputes. The Federation do not advise their members to object to union workmen, or to give preference to non-union workmen."

2. The proposal that the Federation shall not countenance piecework conditions which do not allow "an efficient workman" to earn at least the wage at which he is rated is modified to "a workman of average efficiency."

3. On the question of "Overtime," the proposal is now made that "It is mutually agreed that in cases of urgency and emergency restrictions shall not apply. It is understood that, if mutually satisfactory to the local association of employers and the workmen concerned, existing practices regarding overtime may be continued."

4. The rating of workmen according to ability was a point round which considerable discussion arose, as the original proposal of the employers was that every workman should be paid "according to his ability," and that no employer should be restricted in engaging any workman "at any rate of wages mutually satisfactory to them." This now reads, "Employers shall be free to employ workmen at rates of wages mutually satisfactory. They do not object to the unions or any other body of workmen in their collective capacity arranging amongst themselves rates of wages at which they will accept work, but while admitting this position they decline to enforce a rule of any society or an agreement between any society and its members. The unions will not interfere in any way with the wages of workmen outside their own unions. General alterations in the rates of wages in any district or districts will be negotiated between the employers' local association and the local representatives of the trade unions or other bodies of workmen concerned."

4. In order to avoid future disputes the proposals of the masters was that deputations of workmen should be received by employers or their represen-

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tatives. The words "or their representatives" are now struck out, and also the words "but only local associations of employers will negotiate with trade union officials," the understanding now submitted reading: "In case of disagreement the local associations of employers will negotiate with the local officials of the trade unions. In the event of any trade union desiring to raise any question with an employers' association, a meeting can be arranged by application to the secretary of the employers' local association to discuss the question."

The other suggestions provide that there shall be no limitation to the number of apprentices, and that employers shall have full discretion to appoint the men they consider best suited to work their machine-tools, and to determine the conditions under which such tools shall be worked. For this purpose they shall be at liberty to select, train and employ such men as they consider best adapted to the various operations carried on in their shops, and to pay them according to their estimate of the ability shown by the workmen.

On the invitation of the officials of the Amalgamated Society of Engineers a conference was held yesterday (Thursday) between these officials and the representatives of the trades' unions closely allied with the engineers, the object being "to arrive at a common understanding on the whole position in the light of the proposals and counter-proposals now before the members of the Amalgamated Society." One of the subjects discussed was that of a 51-hour week throughout the entire "federated trades." At the conclusion of the meeting (which was private) a communication was made that a mutual understanding had been arrived at on the various points presented for discussion, but "for tactical reasons it was decided not to publish the text of the resolutions passed," it being understood that another meeting is to be held. A telegram has been received by the officials of the Amalgamated Society from the Federated Employers complaining (or rather alleging) that the issue before the men is greatly complicated by a reference in the ballot paper to the question of a 51-hour week, to which the Employers make it perfectly clear they will, under no consideration whatever, agree even to discuss.

COMPANIES' MEETINGS AND REPORTS.

Sulphide Corporation (Ashcroft's Process), Limited.

The EARL of KINTORE presided on Tuesday, at the Cannon-street Hotel, at the first annual ordinary general meeting of this Corporation.

The MANAGER and SECRETARY (Mr. J. H. Smith) read the notice calling the meeting.

The CHAIRMAN, after commenting on various items in the profit and loss account, said: When the Directors met the shareholders in November, 1896, you were informed of the progress which had been made in the erection of the works at Cockle Creek, and that our advices from the local board in Australia were to the effect that they would be completed and in operation in January, 1897. Owing, however, to unavoidable delays, more time was occupied in the completion of the works than was anticipated, but on March 8th the works were sufficiently completed to admit of the commencement of operations, and on March 29th the first section of the electrolytic works was started and was maintained in constant running. We were advised from time to time that the practical working of the process was completely established, and that perfect zinc was being deposited. Owing to the magnitude and novel character of the electrolytic works it was found that the original estimates for their erection had been exceeded, and to provide for this expenditure, and for additional working capital, the Directors found it desirable in July last to raise additional capital to the extent of £100,000, by the issue of Five per Cent. First Debenture Stock. Difficulties, however, were afterwards experienced, due directly or indirectly to the corrosive nature of the working solutions, deficient oxydation and defective carbons, and the local board considered it desirable to temporarily shut down the works until these defects could be remedied, and certain alterations in the plant effected. It was hoped that these alterations would not cause more than a very short cessation of work, but owing again to unexpected delays and to the fact that the earthenware pipes, which had to be manufactured in the Colony, proving defective, the stoppage lasted for nearly four months, and it was not until Nov. 16 that the alterations were completed and the works restarted. In face of these delays, and the serious loss on past working, which reached them on Oct. 25, the Directors seriously contemplated whether they would not postpone the reopening of the electrolytic works until profits from the mine, about which they felt there was no doubt, had placed the Company on a dividend-paying basis. The local board, however, and their technical advisers, having regard to the large expenditure which had been incurred in the erection of the zinc works, strongly and unanimously recommended that they should be run for a further period of about 12 weeks, with a view to enable Mr. Ashcroft to demonstrate that zinc could be produced by his process at a profit, and the Directors assented accordingly. Up to the present time our advices are to the effect that in the roasting and leaching departments the costs have been brought within the estimates, and early in January we shall know the result attending the electrolytic working. The Directors do not doubt that the shareholders will approve of the policy adopted, and although they are disappointed that the whole of the works have not for some time past been running and yielding good profits, they trust that the difficulties and checks which have arisen may prove to be of a temporary character. The zinc produced at the works is of so excellent a quality that the consignment which was sent to Europe, when offered for sale, realised the highest price in the market. It has been arranged that the whole of the Company's concentrates produced at the Central Mine shall from Jan. 1st be smelted at the works. We are satisfied that, by the adoption of this course instead of shipping the concentrates to Europe, larger profits will be obtained. The shareholders are in possession of what is undoubtedly a very valuable property in the Central Broken Hill Mine. The Company is not, therefore, dependent upon extraneous sources of supply. As to the position generally I may say that our efforts will be directed to earning dividends for the shareholders from the products of the mine. About our power to do this at the present prices of metals we have no doubt whatever, and this I think will be felt by shareholders to be a very satisfactory feature of our position. Should the result of the present trial run of the electrolytic process prove to be unsatisfactory, and any suspension of those works rendered necessary, we shall still continue our efforts to obtain a satisfactory solution of the problem, but in such a way as not to encroach upon the profits derived from the mine. I now move—

"*That the report and accounts to June 30, 1897, be received and adopted.*"

The Hon. HENRY GIBBS seconded the motion.

Mr. F. A. KEATING (a member of the local board in Australia) expressed his doubt whether the result of the present trial running of the electrolytic plant would be to prove the process a commercial success. However that might be he had no misgiving as to its ultimate success. Meanwhile he saw no reason whatever why operations at the mine should not produce sufficient profit to enable the payment of dividends on both the Preference and the Ordinary shares.

The CHAIRMAN, replying to a question, said no more money would be required to make the Cockle Creek works available for smelting purposes.

The report was then adopted.

Amazon Telegraph Company (Limited).

The Report of the Directors of this Company for the year to 30th June last states that the revenue (including £5,142. 3s. 10d. brought forward), amounts to £25,302. 2s. 2d., and the working expenses to £20,164. 5s. 10d., leaving a balance of £5,137. 16s. 4d. to be carried forward. The revenue figures, owing to the interruptions referred to in the circular to the shareholders dated May 10, only represent the earnings of an incomplete system to the end of last November, when the through cable was finally re-established to Manáos, one of the most important of the Company's stations. At the meeting held on May 21 the creation of £125,000 Debentures (part of £200,000) was sanctioned by the shareholders to restore through communication. It was decided to issue these Debentures at £95 in bonds (to bearer) of £100 each, bearing 5 per cent. interest, and a prospectus, dated May 31 last, was issued, setting forth full particulars. These debentures were fully subscribed, the contract with Messrs. Siemens Bros. (Limited) was signed, and the manufacture of the cable at once commenced. The manufacture of the necessary 512 miles of cable, including 50 miles of stock cable, was completed on July 29, and the expedition, consisting of the s.s. "Faraday" and s.s. "Gamecock," left for Para on July 31, and reached there on Aug. 23. In the meantime every preparation had been made at Para for the reception of the expedition, and as soon as the ships were cleared the two vessels, accompanied by the Company's steamer "Viking," with a launch and lighter, started for up river. As explained in the circular, a most careful survey of the route was made, and this resulted in it being determined to lay a considerable portion of the cable out of the main stream through "furos" or side channels. Communication between Santarem and Manáos was restored on Nov. 18, thus completing direct communication between Para and Manáos. The repair of the branch sections interrupted is now proceeding. The other sections are working well. The retiring Directors are Messrs. John Coppen and D. H. Goodsall, who seek re-election, as do the Auditors, Messrs. Deloitte, Dever, Griffiths & Co.

NEW COMPANIES, STATUTORY RETURNS, &c.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY COMPANY (LIMITED).—This Company was registered on Dec. 9th, with a capital of £150,000 in £10 shares, to carry on the business of electrical engineers, electricians, engineers and contractors, suppliers of electricity, manufacturers of electrical apparatus, mechanical and chemical engineers, and the business of generating, producing and supplying light, heat and power by electricity or otherwise. The subscribers, with one share each, are: A. H. Sanderson, B. H. van Tromp, J. A. Hosker, F. W. Reynolds, R. Percy Sellon, F. E. Savory, and H. G. Jones.

CARBON (NEW) SYNDICATE (LIMITED).—This Company was registered on Dec. 15, with a capital of £30,000, in £1 shares, to enter into an agreement with the Carbon Syndicate (Limited) and Mr. G. Pepper (its liquidator), to manufacture, sell, and deal in carbon plates, slabs, rings, crucibles, rollers, bars and other articles for electrical and electrolytical purposes, and to carry on the business of electricians, suppliers of electricity, electrical and mechanical engineers, and manufacturers of electrical apparatus. The subscribers are: E. A. Green; T. E. Greenwood, electrician; H. P. Holdaway, H. Dobbin, E. L. Jackson, E. W. White and W. Andrew.

CHITTY DYNAMO AND MOTOR COMPANY (LIMITED).—This Company was registered on Dec. 15, with a capital of £200,000, in £5 shares (of which 24,000 are Preference), to acquire certain letters patent granted to Mr. Henry Chitty, and to carry on the business of mechanical and electrical engineers, boiler makers, iron and brass founders, metal workers, &c. The subscribers are: A. Dawson, Howard Lane, engineer; John Sturgeon, engineer; Henry Chitty, engineer; J. H. White, H. W. Evans, and David J. Edmonds. The first directors are: Howard Lane, Alfred Dawson, W. J. P. Moore, and Henry Chitty.

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CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26½d. per oz. (Dec. 23). Consols (2½ per cent.) 112½—112½ for money, 112$^{7}/_{8}$—112$^{9}/_{16}$ for account; 2½ per cent. 105¾—106¼ (Dec. 23). Stock Exchange Settling Days: Consols, Jan. 3; Stocks and Shares Continuation Days, Dec. 28 and Jan. 11; Ticket Days, Dec. 29 and Jan. 12; Pay Days, Dec. 30 and Jan. 13; Mining Share Carry-over Days, Jan. 10 and 24.

AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED).—The coupons on this Company's Four per Cent. Mortgage Debentures to bearer, due Jan. 1, will be paid on and after that day at Parr's Bank, Bartholomew-lane, London, E.C. Coupons must be left three clear days for examination. Warrants in payment of the interest on the registered Debentures will be sent out on the 31st inst. The Debenture register will be closed from the 28th inst. to the 31st inst. inclusive.

AMAZON TELEGRAPH COMPANY (LIMITED).—The half-yearly coupons due on the 31st inst., of the £125,000 Five per Cent. Debentures of this Company will be paid by Messrs. Barclay and Co., 54, Lombard-street, E.C.

ANGLO-PORTUGUESE TELEPHONE COMPANY (LIMITED).—Coupons No. 20 of the First Mortgage and No. 15 of the second Mortgage Debentures of this Company will be paid, less income tax, by Parr's Bank, Bartholomew-lane, E.C., on and after the 1st prox.

AUGUSTA RAILWAY AND ELECTRIC COMPANY.—The North American Trust Company, London, are prepared to pay on and after 1st prox., the coupons (due on that date) of the bonds of this Company at their London office, 95, Gresham-street, E.C.

BARCELONA TRAMWAYS COMPANY (LIMITED).—The fourth half-yearly dividend on the Five per Cent. Cumulative Preference shares of this Company, being in respect of the half-year ending 31st inst., will be paid on the 1st prox. at the National Bank (Limited).

BOURNEMOUTH AND POOLE ELECTRIC SUPPLY COMPANY (LIMITED).—Letters of allotment and regret in the recent issue of Preference and Ordinary shares by this Company have been posted.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The coupons on this Company's second issue of Five per Cent. Debentures, due 31st inst., will be paid on and after that date at Parr's Bank, Bartholomew-lane, London, E.C. Coupons must be left three clear days for examination.

BROCKIE-PELL ARC LAMP (LIMITED).—Lord Suffield (chairman) presided at the second ordinary meeting of the shareholders of this Company on Monday, and stated that the Directors had decided to have the accounts made up to the end of this year, and there were consequently no Directors' report and statement of accounts to present on this occasion. The accounts would most probably be issued towards the end of February, and the annual meeting would be held very shortly after. The engineering strike had much delayed their work, and they had had to procure what was wanted from foreign sources. Some difficulty had also arisen as to the lamps already manufactured when the undertaking was taken over by the Company, but after legal proceedings it had been settled that this Company had the right to them. They had now some large orders in hand; in fact, the business had nearly doubled since the start. If they were allowed a little time he saw no reason why they should not carry out the original intention of the Company. Mr. Brockie, their engineer, had invented a new lamp, the merits of which would be that it was cheaper and more durable than those now used. The Directors knew nothing of the Stock Exchange transactions in the Company's shares, and none of the Directors had bought or sold a share. The contracts for the sale of the French and Belgian patents had been signed and deposits paid. Mr. Pell, managing director, said there was no reason why the Company should not be a highly successful one. On the motion of the Chairman, the meeting stands adjourned to the first week in March.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The transfer books of the Four and a-Half per Cent. Second Debenture Stock of this Company are, in view of the interest payable on the 1st prox., closed until that date.

CENTRAL LONDON RAILWAY COMPANY.—The transfer books of this Company will be closed from the 24th to the 31st inst. inclusive, for the purpose of preparing the interest warrants for the half-year ending 31st inst.

COVENTRY ELECTRIC TRAMWAYS COMPANY.—An extraordinary general meeting of this Company will be held at 4, Bank-buildings, E.C., on Friday, the 7th prox., at 2 p.m., for the purpose of authorising the borrowing on mortgage of £24,000 at 4½ per cent.

CROMPTON AND CO. (LIMITED).—An extraordinary general meeting of the shareholders was held on Monday, under the presidency of Mr. John Trotter, for the purpose of confirming, as special resolutions the resolutions passed at the extraordinary general meeting of the Company on the 29th ult. These resolutions were for cancelling capital which had been lost or was unrepresented by available assets by reducing the nominal value of the shares, and for extinguishing the preferential rights of the preferred shareholders "either in respect of past or future dividends or capital over the holders of the Ordinary shares for the time being of the Company." No questions were asked, and the resolutions were put to the meeting and confirmed.

ELECTRICAL COPPER COMPANY (LIMITED).—The first annual report of the Directors of this Company to be submitted to the ordinary meeting to be held on the 29th inst. states that a portion of the Company's works at Widnes has been put into successful operation, and copper sheets are now being produced there of a highly satisfactory quality. Owing, however, to unavoidable delays in the delivery of the machinery the works were not ready for turning out manufactured copper until the end of October, and the Directors are consequently not in a position to present any report as to commercial results. The experimental laboratory in Paris having been found too small for extensive tests of the process, has been transferred to Brunoy (near Paris), where a factory now exists suitable for experimental tests and the production of certain classes of copper sheets for sale.

HELIOS ELEKTRICITATS-GESELLSCHAFT, COLOGNE.—This Company has declared a dividend of 12 per cent.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY (LIMITED).—An extraordinary meeting of this Company was held on Friday, under the presidency of Mr. H. R. Beeton, when a resolution was passed approving of an agreement with the holders of the Founders' shares for the surrender of the said shares. The Chairman said that, in recommending the resolution, the Directors believed they were acting in the general interests of the undertaking, as well as in the permanent interests of the shareholders. It had been found that Founders' shares, however useful at the inception of an undertaking, had proved to be inconvenient and injurious at the latter stage of its development. The right of Founders' shares for dividend only came after the rights of Ordinary shareholders had been to a large part satisfied, and they were therefore always most urgent as those of the Ordinary shareholders were becoming less urgent. In that way a conflict of interest, often resulting in a divergency of policy, resulted. What the Company got by this arrangement was to the founders £50,000 of capital, and the Company got further the difference between the market right and the full dividend rights, and what the shareholder got was, of course, the full dividend right of 7 per cent. in lieu of a half. They had satisfied themselves that the future of the Company was such as to make the arrangement highly profitable. If the Company should ever pay 10 per cent. upon £250,000 of capital, or a larger dividend upon a proportionately smaller capital, the shareholders would be gaining by the arrangement. The directors were further authorised to take the necessary steps to carry the scheme into effect, and to offer to the holders of the Founders' shares the Ordinary and Preference shares to which they would respectively become entitled under the agreement, holders of the Founders' shares being fully in accord with the directors' proposals. The Debenture stock registers of this Company are closed from the 22nd to the 31st inst., inclusive, for the preparation of interest warrants for the half-year ending 31st inst. and payable on the 1st prox.

LONDON ELECTRIC OMNIBUS COMPANY (LIMITED).—The transfer books of this Company are closed from the 22nd inst. to the 4th prox. inclusive.

SMITHFIELD MARKETS ELECTRIC SUPPLY COMPANY (LIMITED).—Letters of allotment and regret in the recent issue of this Company's capital have been posted.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Dec. 17 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,949.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half month ended Dec. 15 is £2,240, against £2,504 in the corresponding period of 1896.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Dec. 18	3,578	+601	...	...	...
Bristol Trams & Carriage	,, 17	2,363	+504	24	62,791	+9,586
City & South London Ry.	,, 19	1,060	- 2	25	24,060	- 43
Dover Tramways	,, 18	109	...	15	1,692	...
Dublin United (Southern)	,, 17	366	- 48	24	15,035	- 818
Liverpool Overhead Rly.	,, 19	1,342	+226	25	35,220	+4,796
Sheffield Tramways	,, 19	996	+178	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Dec. 15.		Price Wednesday, Dec. 22.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 18.	
			ELECTRIC RAILWAYS AND TRAMWAYS.					£ s. d.		Highest	Lowest
£19,120	£10	3/0	Central London Ordinary	9¼	10	9⅞	10¼	2 13 6	June and December	9⅞	..
145,166	10	1/6	Do. (66 paid)	5½	6	5⅝	6	3 0 0	,, ,,	5⅞	5¼
£500,000	Stock	2½	City and South London Railway Con. Ordy.	66	68	66	68	2 15 2	January and July	67½	66⅝
3,419	£10	5½	Do. 5% Perpetual Preference	15½	16	15	16	3 2 6	,, ,,	..	..
£120,781	Stock	4½	Do. 4% Perpetual Debenture	138	140	138	140	2 17 2	May and November	..	..
54,000	10	2/6⅞	Waterloo and City Ordinary	12½	13	12½	13	2 6 1	June and December	12⅞	12⅝
27,000	10	3½	Liverpool Overhead Railway Ordinary	11$^{7}/_{8}$	11$^{15}/_{16}$	11$^{7}/_{8}$	11$^{15}/_{16}$	2 11 11	February & August	..	..
10,000	10	5½	Do. 5% Preference	16	16½	16	16½	3 0 7	,, ,,	..	..
125,000	Stock	4½	Do. 4% Debenture	110	113	110	113	3 11 5	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price Dec. 15.		Price Wednesday, Dec. 22.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 18.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£2923,960	Stock	14/0	Anglo-American	58	60	59	61	4 11 3	Feb., May, Aug., Nov.	60	59
£3,038,020	Stock	23/0	Do. Preferred	105	106	106	107	5 7 6	" "	106⅝	106¼
£3,038,020	Stock	5/0	Do. Deferred	12	12½	12⅝	13½	..	—	13	12⅝
£137,400	£100	4%	*African Direct Telegraph (Red)	101	105	101	105	3 16 11	January and July	—	..
£25,000	10	..	Amazon Telegraph	5½	6½	5½	6½	..	—	..	..
130,000	10	3/0	Brazilian Submarine xd	16	16½	16	16½	4 4 10	Mar., June, Oct., Dec.	16½	..
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	114	118	114	118	4 5 10	June and December	—	—
10,000,000	$100	7%	Commercial Cable Capital Stock	183	188	183	183	4 5 1	Jan., Apr., July, Oct.	—	—
£853,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105	107	105	107	3 14 9	" "	106¼	106¼
16,000	10	8/0	Cuba Submarine	8½	9½	8½	9½	8 8 5	February and August	9½	—
6,000	10	10%	Do. Preference 10 per Cent.	18½	19½	18½	19½	5 2 7	" "	..	—
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	—	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	—	—
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	103⅞	4 4 11	January and July	—	—
60,710	£20	3/0	Direct United States Cable, 1877	10	10½	10½	10½	4 17 8	Jan., Apr., July, Oct.	10 1/16	..
400,000	£10	2/6	Eastern	17	17½	17	17½	3 14 4	" "	17½	17 1/16
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18	19	18	19	3 3 8	" "	18½	..
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	130	133	130	133	3 0 6	May and November	130⅜	..
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 14 9	February & August	—	..
250,000	10	2/6	Eastern Extension	18½	18¾	18½	18¾	3 17 9	Jan., Apr., July, Oct.	18¾	18 1/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	133	135	132	135	2 19 3	February & August	133½	—
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	100	104	101	105	4 17 3	January and July	—	—
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	100	104	101	105	4 17 3	" "	—	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103	106	103	103	3 15 8	February & August	105½	104½
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞	111⅞	108⅞	111⅞	3 12 1	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	11½	12	11½	12	3 15 0	Jan., Apr., July, Oct.	..	..
180,042	10	6%	Do. 6 per Cent. Preference	17⅜	18	17⅜	18	3 6 8	" "	17 1/16	17½
150,000	10	5/0	Great Northern of Copenhagen	25½	26½	25½	26½	3 15 6	January, April, July	26	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	102	105	102	105	4 15 3	March & September	..	—
17,000	25	12/3	Indo-European	52	55	52	55	4 10 11	May and November	53⅜	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	107	110	107	110	5 9 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	107	110	107	110	3 13 5	June and December	..	—
11,839	8	4/0	Reuter's	7½	8½	7½	8½	4 14 1	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	136	141	136	141	4 5 1	" "	138	—
15,609	10	6/0	West African Telegraph	4½	5½	4½	5½	5 0 0	..	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 14 4	March & September	—	—
30,000	10	..	West Coast of America	¾	1½	¾	1½	..	..	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	107	110	107	109	3 14 9	June and December	108	..
88,321	10	1/0	West India and Panama	½	¾	½	¾	..	May and November	—	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7¼	8¼	7¼	8¼	7 5 5	" "	7 13/16	7¾
4,689	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	—	—
£30,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 12 2	January and July	109½	..
64,256	15	3/0	Western and Brazilian	9½	10½	9⅝	10½	2 18 5	May and November	10 1/16	9½
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	7¾	7½	7⅞	3 17 8	" "	7 1/16	..
33,129	7½	1/6	Do. Deferred Ordinary	2⅝	3¼	2⅝	3¼	..	" "	3 1/16	2 13/16
£382,230	—	4%	Do. 4 per Cent. Debenture Stock	106	109	106	109	3 14 1	June and December	..	—
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	103	107	105	110	6 7 10	Feb., May, Aug., Nov.	—	—
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chill Telephone (fully paid)	3	3½	3	3½	5 14 4	August	—	—
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	1/16	1/16	1/16	..	July	—	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	..	—
484,597	5	3/0	National	6⅜	6⅝	6½	6¾	4 8 11	February & August	6⅜	6 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 10 7	" "	—	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14	16	14	16	3 15 0	" "	—	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6	6½	6	6½	3 16 11	" "	6 1/16	6 1/16
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104	109	104	109	3 5 0	June and December	106½	105½
171,504	1	0/4	Oriental	1/16	1/16	1/16	1/16	4 2 4	April and October	—	—
58,000	5	5/0	United River Plate	3½	4½	3½	4¼	5 17 8	July	—	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	107	102	107	4 14 4	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	10½	11	10⅝	..	..	March	..	—
£50,000	5	..	Do. (New Issue) £3, 10s. paid	..	..	..	..	—	..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	26½	27½	26	27	2 11 10	February & August	27	26 1/16
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17	18	17	18	3 6 8	January and July	17½	..
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131	134	131	136	3 14 3	June and December	133½	—
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12½	13½	12½	13½	2 8 2	February & August	13½	—
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 6 8	" "	6½	6⅝
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	—	—	January and July	—	—
£26,000	5	2,6	Chelsea Electricity Supply Ordinary	10½	11	10½	11	3 8 2	March	..	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	116	113	116	3 14 7	June and December	115½	114
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	14⅜	15½	13½	14	..	..	15 1/16	13¾
20,000	£10	6/0	Do. 6% Cumulative Preference	15½	16	15½	16	3 15 0	March & September	15 5/8	15⅞
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9½	9¾	9	10	..	..	9⅝	9½
10,000	£5	7%	Do. 7 per Cent. Preference	11	11½	11	11½	3 0 11	March & September	—	..
111,000	£5	..	London Electric Supply Ordinary	2⅜	2¼	2⅜	2⅜	..	..	—	—
48,050	£5	..	Do. Preference	6	6½	6	6½	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	19	20	18½	19½	2 16 5	April and October	19½	18⅝
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	18½	19½	18½	19½	..	" "	18 13/16	—
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119	123	119	123	3 13 6	June and December	..	—
6,452	10	8/0	Notting Hill Electric Ordinary	17½	18½	17⅛	13½	2 3 3	March	18½	18½
275,000	1	—	Rand Electric	1 1/16	1⅛	1 1/16	1 1/16	..	—	—	—
£125,000	Stock	..	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	93	98	93	93	..	..	..	..
150,000	$100	2s	Royal Electric Company of Montreal Shares xd	148	150	145	147	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	105	107	4 4 1	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	17	18	17	18	3 3 11	February & August	17½	..
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	..	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	103	106	103	106	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	16	17	16	17	2 19 0	March & September	16 1/16	16½
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	1/6	Brush Electrical Engineering	1⅞	2	1¾	2⅛	—	—	2	1 13/16
90,000	3	2/0	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	..	—	2 1/16	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	103	112	108	112	4 1 1	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	103	105	103	105	4 7 7	June and December	..	—
10,000	£10	..	British Aluminium Ordinary	—	—	..	..	—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference	—	—	..	..	—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7	8	7	8	6 5 0	June and December	7 1/16	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	108	113	103	113	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½	1⅝	1½	1⅝	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½	—	—	—	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	89	94	89	94	5 6 5	January and July	—	—
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½	3½	2½	3	5 10 0	February & August	3 1/16	2⅞
17,139	5	2/9½	Do. (£5 paid)	4½	5½	4½	5½	5 0 0	" "	5 1/16	..
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101	103	101	103	3 17 8	June and December	..	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2½	2½	2½	2½	4 0 0	February & August	2	2½
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3⅝	3½	3⅝	4 3 4	August	3½	3⅝
91,196	1	10/0	Elmore's Patent Copper Depositing	½	⅝	½	⅝	..	..	..	—
10,000	10	6/0	Henley's Telegraph Works Ordinary	20	21	20	21	4 15 3	February & August	20⅝	20½
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 12 0	" "	..	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 10	" "	..	—
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	23	24	23	24	4 3 4	" "	23½	23⅜
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	103	107	3 14 9	March & September	..	..
$7,350	12	4/0	Telegraph Construction and Maintenance	36	39	36	39	4 12 4	March and July	38½	37
£50,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July	—	—
£22,500	£5	3/6	Willans and Robinson Ordinary	8	8½	7⅞	8½	4 4 10	April and October	—	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	7	7½	6⅞	7¼	4 2 9	" "	—	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	104	106	105	107	3 19 6	May and November	106	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

AT the meeting yesterday of shareholders of the London Electric Omnibus Company, Major FLOOD PAGE, who presided, announced that the Company had entered into a working arrangement with the Electric Street Car Manufacturing Syndicate recently registered, and would by this arrangement be able to make greater progress than hitherto in placing electric omnibuses on the streets. He also announced that one of the Company's 'buses, carrying 10 passengers, had the day previously been licenced by the police authorities, and that a 26-passenger omnibus would shortly be ready for inspection by the authorities with a view to licence. Further, that a second 26-passenger omnibus was shortly to be ready. It will be seen from the report, which appears in another column, that Mr. THOMAS PARKER and Major FLOOD PAGE are directors of the new manufacturing syndicate. We cannot forbear sympathising with the shareholder who expressed the view that the Company had evidently "started before it was ready." This seems to have been the case with all the "horseless" vehicle companies.

THE management of boilers and steam plant is so important a department of electric power station working that Mr. A. B. MOUNTAIN's recent Paper on the subject, which we commence to reprint this week, will strongly appeal to a large circle of electrical engineers. Mr. MOUNTAIN has adopted a thoroughly practical tone for his Paper, and his recommendations are laudably free of merely academic considerations; he is clearly in touch with the real difficulties to be faced and has had practical experience in surmounting them. If, therefore, any of his *confrères* should be found to traverse any of his conclusions, or to question the recommendations he makes, this will aris from the fact that the great diversity in the conditions of supply station working, and the variety in the experience of different engineers must tend to produce a considerable diversity of opinions in regard to details of practice.

MR. MOUNTAIN lays his finger on a matter that has not always had the prominence it merits when he shows that the choice of a type of boiler should depend on the quality of the feed water available. Really practical men know this from past experience; but, unfortunately, there is a great bulk of second-rate men, who, taking their views ready-made from the loudest shouter in their neighbourhood, group themselves into cliques pledged to support through thick and thin, and in all circumstances, one or other particular type of plant. The Paper has a word of commendation for economisers, but Mr. MOUNTAIN fears they may prejudicially affect the chimney draught. Where the temperature of the gases is lowered to 250°F., the draught, by comparison with that at 600°F., is undoubtedly lower; but in selecting these temperatures Mr. MOUNTAIN has taken extreme cases. Very rarely would a boiler plant without an economiser be designed to reject the furnace gases so hot, while quite commonly the economiser rejects them at above 250°F. It should be remembered that the draught diminishes in a much lower ratio than the fall in chimney temperature. Beyond this, we may add that it is practically proved to be better to adopt mechanical draught, either forced or induced, rather than to secure a better chimney draught by rejecting the gases at an unusually high temperature.

ON some few points we are not quite in agreement with Mr. MOUNTAIN. His preference for sprinkling rather than coking stokers in a Lancashire boiler plant is at variance with our experience. The class of fuel best adapted to the Lancashire boiler is that giving a moderately long flame, and fairly bituminous in quality; and it is well known that, with hand firing, this fuel burns more economically and with least smoke if fired from the dead-plate or by alternate side-firing rather than by spreading. In our opinion, the coking stoker better

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imitates these conditions than does the sprinkling type, and it certainly gives rise to less smoke, even with highly bituminous coal. For the types of boilers that are best fired with dry fuel, such as coke or anthracite, on the other hand, the sprinkling stoker is the more serviceable. In regard to the action of water or steam on a furnace fire, although we do not agree that it "adds considerably to the heat," if by this is meant the heat generated in the furnace, we are quite sure that with dry fuels burned in certain types of boilers moisture and steam play an important part in deferring the combustion, producing flame, and thereby improving the action of the heating surfaces. Thus, although no more heat is actually generated, the process adds considerably to the heat usefully absorbed.

Prof. Oliver Lodge can scarcely be accused of too precipitately plunging *in medias res* in commencing his series of Christmas lectures, "adapted to a juvenile auditory," at the Royal Institution. His first lecture in the course, on "The Principles of the Electric Telegraph," began with the time-honoured elementary experiments with electrified glass rods and attracted bits of paper, jumping pith balls and suspended light bodies; and not until all the fundamental principles of electrical action had been thoroughly explained did the lecturer allow his audience any insight into the relation of these principles to the various means of electrical telegraphy. Whether the auditory was or was not sufficiently juvenile to render this elementary drilling in first principles absolutely necessary—and it must be presumed that the youths of the present generation are not usually unfamiliar with the experimental side of elementary electrical science—to see Prof. Lodge's masterly hand arranging the experiments in their logical order, and to hear him expound them in his inimitable and suggestive way, delighted many of the elder as well as the younger among his audience.

In the second lecture, yesterday afternoon, the practical applications of the phenomena exhibited in the first discourse loomed more distinctly into view. Discussing first the various aspects of the electric current, the lecturer showed that every kind of electric current, whether due to conduction, convection, or the displacement of large charged bodies, gives rise to a magnetic field. From this stage to electromagnetic action on a compass needle and its application to signalling was a direct and easy transition; and Morse-recording instruments and other telegraphic apparatus speedily came on for explanation. In the next three lectures telegraphy on land and under sea will be described, in so far as it has become a commercial achievement; while in the concluding lecture the possibilities of wireless telegraphy will impart to the series of lectures probably its most attractive feature.

Our readers will find in another column a short communication made by M. E. Branly to the Académie des Sciences on the subject of coherers, or, as M. Branly prefers to call them, "radioconductors," he maintaining that the phenomenon in question is not merely due to cohesion, but is also observable in solid substances prepared in a special manner. The author contends that the Marconi form of coherer is unnecessarily complicated in construction, and that a simpler form would answer the purpose equally well. Unfortunately, although the French physicist refers to numerous experiments, he purposely refrains from going into detail, so that we are still left in the dark as to the relative efficacy of the various mixtures of filings and of filings and insulators, and as to the best degree of coarseness to use in different cases. This lack of detail is especially to be regretted in the case of the last two sentences in the Paper. If mixtures can be obtained which will decohere, or—to give way to M. Branly, and use a more cumbrous phrase—which will return to the non-conducting state, without any tapping being necessary, it is a great step forward; it would probably, in most of the cases to which wave telegraphy will be first applied in practice, be preferable even to sacrifice sensibility to some extent so as to do away with the electromagnetic tapper. But what are these mixtures?

Another point on which M. Branly appears to attach considerable importance is conveyed in the sentence, "I do not insist on the sensitisation by the first effect"—a literal translation from the original French. By this M. Branly appears to mean that the filings do not always assume conductivity on the first discharge taking place. We think that this only results from the special conditions of the actual experiment. It has frequently been observed that coherers become more sensitive after some hours' use, and even that one which will not respond when first set up will do so regularly after being subjected to the influence of Hertz waves for a considerable time. This merely points to the fact that perfection or perfect reproduction has not yet been attained in coherer manufacture, which is certainly not surprising.

A letter to *The Times* by Mr. C. G. Mott, the chairman of the City and South London Railway Company, calls attention to the desirability of co-ordinate action in the construction of underground railways in London. Railways are not merely a convenience to the generation that builds them, they are a legacy to posterity; and it would be well if future generations should bless us for exhibiting more sense and system in laying out our metropolitan railways than our forefathers displayed in planning streets. Mr. Mott would have the matter placed under official regulation:—

> In order to accomplish this result it is necessary that a controlling influence should be exerted to determine the best lines of route for these railways, and the points at which the exchange of traffic should take place, as, if this is not done, enormous future public inconvenience will be the result.

Intimately connected with this matter is the route to be taken by each of the various lines forming the network of underground railways. To follow the line of streets is the simplest and cheapest plan, but, owing to the shortsightedness of our ancestors in not laying out our streets in regular blocks, the result is not the most satisfactory in the end. It would be an immense advantage if facilities were to be granted for the construction of deep-level railways beneath private buildings:—

> This was recognised by a joint committee of both Houses of Parliament, to which the question was referred several years ago, and upon their recommenadtion powers have since been granted authorising the railways

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in these cases to take an easement only, instead of being compelled to purchase the property on the surface. Considering the great depth at which these railways are constructed (generally from 70ft. to 90ft. below the surface of the ground), the value of this easement is exceedingly small, but the number of separate properties under which the line in such a case would pass is so great that the legal expenses involved in settling the amount to be paid, and obtaining a separate conveyance in each case, are such that at present the passing under private properties for any distance is not practicable

THE remedy proposed by Mr. MOTT is that Parliament should fix an uniform scale of payment for sub-soil at those depths, his contention being that all over the metropolis the value of property at that great depth is uniform. We are not concerned to argue this point, which lies somewhat outside our usual sphere; but the desirability is manifest for an improvement of one sort or another in the facilities for constructing an organised and well-planned network of electric railways in London, which, in many parts of the metropolis, could not be effected without considerable tunnelling under private property.

The Institution of Electrical Engineers.—We invite the attention of our readers to a letter in our correspondence column dealing with a matter of immediate interest to members of the Institution of Electrical Engineers.

Personal.—The Electricity Committee of the Glasgow City Council have decided to recommend Mr. W. A. Chamen, outdoor superintendent to Messrs. Crompton and Co., for election to the post of City electrical engineer, at a salary of £800 per annum.

Cable Interruptions.—

	Date of Interruption.
Otranto—Vallona	Oct. 11, 1897
San Thomé—Loanda	Dec. 13, 1897
Ceara—Maranham	Dec. 23, 1897
Teneriffe—St. Louis (Senegal)	Dec. 24, 1897
Emden—Vigo	Dec. 24, 1897

Obituary.—The death is announced of Signor Brioschi, President of the Accademia dei Lincei and member of the Italian Senate.——On the 20th inst. the death occurred, at Dundee, of Mr. Walter Hughes Brownlee, who preceded Mr. Tittensor in the post of electrical engineer at the Dundee Corporation electric light station. Mr. Brownlee was a son of ex-Provost Brownlee, of Dundee.

King's College (London).—The Lent term of the Engineering, Architecture and Applied Science division of the Faculty of Science at this college commences on Thursday, January 13th. Particulars of the courses and a list of the professors will be found in an advertisement elsewhere, and prospectuses and all further information can be had on application to the Secretary, King's College, Strand, London, W.C.

The American Bell Telephone Company.—Since 1880 the American Bell Telephone Company has, according to figures published in *Electrical Engineering* of Chicago, spent no less than £469,685 in litigation; and, what is more significant, the *minimum* sum spent during any year of that period was £8,964—spent in 1880—the maximum being £44,451 in 1888. This appears a very large expenditure for the sake of upholding an incomplete monopoly.

Electric Train-lighting in France.—The Northern Railway Company of France has decided to light all their carriages electrically. A note in the *l'Electricien* states that secondary batteries will be used, these being carried in trays beneath the carriage body. The cells will be charged at the terminus, the time taken for a complete charge or discharge being five hours. The first-class carriages will be lit by 10 c.p. lamps, second-class carriages will have 8-c.p. lamps, and third-class 6-c.p.

A Heavy Electric Train.—A train composed of 11 American passenger cars, with a load of 1,375 passengers, was recently hauled by a single 200 H.P. Westinghouse electric locomotive over the Akron, Bedford and Cleveland Electric Railway, a line about 25 miles in length. This railway is equipped on the overhead trolley system, and is usually worked by single cars of the Pullman type. There are some sharp curves and near Akron some very nasty gradients, on this line, which make the experimental trip an altogether remarkable one.

The Massena Power Plant.—We learn from the *Scientific American* that a syndicate has already contracted for 35,000 H.P. to be supplied by the Massena, N.Y., water-power utilisation scheme, for the purpose of manufacturing acetylene, the process at this locality being favoured by the limestone formation that underlies the Massena district. By the electrical process this rock is converted into calcium carbide. Numerous other chemicals are also to be produced there. The Power Company assert that they have already contracted for all the power they can supply for some years to come.

Proposed Police Telephone Service for New York.—Capt. McCullagh, Chief of the New York Police, according to the *Electrical Engineer* of New York, has submitted to the Police Commissioners a complete system of police inter-communication by means of telephonic posts connected to the police stations. He proposes to erect, in every fifth street running from east to west, at every street corner where an avenue crosses, an ornamental iron booth containing a telephone in connection with the police station. The policeman patrolling the streets from east to west would in that manner always be within three blocks of a telephone post, and thus be able to communicate easily with the station either to transmit reports or to receive instructions.

Street Lighting by Enclosed Arcs.—The *Electrical World* of New York has some editorial notes on the application of enclosed arcs to street lighting, and remarks that this form of lamp supplied from a constant potential direct-current circuit possesses great advantages over the usual form of open arc lamp run on a series circuit, especially where a three-wire or other system of direct-current constant potential supply is already in use. The abolition of the high-pressure arc conductors also serves to reduce the troubles of defective insulation. Trimming lamps burning so long as 100 to 150 hours requires a smaller staff of trimmers. The light is more steady and is less affected by wind, while the objectionable collection of scorched insects inside the globes is rendered impossible. It is pointed out that "the substitution of constant potential generators for the series arc machines means the simplification of the station and the switchboard"—an enormous gain in flexibility.

Australasian Association for the Advancement of Science.—The Sydney meeting of this Association is being held from January 6th to January 14th. A number of interesting Papers are down for reading, including: "The Investigations of the Thermodynamics of a Voltaic Cell," by E. F. G. Love; "On the Contact Force between Different Varieties of Sulphur, and on the Question of the Effect of Light on the Electrical Resistance of Sulphur," by Prof. R Threlfall; "On the Magnetic Hysteresis Losses in Feebly Magnetic and in Diamagnetic Substances," by Prof. R. Threlfall and Miss F. Martin; "The Molecular Mechanism of an Electrolyte," by W. M. Hamlet; "On Narrow-Gauge Tramways," by F. Back. There are also to be evening lectures, and, following the example of the British Association, a lecture to working men. The latter will be delivered by Prof. R. Threlfall, who has chosen "Electric Signalling Without Wires" as his subject. Prof. A. Liversidge is president for the year, and the sectional presidents include: Section A. (Astronomy, Mathematics, and Physics), Mr. P. Baracchi; Section B. (Chemistry), Mr. T. C. Cloud; and Section H. (Engineering and Architecture), Mr. A. B. Moncrieff.

Factory Lighting and Power Plant at Brooklyn.—The *Electrical Engineer* of New York for November 18th has a detailed description of the electrical plant which has recently been installed to operate and light the Mergenthaler Linotype Company's factory, in Brooklyn, N.Y. Originally this factory was driven by belt gearing, and although this system of distribution appears from the description to have been well up to usual practice, it was entirely replaced, even to the boilers, by a combined electric lighting and power plant. The new plant consists of two "Sterling" boilers, one of 100 H.P. and one of 200 H.P., with feed-water heater

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and separator; these supply steam at 140lb. pressure to two "Ideal" horizontal tandem compound non-condensing engines running at 250 revolutions per minute, and capable of developing 150 H.P. each. Direct coupled to these engines are two Walker generators, each of 100 kilowatt capacity at 115 volts pressure. These generators supply current to 1,600 16-c.p. lamps, and also for seven 5 H.P. and eight 10 H.P. motors. The latter are fixed to the ceilings and connected direct to their respective shafts by flexible couplings. It appears there are enough data available to show an actual saving over the cost of running the old plant, notwithstanding the fact that the new plant furnishes light as well as power to the extent of 1,600 lamps.

The Transformation of X-Rays by Metals.—An article by M. G. Sagnac, with the above title, appears in the *Comptes Rendus* of Dec. 6. When Röntgen rays strike a metal plate, even when this is formed by a mercury bath and the angle of incidence is 75deg., they are diffused without experiencing any appreciable regular reflection. M. Sagnac has been investigating the characteristics of these secondary rays, and has arrived at the following conclusions:—The secondary rays are propagated in a straight line, and do not experience any sensible diffraction or refraction. They are not reflected either, and if they themselves impinge on another mirror they are diffused in the same way as X-rays; in discharging electrified bodies they also act similarly to X-rays. The secondary rays from different metals can be distinguished by their different transmission through the same substance. Thus, for instance, the rays from copper are transmitted by black paper to a greater extent than the rays from zinc and tin. Rays from lead are absorbed more by the atmosphere than rays from zinc and copper. It is also noteworthy that various bodies are more opaque to the secondary rays than to the incident rays which generate them. Thus if a sheet of aluminium 0·2mm. thick be placed between the Crookes' tube and the radiating metal sheet, the photographic or discharging action of the secondary rays is reduced but slightly—say, by one-third. If, on the other hand, the aluminium sheet be placed between the secondary rays and the photographic plate or electroscope, their action is considerably diminished. Finally, M. Sagnac is of opinion that the secondary rays, which metals emit under the influence of X-rays, are new rays neighbouring on X-rays, and that they must doubtless be placed in a similar position to the rays issuing from a Crookes tube as that taken by the radiation of a luminescent body with regard to the rays of shorter wavelength which have produced it.

Electric Supply in Paris.—In 1888 various electric supply companies obtained concessions for laying mains in Paris, and in spite of numerous difficulties they are at present in a fairly flourishing condition. The concession was, however, only for 18 years, and the companies have now come to the conclusion that it will not pay them to further add to their networks unless this time limit is extended. M. Charles Bos, who was instructed by the Municipal Council to inquire into the matter, prepared a voluminous report on the question, finally recommending that an extension of the concessions until the year 1931 be granted under certain conditions. These conditions may be summarised as follows: The charges for electrical energy for lighting shall be reduced to a tariff corresponding to less than the price of ordinary gas lighting, and corresponding more nearly to that of gas lighting with incandescent burners, and the charge for electrical energy for power distribution shall be diminished in the same proportion. (It must be remembered that the price of gas is exceptionally high in Paris. M. Bos estimates that, assuming the use of lamps at 3 watts per candle-power, it corresponds to 1fr. (9·6d.) per kilowatt-hour.) At the requisition of the municipal authorities the companies shall erect kiosks or distributing stations at every cab-rank, for the purpose of charging electric motor-cars. The cost of transforming currents and the cost of service lines is in all cases to be borne by the companies, and not by the consumers. The lighting of municipal buildings is to be done at half the cost of private lighting. The Council are generally in favour of M. Bos' recommendations, and have entered into negotiations with the companies with a view to granting the requested prolongation of the concession on the companies undertaking to extend their networks of mains and reduce their tariff. The following particulars, contained in M. Bos' report, are also of interest: There is in all a lamp connection of 700,000 in Paris, of which more than one-third are fed by private plants. The remaining two-thirds are connected to the mains of six companies and one municipal station. The average price per kilowatt-hour charged by the companies varies from 9·3d. charged on the left bank of the Seine to 10·3d. charged by the Edison Company. Compared with the tariffs in the departments, however, this is not so extremely high, the rates per kilowatt hour at Grenoble and Marseilles being 14·4d. per kilowatt hour; in the latter town, however, only 4·8d. per kilowatt hour is paid for electrical energy supplied for "public services." The town in which the lowest charge is made is Havre, where the rate is 7·7d. per kilowatt hour. M. Bos also points to the fact that electricity is used very little for heating purposes in Paris, although 8-ampere gridirons, 2 to 4-ampere broilers, 5-ampere kettles, laundry-irons, foot-warmers, and radiators can be obtained and have been used experimentally in the Clichy district.

A New Transmission Dynamometer.—At an ordinary meeting of the Institution of Civil Engineers, on the 21st inst., a Paper was read on "A New Transmission Dynamometer," by Mr. W. E. Dalby, M.A., B.Sc. In transmission dynamometers in which the deformation of a spring was used to measure the work being transmitted, the mechanism might be divided into two parts: (1) The measuring-springs, and the apparatus fixing them to the several parts of the dynamometer; and (2) the apparatus used to measure the deformation of the spring. The paper treated of a new device for measuring the deformation of the spring. The deformation of the spring was in general communicated to two pieces of the dynamometer causing relative angular displacement between them. Thus, if one end of the spring was fixed to a pulley and the other end to the shaft on which the pulley was mounted, the relative angular displacement would be between the pulley and the shaft. To measure this whilst the pulley and shaft were rotating, a sprocket-wheel was fixed to the pulley and another of equal diameter to the shaft. Over these an endless band was placed, arranged to form two loops, the parts of the band forming one loop leading the one to the sprocket-wheel and the other to the opposite side of the other sprocket-wheel. In these loops were placed guide-pulleys, mounted in frames, constrained by a slide to move in the direction of the band. A relative angular displacement of the sprocket-wheels was necessarily accompanied by a relative linear displacement of the guide-pulleys in the loops proportional to the torque acting between the shaft and pulley, and by suitably calibrating a scale to measure their distance apart this torque, or change in torque, might be read off directly. To obtain a good fit, and yet at the same time avoid any sticking of the slide, the frame carrying the guide-pulleys had only six properly arranged points of contact with a group of three bars forming the slide, and to control the motion of the pulleys in any position and constrain them to follow the motion of the loops, a spring was arranged to act on a cord connecting the two frames in such a way that the guide-pulleys were always compelled to sit in their respective loops, the tension on the spring causing them to do so, being constant. Two dynamometers had been made on these principles for the engineering laboratory at Cambridge. One was arranged on a main driving-shaft, the dynamometer being formed by connecting a pulley driving a dynamo to the shaft by means of a spring, a sprocket wheel was fixed to the shaft, and another of equal diameter was fixed to the pulley-boss. An endless steel band passed over the sprocket wheels so as to form the loops described was used to operate two guide-pulleys mounted in frames, free to slide in the direction of motion of the band. This, the apparatus for measuring the torque, was placed several feet below the shaft in a convenient place for observation. A second dynamometer was made on the same principle, but arranged to be self-contained. Any machine could be driven through it, and the power given to the machine be directly observed.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Electric Balloon Observations.—Since it has become known that the equipotential surfaces above the negatively-charged earth follow the contours of the landscape, except in so far as they are crowded more closely together over the tops of the mountains, the old attempts to determine the potential in the higher regions of the atmosphere by mountain observations have been recognised as futile, and recourse has been had to kite and balloon observations. The last are the most satisfactory, since they enable the observer to determine the difference of potential of any two points in a vertical line. But these observations are subject to an error due to the charge of the balloon itself. At the start the balloon has the potential of the earth's surface. Losses of gas and ballast may dissipate the original charge, and sunlight and friction may affect it in various ways. R. Börnstein points out an easy method of eliminating this error, which only requires an additional collector and electrometer. Take three points, A, B, C, in a vertical line, say 2 *m* apart. If the difference of potential δV between A and B is the same as between B and C, the charge of the balloon is zero. In any other case this charge M may be calculated from the equation

$$-\frac{d^2V}{dr^2} = \frac{2M}{r^3}.$$

[Börnstein, *Wied. Ann.*, No. 12, 1897.]

Luminescence.—K. Wesendonck endeavours to explain that certain curious temperature phenomena connected with luminescence, and first described by E. Wiedemann, do not contradict the second law of thermodynamics, according to which heat cannot pass from a colder to a hotter body without the intervention of machinery. As a matter of fact Wiedemann observed that a luminescent body at 0deg., surrounded by a platinum shade at 1deg., raised the temperature of the latter still further. Similarly, a flame at 500deg., rendered non-luminous by means of carbonic acid, would raise the temperature of a surrounding platinum cylinder, which already had a temperature of 700deg. Wesendonck points out that this is not a direct transfer of heat—*i.e.*, irregular molecular motion. It is more like the process whereby a body in vibration may raise the temperature of a connected body by friction, although that body may already have a higher temperature. It all depends upon the "exchange value" between luminescence and light on the one hand and light and heat on the other. This practically amounts to saying that luminescence is a thing which must not be regarded as of the same nature as heat, but that, like sound, it may give rise to heat. It is, in fact, a borderland phenomenon, like cathode rays, and its laws are only half investigated.

[Wesendonck, *Wied. Ann.*, No. 12, 1897.]

Absorption of Electric Waves.—An important test, and, as it turns out, a verification of Maxwell's fundamental equation

$$\frac{d^2x}{dt^2} + \frac{4\pi\sigma}{\epsilon}\cdot\frac{dx}{dt} = \frac{V^2}{\mu\epsilon}\frac{d^2x}{dz^2}$$

has been carried out by A. Eichenwald by a method resembling that of Zeeman. As the author points out, the above equation can only be fully tested by investigating the propagation of electric force in a medium of finite resistivity, since that alone brings the second term on the left-hand side into play. He conducted the ends of two long Lecher wires into a vessel filled with water, bending them down into the water instead of taking them through the walls of the vessel like Zeeman. He thus obtained a perfect exponential absorption curve along the wire, free from fluctuations suggesting interference. The curve was plotted from the readings of a bolometer. The ends of the wires were held down by a weight hanging to them, and the hooked bolometer leads drew the wires slightly aside, thus obtaining a good sliding contact. It was found important to allow no waves to reach the bolometer except by way of the leads, which were therefore encased in a brass tube, and all the leads of the measuring circuit and the bolometer itself were similarly encased in metal. The result was an agreement with Maxwell's equation as close as could be expected with the apparatus used.

[Eichenwald, *Wied. Ann.*, No. 12, 1897.]

Magneto-Optic Phenomena.—P. Drude points out that Leathem's theory of magneto-optic phenomena in iron, nickel, and cobalt, recently given to the Royal Society, does not supersede his own, as the two theories are in reality equivalent. Drude's magneto-optic constant is a complex quantity, and really consists of two constants. Drude very justly points out that before seeking for crucial experiments to decide between two theories it is better to find the points they have in common. The interesting new phenomenon predicted by Wend, and discovered by Zeeman, which occurs when the magnetisation of the mirror is normal to the plane of incidence of the light, may be deduced from both the theories in question in precisely the same manner.

[Drude, *Wied. Ann.*, No. 12, 1897.]

Standardising Ballistic Galvanometers.—A new method of standardising ballistic galvanometers by a coil of known inductance, due to Max Wien, is essentially a reversal of Maxwell's method for measuring inductances by means of a ballistic galvanometer and Wheatstone's bridge. This reversal is a distinct gain, since inductances are now capable of being measured with extreme accuracy by means of alternating currents. The theory of the method results at once from Maxwell's equations. In one branch of a Wheatstone bridge is inserted a coil of inductance L. The other branches possess no perceptible inductance. The resistances of the four branches are all $= r$, and that of the galvanometer circuit $= r_0$. The bridge is in equilibrium, and the strength of the constant current in the battery branch is J. Then if α is the deflection of the galvanometer on breaking the circuit, the constant of the galvanometer is

$$\frac{JL}{4\alpha(r_0+r)}.$$

The greatest source of error lies in heating effects. To avoid them, it is best to keep the galvanometer circuit closed and to measure the ballistic deflection only on breaking the battery circuit. The deflection should be brought about just as the needle, in its wanderings due to the unequal heating of the branches, passes through zero.

[Wien, *Wied. Ann.*, No. 12, 1897.]

Rheostene.—Glover's rheostene, a kind of nickel steel of unknown composition, has a remarkably steady temperature coefficient of resistance, and its resistivity is very high (77·07 at 0·44deg.) E. van Aubel has made some experiments with it, and finds its temperature coefficient to be 0·00119 between 0·4deg. and 14·5deg., and 0·00114 between 57deg. and 74deg. At 100deg. it is 0·00098, and after that it presumably falls more rapidly. Its density is 7·899. Its high resistance, which exceeds that of its constituents six or eight times, renders it fit for determining temperatures by the variation of its conductivity. As C. E. Guillaume has since pointed out, the resistivity-temperature curve is really a curve of the second order, with a small term of the second degree.

[Van Aubel, *Journal de Physique*, 1897.]

Resistivity of Bismuth.—E. van Aubel publishes some further studies of certain varieties of bismuth obtained by various processes of purification. He finds that no reliance can be placed upon the purity of any "chemically-pure" bismuth unless it is further purified by electrolysis according to Lenard's or Classen's method. The most troublesome impurity is lead. The bismuth must be dissolved in hot nitric acid, and electrolysed in a platinum dish, with a platinum disc as anode, to test for lead. If it is present, peroxide of lead is deposited upon the disc. Copper is also sometimes present. Molecular structure has a great effect upon the electric qualities of bismuth if impurities are present, but has no effect when the bismuth is purified by

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electrolysis. In all experiments on bismuth, therefore, the absolute purity of the substance must be ascertained before proclaiming the results. The temperature coefficient is higher than that obtained by Dewar and Fleming. Van Aubel attributes this to the fact that he operated with absolutely straight wires, thus elimiuating the errors due to the inevitable deformation of a bismuth wire produced by bending.

[Van Aubel, *Archives de Genève*, 1897.]

ON MAGNETIC SHIELDING.—II.

BY PROF. H. DU BOIS.

(Continued from page 218.)

§ 10. Very similar equations would hold for the inverse case of spherical or cylindrical "interferric" cavities or tunnels hollowed out of an infinitely extended ferromagnetic uniformly magnetised throughout; however, such an absolutely rigid magnetisation could only be produced in a substance of infinite coercive force devoid of temporary inductive susceptibility. If for a moment we imagine the feasibility of this, we would obtain within a *spherical cavity**

$$\mathsf{H}_i = +\frac{4\pi}{3}\mathsf{I}, \quad \ldots\ldots\ldots \quad (1\text{A})$$

the + denoting that the force in the cavity now is in the same direction as the surrounding magnetisation to which it is due, whereas the negative demagnetising force of equation (1) is well known to essentially oppose the magnetisation in the case of solid spheres.

Similarly within a *cylindrical tunnel* at right angles to the direction of uniform and rigid magnetisation we would find

$$\mathsf{H}_i = +2\pi\mathsf{I}. \quad \ldots\ldots\ldots \quad (1\text{A}^*)$$

It is hardly necessary to add that this state of affairs is considerably modified for an ordinary "soft" ferromagnetic, the non-rigid magnetisation of which may still on the whole be supposed uniform; but it will show deviations from uniformity, especially in the neighbourhood of cavities, thus completely altering the conditions under which the above equations hold. This case is represented by many dynamos, which may be considered as large masses of ferro-magnetic substance, cut up here and there by interferric crevasses, cavities or tunnels; I shall revert to it and its graphic representation further on, and proceed at once to the theory of bi-lamellar sheathing.

§ 11. The four bounding surfaces between ferromagnetic and interferric, *e.g.*, between iron and air, occurring in our problem give rise to four conditional equations following from the principle of the continuity of induction as applied to boundaries. This principle lies at the root of the whole method of solution; it would lead us too far to reproduce all the mathematical details of the rather lengthy calculations. It will be sufficient to state that the formulæ hitherto given enable us to write out the four boundary equations mentioned. After the elimination of a number of auxiliary field-vectors temporarily introduced, these lead up to the final expression for the field-ratio g, as defined in § 8. It is found that the product $\mu^2 g$ is equal to an expression of the fourth degree in μ; each of the coefficients in general contains seven geometrical and one numerical term. This somewhat complicated equation may be grouped in various ways, acccording to the particular properties which we may choose to specially emphasize; one method of grouping gives the following expression for a spherical bi-lamellar:

$$g - 1 = \frac{2}{9}\frac{(\mu-1)^2}{\mu}\left\{(1-p_1p_2) + \frac{2\mu^2+5\mu+2}{9\mu} m_{12}m_1m_2\right\}, \quad (\text{I})$$

and correspondingly for a double cylindrical sheathing.†

$$g - 1 = \frac{1}{4}\frac{(\mu-1)^2}{\mu}\left\{(1-q_1q_2) + \frac{(\mu+1)^2}{4\mu} n_{12}n_1n_2\right\}. \quad (\text{I}^*)$$

* Compare Sir W. Thomson, reprint of Papers on "Electrostat. and Magnetism," p. 476.

† In the sequel, corresponding spherical (three-dimensional) and cylindrical (two-dimensional) problems are always treated side by side for the sake of brevity and clearness; the equations relating to the latter are denoted by an asterisk.

Transformation and Discussion of Theoretical Equations.

§ 12. The right-hand side of the above equations is easily seen to vanish, either for unit permeability ($\mu = 1$), or else for infinitely thin shells ($p_1 = p_2 = 1$, $m_1 = m_2 = 0$, or $q_1 = q_2 = 1$; $n_1 = n_2 = 0$). We then have $g - 1 = 0$, *i.e.*, a field-ratio equal to unity, as of course should be the case. In the first place we now have to discuss the relation between the shielding of the bi-lamellar and that of each of its constituent single shells. In order to first obtain an expression for the latter, we imagine the outer shell to vanish by supposing R_2 to tend to equality with r_2 (*see* Fig. 1); then p_2 or q_2 converges towards unity, and m_2 or n_2 towards zero; what remains of the general equations then evidently gives the field-ratio g_1 for the inner shell alone. For a single spherical shell we thus obtain the far simpler formula

$$g_1 - 1 = \frac{2}{9}\frac{(\mu-1)^2}{\mu}(1-p_1), \quad \ldots\ldots \quad (5)$$

being equivalent to the expression

$$(\mathsf{H})_1 = \frac{9\mu}{9\mu + 2(\mu-1)^2\left(1-\frac{r_1^3}{R_1^3}\right)}\mathsf{H}_e,$$

given by Maxwell as the result of Poisson's solution of this problem for the particular case of a uniform external field.

Similarly (I*) for a single cylindrical shell reduces to the simpler expression

$$g_1 - 1 = \frac{1}{4}\frac{(\mu-1)^2}{\mu}(1-q_1), \quad \ldots\ldots \quad (5^*)$$

identical with the formula given by Stefan (*loc. cit.*, p. 629) for this particular case.

§ 13. It has already been remarked in § 7 that geometrically similar sheathing combinations necessarily exert the same shielding effect. In the present case, geometrical similarity must extend to both the ferromagnetic shells as well as to the air-shell between the two; for, if we cause the latter to *contract* so much as ultimately to vanish, the result becomes entirely different. To prove this, suppose r_2 to tend to equality with R_1, implying convergence of p_{12} or q_{12} towards unity, and of m_{12} or n_{12} towards zero. Then the product $p_1p_2 = \frac{r_1^3}{R_1^3}\frac{r_2^3}{R_2^3}$ evidently converges towards the value r_1^3/R_2^3, which may be denoted by p', and applies to the thicker spherical sheath resulting from the welding together of the two constituent shells when the air-space has entirely vanished. Similarly, for the cylindrical case,

$$q_1q_2 = \frac{r_1^2}{R_2^2}\frac{r_2^2}{R_2^2} \text{ converges towards } \frac{r_1^2}{R_2^2} = q'.$$

If now we consider the equations (I.) and (I.*) we see that when the air-space contracts indefinitely they tend to assume the forms

$$g' - 1 = \frac{2}{9}\frac{(\mu-1)^2}{\mu}(1-p'),$$

and

$$g' - 1 = \frac{1}{4}\frac{(\mu-1)^2}{\mu}(1-q'),$$

which give the field-ratio g' for the resulting spherical or cylindrical sheath, and are of course identical in form with (5) and (5*). It is seen at once that g' is considerably less than the original g; the reason being that the second *positive* term of the { } bracketed expression in (I.) and (I.*) (which as it were represents analytically the advantages of the intermediate air-shell) vanishes with the air-space owing to the factor m_{12} or n_{12} becoming equal to zero.

§ 14. If, on the other hand, we allow the air-space to *expand*, driving the outer shell outward (this shell retaining a similar shape, however) the mutual magnetic interference of the shells diminishes indefinitely. We may then expect to be able to annul it altogether, so that the uniform internal field $(\mathsf{H})_2$ of the outer shell may be considered to act directly on the inner shell as an impressed external field. In notation, which is self-explanatory, we ought to have, then,

$$g = \frac{\mathsf{H}_e}{(\mathsf{H})_1} = \frac{\mathsf{H}_e}{(\mathsf{H})_2}\cdot\frac{(\mathsf{H})_2}{(\mathsf{H})_1} = g_1g_2, \quad \ldots \quad (6)$$

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which simply expresses *multiplication* of the shielding effects of the constituent shells of a sheath. This interesting property may be made more conspicuous analytically by a different system of grouping the fundamental equations. Instead of (I.) and (I.*) we may in fact write, for a spherical bi-lamellar,

$$g=\left\{\frac{2}{9}\frac{(\mu-1)^2}{\mu}(1-p_1)+1\right\}\times\left\{\frac{2}{9}\frac{(\mu-1)^2}{\mu}(1-p_2)+1\right\}-\frac{2}{81}\frac{(\mu-1)^2(2\mu^2+5\mu+2)}{\mu^2}p_{12}m_1m_2, \quad . \quad (7)$$

and for the corresponding cylindrical case—

$$g=\left\{\frac{1}{4}\frac{(\mu-1)^2}{\mu}(1-q_1)+1\right\}\times\left\{\frac{1}{4}\frac{(\mu-1)^2}{\mu}(1-q_2)+1\right\}-\frac{1}{16}\frac{(\mu^2-1)^2}{\mu^2}q_{12}n_1n_2. \quad . \quad (7^*)$$

If now, according to (5) and (5*) we substitute for the above { } bracketed expressions their simple values g_1 and g_2, we find

$$g=g_1g_2-\frac{2}{81}\frac{(\mu-1)^2(2\mu^2+5\mu+2)}{\mu^2}p_{12}m_1m_2, \quad . \quad (\text{II.})$$

and

$$g=g_1g_2-\frac{1}{16}\frac{(\mu^2-1)^2}{\mu^2}q_{12}n_1n_2. \quad . \quad . \quad . \quad . \quad . \quad (\text{II.}^*)$$

The second right-hand term in this modified form of the fundamental equations is easily seen to vanish on indefinite expansion of the air-shell, for when r_2 increases indefinitely, $p_{12}=R_1^3/r_2^3$ and $q_{12}=R_1^2/r_2^2$ tend towards zero. The resulting simple form of (II.) and (II.*) thus confirms the presumption expressed by (6). For any given bi-lamellar the *negative* term in question affords a measure of the mutual magnetic interference of the two shells and of the amount by which the resultant shielding effect still remains below the ideal value resulting from simple multiplication of its constituent factors. This will be illustrated by suitable examples taken from the actually observed shielding effect of bi-lamellar sheaths, and graphically represented in a later article.

§ 15. The general method of solution for the case of n-lamellar sheaths, presenting $2n$ bounding surfaces, follows by analogy from the preceding calculation for spherical and cylindrical bi-lamellars. By inference from and generalisation of the results obtained above we may expect an equation of the $2n$th degree in μ, the coefficients of which will in general contain one numerical and $\frac{1}{2}n\ (5n-3)$ geometrical terms. However, for the present there appears to be no sufficient reason for actually carrying out the calculations, which prove rather laborious, even for the case of a tri-lamellar sheath.

The attempt of a solution for shields of a shape different from those hitherto considered hardly looks promising. But if we consider the coefficients containing μ in (I) and (I*), or in (II) and (II*), we find that these differ but little for the spherical and cylindrical cases; in fact the ratio:

$$\frac{\text{spherical coefficient}}{\text{cylindrical coefficient}}$$

for large values of the permeability attains the value 8/9 or 64/81 respectively. We may therefore safely assume that, the volume-ratios of § 7 being supposed unvarying (*i.e.*, $p=q$, and $m=n$), those coefficients, and therefore the values of g, will pass through intermediate values if we transform the hollow sphere into a hollow cylinder through the intermediate figures of revolution—*e.g.*, through a gradation of shells bounded by confocal ovoidal surfaces. We hereby obtain a means of approximately evaluating the shielding effect of variously-shaped sheaths so far as obtainable in the lathe. We need only determine the fraction corresponding to m or n, *i.e.*, the ratio of the actual volume of the shells (proportional to their weight) to the volume enclosed by their outer surfaces.

§ 16. Hitherto we have introduced no approximations or limitations beyond supposing μ constant; the equations are therefore to be considered perfectly general in their applicability, though, of course, the restriction as to unvarying permeability has always to be borne in mind. We shall now simplify with a view to the actual applications by supposing μ rather large (say, $\mu>100$). The equations for bi-lamellars are then easily seen to reduce to the following simpler expressions:—

$$g-1=\frac{2}{9}(\mu-2)\left\{(1-p_1p_2)+\frac{2}{9}\left(\mu+\frac{5}{2}\right)m_{12}m_1m_2,\right\} \quad . \quad (\text{I}_\text{A})$$

$$g-1=\frac{1}{4}(\mu-2)\left\{(1-q_1q_2)+\frac{1}{4}(\mu+2)n_{12}n_1n_2.\right\} \quad . \quad . \quad (\text{I}^*_\text{A})$$

Or, if we start from the modified unrestricted form (II) of those equations we obtain, by introducing the same simplification

$$g=g_1g_2-\frac{4}{81}\mu\left(\mu+\frac{1}{2}\right)p_{12}m_1m_2, \quad . \quad . \quad . \quad (\text{II}_\text{A})$$

$$g=g_1g_2-\frac{1}{16}\mu^2q_{12}n_1n_2. \quad . \quad . \quad . \quad . \quad . \quad (\text{II}^*_\text{A})$$

The equations (5) and (5*) for single shields reduce to the very simple formulæ

$$g-1=\frac{2}{9}(\mu-2)m, \quad . \quad . \quad . \quad . \quad (5_\text{A})$$

$$g-1=\frac{1}{4}(\mu-2)n. \quad . \quad . \quad . \quad . \quad (5^*_\text{A})$$

Moreover, the positive or negative number beside μ in the bracket may be neglected in the majority of cases. Introducing the susceptibility κ, and remarking that

$$\mu-2=4\pi\kappa-1\doteqdot 4\pi\kappa,$$

we may also approximately write

$$g-1=\frac{8}{9}\pi\kappa m \quad \text{(sphere)},$$

and

$$g-1=\pi\kappa n \quad \text{(cylinder)}.$$

The latter extremely simple form of the cylindrical equation was first given by Stefan (*loc. cit.*, p. 630).

With a view to the adaptability of transformer plate for sheathing, examples of which will be given below, it is useful to introduce further simplifications for thin shells, whose thickness d are of the order of, say, $\frac{1}{100}$th of their outer radius R. We have $d=R-r$ and (by § 7) for spheres

$$m=1-\frac{r^3}{R^3}=\frac{R^3-r^3}{R^3}=\frac{(R-r)(R^2+Rr+r^2)}{R^3}\doteqdot\frac{3d}{R};$$

for cylinders:

$$n=1-\frac{r^2}{R^2}=\frac{R^2-r^2}{R^2}=\frac{(R-r)(R+r)}{R^2}\doteqdot\frac{2d}{R}.$$

Substituting these in the preceding equations, and remarking that for small values of m and n we may write

$$1-p_1p_2=1-(1-m_1)(1-m_2)=m_1+m_2,$$
$$1-q_1q_2=1-(1-n_1)(1-n_2)=n_1+n_2,$$

we obtain for thin bi-lamellars—

$$g-1=\frac{2}{9}(\mu-2)\left\{\frac{3d_1}{R_1}+\frac{3d_2}{R_2}+2\left(\mu+\frac{5}{2}\right)m_{12}\frac{d_1}{R_1}\cdot\frac{d_2}{R_2}\right\}, \quad . \quad (\text{I}_\text{B})$$

and

$$g-1=\frac{1}{4}(\mu-2)\left\{\frac{2d_1}{R_1}+\frac{2d_2}{R_2}+(\mu+2)n_{12}\frac{d_1}{R_1}\cdot\frac{d_2}{R_2}\right\}; \quad . \quad . \quad (\text{I}^*_\text{B})$$

and for thin single shells—

$$g-1=\frac{2}{3}\frac{d}{R}(\mu-2)\doteqdot\frac{8\pi\kappa}{3}\frac{d}{R}\ \text{(sphere)}, \quad . \quad . \quad . \quad . \quad (5_\text{B})$$

and

$$g-1=\frac{1}{2}\frac{d}{R}(\mu-2)\doteqdot 2\pi\kappa\frac{d}{R}\ \text{(cylinder)}. \quad . \quad . \quad . \quad . \quad (5^*_\text{B})$$

(To be continued.)

WATER-POWER UTILISATION ON THE SIHL.

We have received a reprint from the *Schweizerische Bauzeitung* of an illustrated description by Prof. W. Wyssling of Zürich, of the electricity works on the Sihl, and although this plant only deals with some 1,200 or 2,000 H.P. it has several features of interest. By its means a very inconstant flow of water is made to furnish light and power to twelve villages lying between the River Sihl and the Lake of Zürich, the extreme points being Rüschlikon and Richtersweil on

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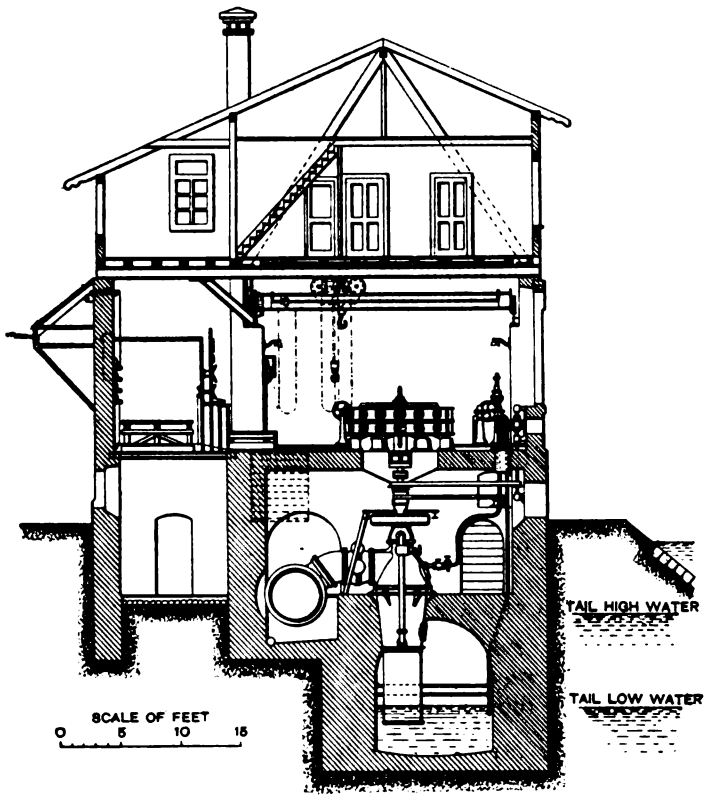
the Lake of Zürich, and Menzingen and Hütten inland, and the most important part being the factory district around Wädensweil.

A fall of 275ft. is obtained between two points 2·8 miles apart on the River Sihl, and but 1·8 miles apart as the crow flies. A weir has been constructed near Hütten, and the long head-race is a tunnel 1·5 miles long, with a 1 per cent. gradient, ending in a closed iron pipe for the last 600 yards. The head available at the turbine-house varies from 200 to 245ft. according to the season of the year, and the average minimum flow in winter is 3,800 cubit feet per minute, but the actual minimum known is 3,200 cubit feet per minute. As an average, therefore, 1,200 H.P. can be obtained during the winter, and in the summer from 1,600 to 2,000 H.P. if it were needed. Five units each of 400 H.P. have therefore been erected, one being intended as a reserve. The turbines have been built by Messrs. Escher Wyss and Co. They are of the closed impulse type with vertical shafts, one noticeable feature being that a regulated air supply is led to the vane-wheel, by means of which the height of water in the suction pipe is regulated and a free discharge and the best employment of the smallest quantity of water is ensured. The regulation of



Section through Power House, showing one Turbine and Dynamo.

the air supply is accomplished by means of a valve, which is controlled by a float in a pipe communicating with the suction pipe. The turbines deliver an average of 400 H.P. at 360 revs. per min. (the diameter of the wheels is 35½in.). Tests have shown, however, that with a greater pressure they will furnish considerably greater power. The efficiency is guaranteed at 74·5 per cent. at full load, and 73·2 per cent. at half-load.

The design of the dynamos presented not too simple a problem. The number of revolutions per minute is rather large relatively to the size of the machines, and each machine must, wherever possible, furnish current both for light and power, there being only one machine in reserve. Finally, the machines when subjected to sudden variations in load (power being furnished to cement factories, compressors, brickworks, &c.), must undergo no serious variations in pressure, as the same machines also supply power for silk-weaving and cotton-spinning, for which steady running is essential. It was however decided that during the hours of maximum demand for light, the lighting and motors should be supplied from separate machines on account of the regulation of the turbines; for it appears impossible with automatic governing to have satisfactory lighting service from the same machine as the power service at times when the motor load is enormously varied, *e.g.* at evening, when all the factory motors are being stopped, or later in the evening when few lamps are on and a relatively large power demand (from all-night pumps and motors at breweries) is being experienced.

The dynamos are built by Messrs. Brown, Boveri and Co. They are two-phase machines, but so dimensioned that from either *one* of the phase-windings of the armature the full 400 H.P. can be taken as *single-phase* output, assuming the absence of a difference in phase between current and pressure, which is not far wrong in the case of fully-loaded lighting transformers. By this means also, as a two-phase machine, the dynamo can conveniently deliver its full 400 H.P. to a motor load with even a very large phase difference, as it could furnish double the current required if there were no lag. The generator is in other respects of the usual Brown pattern with revolving magnets, whose poles are individually wound, and a stationary armature whose internal diameter is 6ft.-7in. The number of poles is 14, corresponding to a periodicity of 42 ∿ per second, which is not too low for arc lamps. The exciters are two-pole machines of the Manchester type, with vertical shafts, driven by belts from the generator shafts. The efficiency of the generators is guaranteed at 92½ per cent at full-load, including the excitation losses.

The primary network has been calculated for a maximum drop in pressure of 5 per cent. in the lighting mains and 7 per cent. in the power mains. Although the maximum distance from the power station is only 11 miles, some 150 miles of wire have been used in the primary network (corresponding to about 52 tons of copper) and 1,000 poles. To diminish the effect of self induction as much as possible no thicker wires than 6½mm. diameter have been employed. Every pole is capped with a cast-iron top ending in a pointed lightning rod about 9in. high. This is connected to earth by a bimetallic wire (copper, with steel core) leading into the ground At particularly exposed points regular lightning conductors are used with large earth-plates. There are in all 25 transformer stations, the majority of these being in small iron towers, at the top of which the high pressure mains are led in, the secondaries leaving at a lower level. The largest of these towers are equipped for 150 kilowatts, and the smallest for 50 killowatts, the very small stations (ten out of the 25) of from 2 to 15 killowatts being placed in buildings where current is required. The secondary network is also entirely overhead. There is a fairly large telephone network in the district, and as the telephone wires are mostly at a higher level than the secondary lighting wires, a guard-net is put between them wherever they run concurrently or cross, and a fuse has been inserted in front of every subscriber's instrument.

In conclusion, it may be interesting to mention the cost of the various parts of the system and the number of connections. The hydraulic parts, including buildings and turbines, cost £57,000, of which over £20,000 went to building the tunnel. The electrical plant, including primary and secondary networks, cost about £25,000, of which £9,000 was spent on the primary network. In March, 1897, after the plant had been running a year and a-quarter, the number of connections were as follows:—6,700 lamps aggregating 104,000 c.p., 30 motors for all-day and all-night load aggregating 710 H.P., and 28 motors on day-load tariff aggregating 152 H.P.

AN ELECTRIC CURVE TRACER.

BY PROF. EDWARD B. ROSA, PH.D.

(*Concluded from page 223.*)

Curve IV. (Fig. 10) is the current flowing into the condenser. As can be seen at a glance, its fifth harmonic is very pronounced and gives the curve a very striking form. The third, fifth, thirteenth, and fifteenth harmonics are also present, and in nearly the same proportion, while the seventh is represented very slightly. Of course the seventh harmonic could not be present in the current if it were not present in the electro-

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motive force, but its magnitude in the latter is too minute to detect with certainty. The equation of Curve IV. is:

$$i = 21{\cdot}05 \sin(x - 20°16') + 2{\cdot}66 \sin(3x - 78°49') - 12{\cdot}40 \sin(5x + 36°37') + 0{\cdot}36 \sin(7x - 82°) - 2{\cdot}49 \sin(9x + 30°22') - 2{\cdot}08 \sin(13x - 48°30') - 2{\cdot}08 \sin(15x - 87°32') \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The ordinates of Curve IV. are everywhere proportional to the rate of change of Curve III. In other words. Curve IV. is the derived curve of III. This is readily seen from the fact that the current flowing into or out of a condenser is proportional to the rate of change of the difference of potential of its terminals, that is $l = c\frac{de}{dt}$. By inspecting the curve it will be seen that wherever Curve III. is increasing the ordinates of Curve IV. are positive, and wherever the electromotive force is decreasing the current is negative. Also, Curve IV. crossed the zero line wherever Curve III. has a maximum or minimum. To show how beautifully these two curves correspond, several points on the top of Curve III. have been numbered. At point 1 the electromotive force is still diminishing, but not so rapidly as before, and the current is decreasing. At 2 the electromotive force has ceased to decrease, and the current is zero. At 3 the electromotive force has slightly increased, and the current is small but positive. At 4 the electromotive force is still increasing, but more slowly, and the current is diminishing. At 5 the electromotive force curve is level, and the current has fallen to zero. At 6 the electromotive force is increasing again and the current is again positive. At 8 the slope of the electromotive force curve is a maximum and the current is a maximum. At 10 the electromotive force has reached a maximum and the current has fallen to zero.

Suppose we consider that each one of the harmonics components of the electromotive force acts independently of all others, producing its own current. Thus, knowing the capacity of the condenser and the period of the current, we could calculate all the harmonic components of the current, knowing the component parts of the electromotive force, or *vice versâ*. Let us proceed to do the latter.

Take e_1, e_3, e_5, &c., as the instantaneous values of the components of the electromotive force; E_1, E_3, E_5, &c., as the maximum value of the same; i_1, i_3, i_5, &c., and I_1, I_3, I_5, &c., corresponding quantities of the current.

C = capacity, $p = 2\pi\eta$, ϕ = phase angle.

Then,

$$e_1 = E_1 \sin(pt + \phi_1),\ i_1 = C\frac{de_1}{dt} = pCE_1 \cos(pt + \phi_1),\ I_1 = pCE_1$$

$$e_3 = E_3 \sin(3pt + \phi_3),\ i_3 = C\frac{de_3}{dt} = 3pCE_3 \cos(3pt + \phi_3),\ I_3 = 3pCE_3$$

$$e_5 = E_5 \sin(5pt + \phi_5),\ i_5 = C\frac{de_5}{dt} = 5pCE_5 \cos(5pt + \phi_5),\ I_5 = 5pCE_5$$

$$\ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots$$

$$e_{15} = E_{15} \sin(15pt + \phi_{15}),\ i_{15} = C\frac{de_{15}}{dt} = 15pCE_{15} \cos(15pt + \phi_{15}),\ I_{15} = 15pCE_{15}$$

$$i = i_1 + i_3 + i_5 + \ldots + i_{15}.$$

$$\therefore i = pCE_1 \cos(pt + \phi_1) + 3pCE_3 \cos(3pt + \phi_3) + 5pCE_5 \cos(5pt + \phi_5) + \ldots + 15pCE_{15}(\cos 15pt + \phi_{15}).$$

Thus we see why the higher harmonic components of the current are so much greater than those of the electromotive force, the fifteenth being 15 times as great, in proportion to its electromotive force as the fundamental.

From the above equations we have:—

$$\frac{E_1}{I_1} = \frac{3E_3}{I_3} = \frac{5E_5}{I_5} = \ldots \frac{15E_{15}}{I_{15}} = \frac{1}{pc};$$

From the first terms of equations (3) and (4) above, we see that $\frac{1}{pc} = \frac{31{\cdot}43}{21{\cdot}05} = 1{\cdot}50$ very nearly. Using this value of $\frac{1}{pc}$ and the values of I_3, I_5, &c., from equations (4) we will calculate the E_3.

$$E_n = \frac{1}{pc} I_n = \frac{1{\cdot}50}{n} I_n.$$

n	$\frac{1{\cdot}50}{n}$	I_n	E_n calculated.	E_n found by analysis.
3	0·50	2·66	1·33	1·38
5	0·30	12·40	3·72	3·46
7	0·21	0·36	0·07	—
9	0·17	2·49	0·42	0·38
13	0·11	2·08	0·24	0·25
15	0·10	2·08	0·21	0·18

The agreement between the values of the coefficients of the equations of the electromotive force, as calculated from the current, and as found by analysing the curve of electromotive

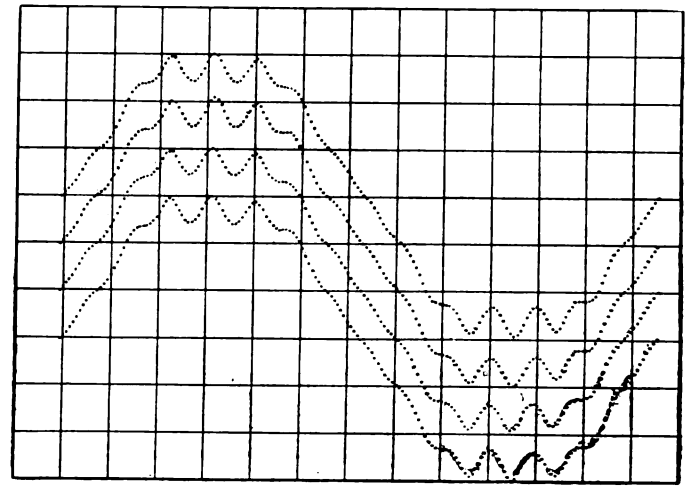

Fig. 11.

force, is very close, the difference being appreciable only in the fifth harmonic, and there it is less than one per cent. of the fundamental. The last three terms have coefficients which

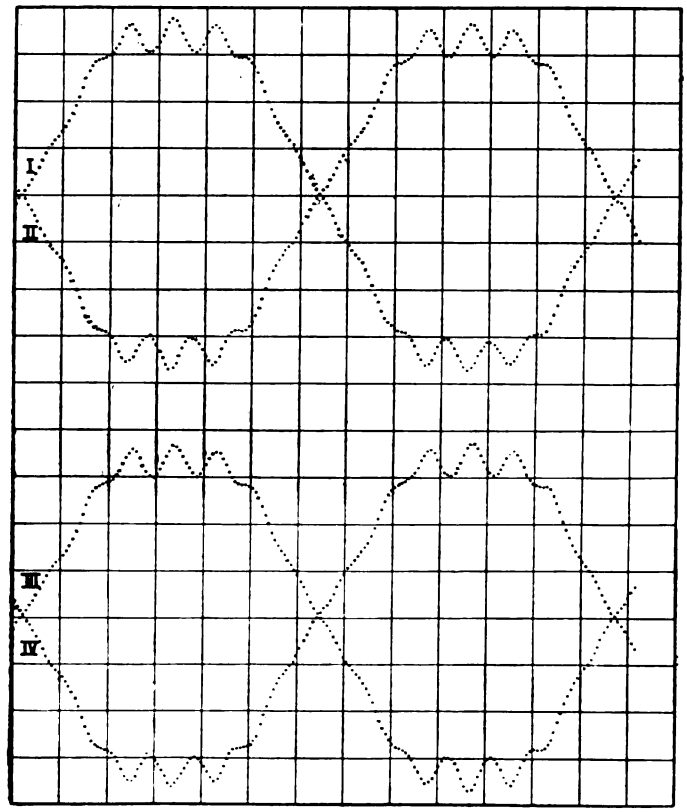

Fig. 12.

average *less than a hundredth part of the fundamental*, and yet the curve-tracer has picked them up and placed them so exactly where they belong that we get nearly the same values by analysing either curve. This is a most severe test of the work of the curve-tracer.

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The accuracy and beauty of Curve IV. will be further appreciated by comparing the first part with the last part one wave-length distant.

Fig. 11 shows the four successive waves generated by one revolution of the eight-pole alternator. The brush of the contact maker is advanced exactly 90deg. for each wave. These four waves which, for convenience of comparison and of printing, are placed under one another instead of in succession, are so nearly alike that one can scarcely detect any difference. The first part of the second wave shows

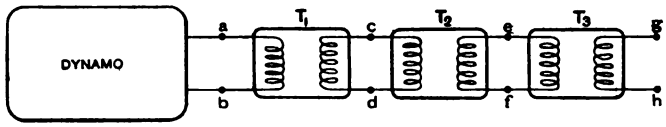

FIG. 13.

maxima a little higher than the others. But this is due to the fact that by an oversight the voltage of the dynamo was here allowed to run a little too high. These curves not only show how symmetrical the generator is, but also show how perfectly the instrument follows the fluctuations in the electromotive force. One can readily follow the ripples down the sides of the waves, although their amplitude here becomes very small. The two harmonics of frequencies, 13 and 15 times the fundamental, reinforce each other at the

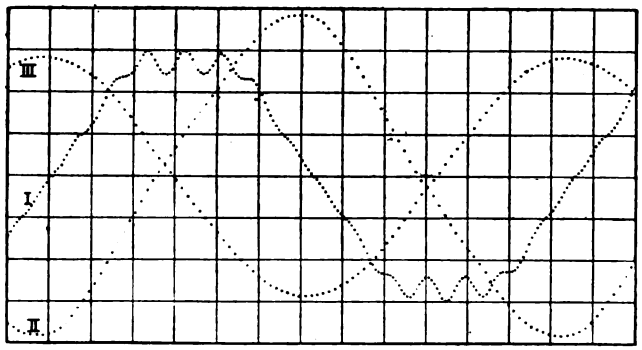

FIG. 14.

summits of the fundamental, and produce ripples of double amplitude. On the sides of the waves, however, midway between the summits, the two waves are in opposite phases, and nearly annul each other.

Fig. 12 shows four electromotive-force waves which very closely resemble each other. There are three transformers in series, as shown in Fig. 13. Curve I. is taken by connecting the curve tracer to *ab*, and is the electromotive force impressed

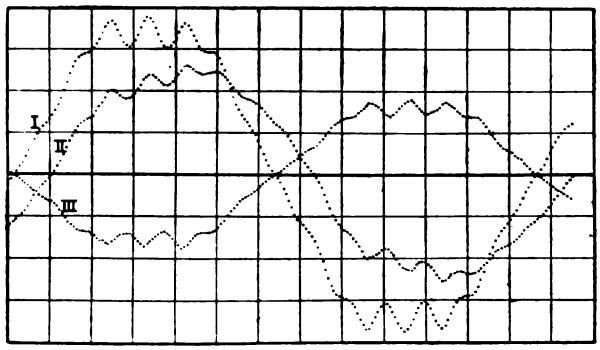

FIG. 15.

upon the first transformer. Curve II. is taken at *cd*, III. at *ef*, IV. at *gh*. Thus, as the wave of electromotive force is propagated through the chain of magnetic circuits it is exactly reproduced, and the phase of each wave is almost exactly opposite to the one before or behind it. There is a slight diminution in magnitude due to magnetic leakage and resistance.

Fig. 14 shows the primary (II.) and secondary (III.) currents of a transformer when the load is inductive. The former lags about 72deg. behind the primary electromotive force (I.), while the secondary lags 84deg. behind the positions opposite the primary electromotive force which it would take if there were no inductance. The coil has no iron core, and the curves are very nearly simple sine curves, the harmonics being almost completely wiped out. To see the precise reason for this we have only to write down the equation for the current in terms of the electromotive forces and impedances.

$$i = \frac{E_1}{\sqrt{R^2+p^2L^2}}\sin(pt+\phi_1) + \frac{E_3}{\sqrt{R^2+9p^2L^2}}\sin(3pt+\phi_3)$$
$$+\frac{E_5}{\sqrt{R^2+25p^2L^2}}\sin(5pt+\phi_5)\ldots+\frac{E_{15}}{\sqrt{R^2+225p^2L^2}}\sin(15pt+\phi_{15})$$

But R is very small in comparison with pL, and hence we may neglect it and write

$$i=\frac{E_1}{pL}\sin(pt+\phi_1)+\frac{E_3}{3pL}\sin(3pt+\phi_3)+\frac{E_5}{5pL}\sin(5pt+\phi_5)\ldots$$
$$+\frac{E_{15}}{15pL}\sin(15pt+\phi_{15}).$$

Thus we see that the fifteenth harmonic in the current is fifteen times less in proportion to the value of the corresponding term in the electromotive force than the fundamental. In other words, the impedance for the fifteenth harmonic is fifteen times as great as for the fundamental, and similarly for the other harmonics. This is just the opposite case to the condenser current, where the impedance is fifteen times less for the fifteenth harmonic, and the current is correspondingly augmented.

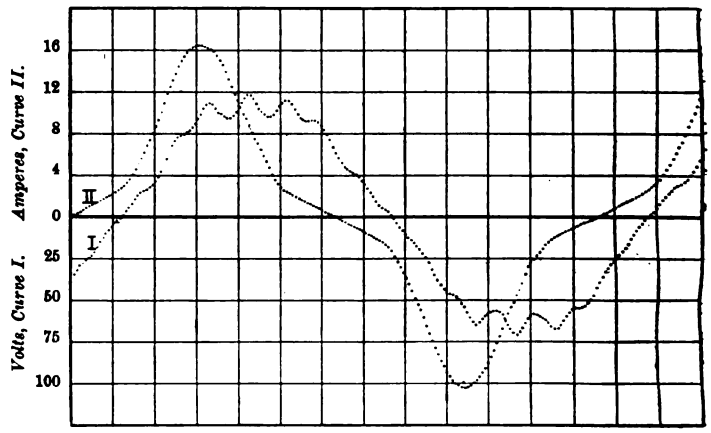

FIG. 16.

An intermediate case between these two extremes appears in Fig. 15, where the load of incandescent lamps is non-inductive and the resistance is the same for each harmonic. Consequently the various upper harmonics are found in the current in the same proportion as in the electromotive force. Curve II. is the primary current and III. is the secondary. There are only four 16 c.p. lamps on the secondary, and hence the magnetising current in the primary coil appreciably affects the form of the primary curve.

Fig. 16 shows the curve of electromotive force of the dynamo and the current flowing under this impressed electromotive force when a coil having an iron core is joined in series with a condenser having a capacity of about 20 microfarads. The voltage of the dynamo is about 50, but by resonance between the coil and condenser it is raised to fully 400 volts both in the coil and in the condenser, and the induction through the iron core is carried up to about 24,000 lines per square centimetre. The maximum value of the current is 16·5 ampere, and it is about 17deg. ahead in phase of the electromotive force instead of being nearly 90deg. behind, as in the case of Curve II. of Fig. 9, where no condenser was used. The effect of the third harmonic in elevating the maximum part of the curve is here very pronounced, the reason of course being that the magnetisation is carried so far beyond the lines of the magnetisation curve that the permeability falls to a low value.

The curves of Figs. 15 and 16 are not so perfect as the others, having been drawn under less favourable circum-

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stances. But they illustrate the points in question satisfactorily, and incidentally show what a relatively poor curve is drawn on this instrument.

It early occurred to me to use a flat record plate, which should advance in its own plane step by step as the contact brush advances; but both the instruments that I have built carry the record sheet upon a cylinder. In accordance with Elliott Brothers' suggestion that the instrument with a flat record plate could be made more compactly and at lower cost, that form has been adopted for future instruments.

In conclusion, I wish to express my obligation to Mr. O. G. Blakeslee, the accomplished mechanician of the College, for his assistance in designing the mechanical features of the curve-tracer, and for his skill in constructing the instrument; and also to Mr. R. H. Hopkins, M.A., for his assistance while a graduate student in the earlier experiments with the curve-tracer.

THE MANAGEMENT OF BOILERS AND STEAM PLANT.*

BY A. B. MOUNTAIN.

During the last few years many exceedingly interesting Papers have been read before learned societies upon steam generating appliances. These Papers have, however, in most cases conveyed the manufacturer's experience of his own plant. It is therefore the author's intention to place before the Society his experience with various types of steam generators. The idea which animates each individual when experimenting with a new form of steam boiler is, if possible, to utilise more of the heat generated by the fuel consumed. When it is considered that only about 50 per cent. of the units of heat in the fuel are utilised, it may be said that the best results obtained are far from those which may reasonably be expected. It is not necessary to discuss the ancient form of steam boilers when pressure of 40 or 50lb. per square inch were in use. It may certainly be taken that no modern works would be constructed in which the steam pressure would be less than 120lb. per square inch; in most cases it would no doubt be from 150 to 200lb. per square inch.

The class of load upon the boiler in a very large measure affects the design. If the works to be constructed will require about the same quantity of steam for a considerable number of consecutive hours, then the heat expended in raising a large body of water to the desired temperature is not such an important matter as it would be if the steam was required for a short time only, as is the case in an electricity works, where the load varies to an extent perhaps unknown to all but those connected with dye works, and in this case the boilers are under full steam for about 10 hours per day at regular stated times; and although the quantity of steam required varies considerably it is usual to signal when a demand is needed; whereas in an electricity works the supply of steam depends upon the demand for energy which is delivered to consumers at a considerable distance from the works, who are quite unable to control the use of their lights, as atmospheric conditions vary so rapidly. It is often necessary, owing to a thunderstorm or sudden fog, to require twenty times the quantity of steam in a very few minutes; this unusual demand must therefore be considered when selecting the type of boiler. Unfortunately an engineer, when considering what type of boiler to adopt, is forced to look very carefully at the commercial side of the question. He must obtain a boiler which will evaporate the largest quantity of water with the smallest quantity of fuel, and he must not forget that the boiler must evaporate the largest quantity of water per pound of capital invested, and this should be considered in its widest sense; not only the actual cost of the boilers, but the additional cost of buildings, value of extra ground, &c., should be added so that the true commercial value may be ascertained.

The question of maintenance is closely connected with the commercial consideration. One of the most important points, and one which influences the commercial side of the question very largely, is the failure of the boiler from any defects. This not only causes loss due to the cost of repairs, but necessitates holding in reserve another boiler, as the electricity supply cannot be stopped in the same way work of another kind might be; and the length of time required for cleaning is another point which seriously affects the cost of maintenance.

It is impossible to consider the type of boiler most suitable for any works without most carefully investigating the water it is proposed to use, and the ultimate effect of this upon the boiler. As an example, assume that the water to be used has in solution a considerable quantity of lime. This would, when heated, throw the lime down in the form of a thick scale; and it would, therefore, be most unsuitable for feeding direct to a boiler of the water-tube type, as it would be difficult to remove the scale, and it would, therefore, increase very considerably the cost of maintenance, and decrease the evaporative power of the boiler. It is, therefore, very desirable to have the water carefully analysed and ascertain as nearly as possible its effects upon each type of boiler proposed to be employed.

For the purpose of comparison it will be advisable to assume some data. Therefore, take the case of an imaginary electricity works, for a small town requiring a sufficient quantity of steam ultimately to drive engines having a total of 5,000 I.H.P. Allowing 25lb. of steam per horse-power, the total evaporation of water would require to be at the rate of 125,000lb. per hour. It will now be necessary to decide how many boilers shall be used and the power of each. Therefore, it will be desirable to ascertain what quantity of steam would be required during the daytime, and taking other towns as an example, it would be safe to estimate that the day load during the summer months would not exceed 200 I.H.P., or 5,000lb. of water per hour. It is clear, therefore, that the boilers must be divided so that one can run this small load efficiently; and 6,500lb. may therefore be taken as about the evaporation which would be required from each boiler.

The next question is, what kind of water is to be used, it being assumed that the engines to be used are condensing, and that surface condensers will be employed, the water being fed to the boilers from the hot well. There are three sources of supply usually: the corporation town supply, the canal, and possibly a river or stream. The town supply is clean but expensive; the canal water is, as a rule, cheap, fairly clean, and is, in fact, usually rain water collected, and therefore very suitable. The river, supposing one to exist, if situated in Yorkshire or Lancashire, would not of necessity be clean, and it would be necessary to construct a pond, which would require a large capital outlay. Having carefully considered the subject, imagine the canal water was found most suitable, and used for condensing purposes and for making up the small quantity of feed water required to replace that lost. It would be clear that the water used being condensed would be soft and suitable for any form of boiler which might be adopted. The next consideration would be the cost of boilers and space to be occupied, and imagine tenders were obtained for the boilers with fittings. The following table gives approximately the particulars and prices for each type:—

From the figures it will be observed that the water tube type is the lowest in price, and it has the great advantage of being a steam generator which may without detriment be forced far beyond its usual limit, and without, to any great extent, reducing its efficiency. It is particularly safe, and specially suitable for employment where high steam pressure is required. It will be noticed that the evaporation per pound of coal is high, and from tests made by the author he has seen these figures obtained repeatedly, but the boiler must be kept thoroughly clean, and it is surprising how quickly the evaporative power of the boiler decreases if the cleaning is not carefully done. The fact that the water and steam space is small is a point both for and against the boiler. It requires less fuel to heat up a small amount of water than a larger quantity would require, and there is practically no limit to the speed with which steam can be raised should another boiler be suddenly needed, but it necessitates careful attention to keep the steam pressure constant. One strong point in favour of the water

Type of Boiler.	Floor space occupied, feet.	Water capacity in lbs.	Steam capacity in cub. ft.	Economiser evaporation. From	Economiser evaporation. To	Lbs. of water evaporated from and at 212°F. per lb. of coal consumed.	Heating surface, feet.	Temperature of gases leaving boiler when working economically.	Price per boiler, including setting & fitting without mechanical stokers.	Cost of buildings and ground at £2 per foot.	Price in £ per 100lb. of water economically evaporated.
Water Tube	180	17,500	200	6,500	9,000	11·5	1,827	350	565	360	14·2
Lancashire	360	43,000	200	6,500	7,500	10·0	1,050	600	575	720	19·7
Lancashire with Economiser	410	76,000	260	6,500	9,000	12·0	1,770	250	725	820	23·3
Locomotive	150	22,000	200	6,500	7,500	11·0	1,500	600	675	300	15·0
Dry Back Marine	160	25,000	220	6,500	7,500	11·0	1,650	600	645	320	14·5
Marine	150	17,000	180	6,500	7,500	11·0	1,500	600	675	300	15·0

* Paper read before the Northern Society of Electrical Engineers.

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tube boiler is its very perfect circulation, which means that practically all the water in the boiler is at very nearly the same temperature. Further, in case of failure in the supply of feed water, it is possible to run for a considerable time without doing any serious damage, as the active tubes are directly over the fire and are at the base of the boiler.

The dry back marine, or economiser type of boiler, occupies very small space, practically no setting, and is being used in several electricity works with very good results. It cannot be so rapidly forced as the water tube type, and a longer time must be allowed for getting up steam, as the circulation is not so good. Like the water tube boiler it must be kept very clean if really good results are to be obtained. It is not so easy to clean or inspect the interior as either the water tube or Lancashire type, and, in the author's opinion, is not so safe.

The marine boiler is being used in some electricity works, and has the advantage of requiring very little setting, occupies small space, and is a rapid steam raiser. It is, however, a type of boiler which requires considerable attention, cleaning and repairs.

The locomotive boiler is also being used in some electricity works. It requires practically no setting, occupies small space, and is a rapid steam raser. Like the marine boiler it must be most carefully cleaned, and the cost of maintenance is comparatively high.

The Lancashire boiler is used in about three-quarters of the electricity works at present constructed. It, however, occupies a considerable amount of floor space, requires an extensive brickwork setting, and is not very efficient. It is usual, however, to combine with the Lancashire boiler some form of economiser for utilising the heat of the gases after they have left the flues of the boiler. The addition of the economiser considerably increases the cost of the boiler, and practically makes it the most extensive type to adopt, but it undoubtedly has many advantages. It has a large water and steam space; it requires less attention than any other form of boiler, and can be easily inspected and cleaned. One of its chief disadvantages is the length of time required to raise steam; although this can be done within two hours, it is usual to allow fully five hours, so that the boiler may be gradually warmed up. Another point against this type of boiler is its bad circulation. It may be practically cold at the bottom for hours after steam has been raised. Further, should the feed-water be stopped from any accidental cause, great care must be taken that it does not fall below the top of the furnace, or the results may be very serious, as the furnace top would become heated and possibly collapse.

Having regard to the varying demand for steam in an electricity works, the author is of opinion that the water tube is the type of boiler specially suitable for adoption at the commencement of an undertaking, and that as the load upon the works increases Lancashire boilers with economisers should be added, so that the continuous load may be supplied from them, and the water tube boilers forced during the period of heavy load. In this way it is possible to reduce the number of boilers employed, and consequently make a considerable reduction in the capital outlay. It would, however, be extremely unprofitable to employ Lancashire boilers without utilising in some manner the heat of the gases leaving the flues. Several methods have been devised for utilising this heat. It may be employed for superheating the steam, for heating the feed water, or the gases may be passed through another fire. If it is desired to heat the steam a larger number of small tubes are usually arranged at the back of the boiler, through which the hot gases have to pass. The amount of superheating required is regulated by the number of tubes attached to each boiler.

The economiser or feed water heater usually adopted consists of a large number of pipes fixed in the main flue, the cold water being fed into the bottom of the pipes, and passing from the top to the boiler. The hot gases, on their way to the chimney, passing through the tubes heat up the water to a very considerable extent. This apparatus has a further advantage—the water in passing very slowly through the tubes becomes heated, leaving a considerable amount of deposit in the economiser, which would otherwise find its way into the boilers. Many different arrangements have been carried out, but it is advisable, in the author's opinion, to arrange for the gases to pass the tubes as much as possible in parallel and not in series. As an example, the temperature of the gases in the main flue at the back of a Lancashire boiler, when working under economical conditions, is at about 600°F., and after passing through an economiser, consisting say of 36 tubes in length and 8 in width, would be about 250°F. If it was necessary to reduce the number of tubes it would be much better to decrease the length of 36 tubes to 18 than the width of 8 to 4, as in practice it is found that the first few rows upon which the heated gases impinge are doing the bulk of the work, and that the tubes nearest the chimney are doing very little. There is, however, an important point often overlooked when considering an economiser or steam superheater and its value, and that is the draught of the chimney. It is perfectly clear that if the temperature of the gases at the base of the chimney is lowered from 600 to 250 degrees, the draught of the chimney must also be very considerably reduced. There are many who hold the opinion that the temperature of the gases at the base of the chimney should not be below 400° F. In the author's opinion it is advisable to have a forced draught and let the heated gases be drawn more slowly away, and that the heat utilised in raising the temperature of the feed water is productive of greater economy than if allowed to increase the draught of the chimney.

(To be concluded.)

ACCUMULATOR TRACTION ON RAILS AND ORDINARY ROADS.

The discussion in connection with Mr. Epstein's Paper was concluded at the meeting of the Institution of Electrical Engineers on December 17th. The following is an abstract of the remarks made. Speakers who have returned their proofs revised are denoted by an asterisk :—

Mr. DESMOND G. FITZGERALD (communicated) said it did not seem to have occurred to the author of the Paper, nor to those who had commented upon it, to compare the accumulators ostensibly available for traction some two or three years ago with those which undeniably existed at the present moment. He thought that it would be most interesting to do so, and also to glance at the directions in which future improvements would probably be made. Certainly the development of the traction accumulator in the face of the normal amount of inertia and stolidity which had opposed its progress would be an instructive phase in the history of applied science. The following is a limited sample of the data upon which—even less than two years ago—traction by accumulators had, as we had been told, to be based; anything much in advance of these was wild and visionary, mere laboratory experimentation and so-called invention :—

Name of Accumulator.	Normal or safe rate of discharge, amp./lb.	Specific capacity, amp. hrs./lb.	Minimum weight per H.P. (cwt.)	Minimum weight per H.P.-hr. (cwt.)
E.P.S. (price lists). L 23	0·193	2·14	13·1	1·63
E.P.S. (price lists). T 11	0·66	2·2	5·3	1·60
E.P.S. (price lists). K	0 33	1·17	10·0	3·00
Epstein (Report of Alabaster & Gatehouse, November, 1894).	0·615	1·856	5·7 ?3·8 (Ayrton)	1·9 ?1·76 (Ayrton)

Much higher rates of discharge for short periods of time might or might not be safe. Now he would ask them to compare the following figures, which were approximately verified three years ago in the case of an electric cab running in Paris, and nearly two years and a-half ago under the difficult conditions of a scramble from Paris to Bordeaux :—

Tommasi Cell. February 7, 1895.

Amp./lb.	Amp. hr./lb.	Weight per H.P. (electrical).	Weight per H.P.-hour (electrical).
0·454	10·0		
1·36	8·2		
3·3	5·0	1·3 cwt.	0·5 cwt.
2·7	7·0	1·7 cwt.	0·55 cwt.
3·41	5·1		
(Time 1½ hours.)			
Max. 6·82	For starting on an incline.		
2·12	6·36		
0·9	9·0		

(Speed attained, 12½ miles per hour.)

These values no doubt are roughly approximate only, but they have not been disproved or contradicted.

The main characteristics of this cell were the embedded supports and the external envelope of perforated celluloid. Now, about two and a-half years ago a young electrical engineer was testing an accumulator which bore a strong family resemblance to that of Donato Tommasi, but which was called the I.E.S. cell. This he compared with an E.P.S. cell, and he had found that when the former was discharged at a rate 6·25 times the maximum safe rate of discharge of the latter, the capacity was, nevertheless, 3·4 times greater than that of the E.P.S. cell. Unfortunately he made a double mistake, in that he selected for purposes of comparison the L type of E.P.S. cell instead of the T or the K type, which would have certainly been more suitable for comparison, and he had also omitted to state which type he had selected; but his observations were nevertheless correct, and had borne strange fruit. For now there was in actual use, working the electrical cabs in London, another battery bearing a strong resemblance to that of Tommasi, but called, on the *lucus a non lucendo*

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principle, the Faure-King, instead of the Faure-Tommasi accumulator. The following figures would allow of its being compared with the accumulators mentioned above:—

E.P.S. (Faure-King) accumulator 0·9 ... 4·5 ... 3·9 ... 0·73

It was true that perforated celluloid had quite recently been replaced—temporarily, he thought—by perforated vulcanite, but the above very encouraging results had been obtained with the former material and by the very gentleman who had declared that he "had used a great number of tons of celluloid and had a large and distressing experience of its use." Although he (Mr. FitzGerald) had taken out a patent (No. 7,636, 1886) for the use of perforated celluloid to retain peroxide active material, it must not be supposed either that he claimed any credit for its introduction, or that he advocated its continued use. He regarded it as a *pis aller*, which had proved useful, but which could and would be dispensed with. It had been stated at the last meeting that an American inventor had proposed to replace the perforated celluloid with soft vulcanised india-rubber, in which he encased the peroxide plates. A more mischievous suggestion it would be difficult to make, excepting, perhaps, in the statement that "it is well-known to everybody that celluloid is absolutely useless in a battery," because outside as well as within the Institution there evidently were people who were not aware that soft vulcanised caoutchouc—the use of which for the purpose in view was claimed in Faure's original patent—was a very oxidisable material, even in air, and that its rapid destruction might almost be regarded as a test of the presence of ozone. On the other hand, pyroxylin—the basis of celluloid—is, under the temperature of 300°F. *bien entendu*, one of the most inoxidisable bodies known, as might be inferred from the fact of its being generated in a bath of the strongest nitric and sulphuric acids. The camphor which was present in celluloid and the impurities which might be associated with it were oxidisable enough, but not the pyroxylin. In regard to his own present idea of a traction battery, the use of very light supports for the active material—in the case of the peroxide as well as the spongy lead element—was the direction in which he thought progress was to be made. The *primâ facie* objections, of course, were: first, that the peroxide element would be rapidly destroyed by local action; and, second, that in the case of large plates with very thin lead (in his experiments the thickness was only 25 mils) the conductivity would be ordinarily insufficient. But there were two distinct methods which had been devised, after years of labour, for obviating the local action to any required extent, and a system of multiple contact with the plate had been thoroughly worked out. There were also minor difficulties, which, however, were much more readily overcome than the above.

Mr. F. J. WARDEN-STEVENS (communicated) said he had lately been contributing to a journal a series of articles on the subject of electric tramways, in which the question of accumulator traction had been discussed, and as there were many points on which he entirely agreed with Mr. Epstein, he made the following remarks. He thought that the author's attempt to compare accumulator traction with the trolley system was not very clear. Although the trolley had the advantage of less attention along the route, the accumulator system should require a smaller plant and less attention in the central station, but he thought it very difficult to compare or copy the trolley system as the conditions were so different. The idea of using a battery car locomotive was certainly a good one, and although it had been suggested often, there seemed to have been no attempt made to carry out the idea. As they no doubt would have these bogey cars, he expressed the hope that they be made to look a little better than the steam cars in Birmingham or the Brixton grip cars. These ugly, square-looking objects disfigured a street far more than any reasonable system of overhead work. Now that the London County Council appeared to be reconsidering the question of the Embankment tramway, might not an attempt be made by the Institution to persuade them to adopt a combination lighting and tramway system, with, say, accumulator traction on the very latest lines? There was no reason why the results in Hanover and Paris should not be equalled or improved upon. Referring to Mr. Epstein's criticism of the Hanover system—when he suggested detaching the accumulator when the trolley section was reached—this was very good from the dead-weight point of view, but surely one of the great advantages of the Hanover system would be lost? He referred to the regulating action of the cells on the car while being charged. This equalised the pressure locally, which would not be done if the cells were charged from the trolley wire at one point. The new Tudor cells, with enormous surface of plate, as used on one of the Paris lines, was a departure which would be watched with interest. When Mr. Epstein stated that charging these cells at constant potential caused very high current-densities he must have been mistaken, as, owing to the extraordinarily large surface of the plates, the current density was never high, and was, in fact, less than usually allowed for pasted plates. However, this misstatement was probably an oversight, and "current-density" was used for current. With reference to the use of the series-parallel-battery control, instead of series-parallel-motor control or the use of a double-wound motor, as in the electric cabs, he should say that it was in every way more convenient, and should be adopted, provided that no difficulty was found owing to the current not being shared equally when the battery was paralleled. If one was allowed to argue from what occurred in a single cell where there were many plates in parallel there should be little difficulty on account of this.

* Mr. R. J. WALLIS-JONES mentioned that he had some years' experience in the working of tramway systems by accumulators. He was of opinion that a system of traction by accumulators had never had a fair trial in England, and they might safely say that, with the exception of the electric cabs, accumulators had never been scientifically used. That was to say, in the cabs they had the battery kept as a single unit, and they also had the great advantage of the series-parallel control. There was another point in connection with accumulator traction which he did not think had received a proper amount of attention. Practically, they could run tramcars on two distinct systems. Either a set of cells having a large trip capacity and of very great weight, or they could have cells merely sufficiently large to run the car for one complete journey. In the former case, of course, they had the condition of slow charging, and in the latter case the condition of quick charging. Mr. Epstein had referred to the Paris system which had recently been installed and was worked on the principle of lighter cells, and he thought the results obtained were well worthy of attention, because probably the greatest difficulty in electric traction by accumulators was the question of carrying the weight. He quite agreed with Mr. Epstein as to the necessity of keeping the battery as one complete unit, as they could not work cells satisfactorily if they split the battery up into quarters and rang the changes on the various groupings. On the Birmingham Central tramways they had had a tandem arrangement, two quarters of the battery being in series while the other two quarters were in parallel series. There was a very bad curve at the end of the Birmingham line, where the cars came into the shed, and if they had a bad battery on board it had been very often found that there was not sufficient energy stored in it to get round the curve. The practice of the drivers then was to simply reverse the connections from the other end of the car on the driving switch, and put the two quarters which were in series in parallel. The car would always go round the corner then, because they had exhausted the series cells much more than the parallel cells on the return journey. Sometimes there had been even as much as five volts difference between the two halves of the battery on entering the depôt. There was another very great advantage in keeping the cells as one complete unit, and in one box. In cases where they put the cells under the seats of the car they had a very objectionable feature in the smell which arose from the battery, and do what they might, they could not prevent the fumes from rising into the car, whereas if they suspended the cells below the car this was quite done away with. But by far the most serious question was the rotting of the cars where the cells were stored, and if they were placed inside this would amount to a very serious figure indeed in the course of, say, four or five years, far above anything suggested in the Paper. Again, if they kept the cells in one complete case they saved the breakage of the ebonite boxes, and that was a most important item. An ebonite box was on the average worth about 10s., and they were very frequently broken if the cells were placed in separate cases on the elevators. There was also a very considerable saving to be made in the charging of the cells in one box if they used elevators. It was exceedingly difficult to keep the leakage down on account of the damp getting to the contact points of the cables, &c. It was his opinion that the traction cell of the future would be a cell which had for the positive plate a Planté type of plate and for the negative a pasted plate. The cost of cleaning such a type of cell was exceedingly low, whereas in pasted cells of any type they might mention this was exceedingly high, and a serious item in the upkeep of a system, With regard to Prof. Ayrton's calculations at the last meeting as to the weight of cell necessary to propel a car of a given weight, the weights of the batteries used on the Birmingham line, including the box of the complete battery of 96 cells, amounted to just under 6,500lb., while a battery of the pasted type amounted to 6,700lb., and the speed at which the car was propelled was 7·2 miles per hour including the stoppages. Mr. Epstein had mentioned the life of a battery at 75,000 car miles, but he was afraid that this was a very sanguine estimate, and it should be noticed that Mr. Epstein had gone in for, in this case, cells of what he should call high "trip-capacity;" that was to say, he estimated on each discharge that the car would run 50 car miles. He thought that, allowing for the obvious difficulties that they must have with a system like that at Birmingham, that was with single motors with double-reduction gearing and other disadvantages. If they got 8,000 car miles as the life of one set of pasted positive plates they would be doing very well, and with a Planté type of cell if they got 17,000 car miles that would be a good result on a line and cars similar to Birmingham. In estimating for the cost of renewal of the battery he noticed that Mr. Epstein only allowed for the renewal of the positive plate. He did not know whether it was an oversight, but it would appear that the author had reckoned upon the negative plate going on for ever, which was, of course, quite out of the question. He thought a fair estimate would be to allow one negative for every two positives. In that case, taking the negatives at the same price as the lead for the positives, the cost of renewal of the plates would amount to something like 0·52d. per car-mile. In conclusion, he thought the system of combined trolley and accumulators, as used in Hanover and elsewhere on the Continent, was likely to prove of great service in this country, where the objection to the trolley wire was very serious.

*Prof. ROBERT H. SMITH thought the last speaker's remarks with regard to the Birmingham line were very instructive. He regretted that these had not been brought out at the first meeting on this Paper. For his own part he could not express any very sanguine feelings with regard to accumulator traction in the future, and for that reason he felt all the more bound to mention one fact that had not been noticed with regard to the Birmingham line. He believed it was a fact that one of the difficulties there—he only put it forward as one small item of the many—was, that the road was badly laid, and that the gauge of the rails varied according to the weather, so that in certain seasons the trams stuck because of the closing in of the rails at certain places. Everyone knew the two great causes that handicap accumulator traction as against most other modes. In the first place, there was the low degree of efficiency. It must be noticed that the ratio between the power put into an accumulator and that brought out was an addition to the inefficiency of the whole plant, an item of inefficiency that did not exist in most other systems. The other great handicapping influence was, of course, the great dead weight, and here again he did not feel able to judge as to the possible future with regard to the reduction of this dead weight. He was quite willing to take for granted that reductions would take place, but it would require a reduction of something like

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60 per cent. of the weight that was common, at any rate two or three years ago, to bring down this defect to anything like reasonable proportions. This being so, it had been his opinion for some time that an accumulator system had really more chance of success in circumstances demanding the use of a locomotive drawing a train behind it, because in a locomotive they wanted dead weight in order to give grip on the rails to draw a heavy train behind it. With regard to the Hanover line, he had pondered a good deal as to the possible advantages of that system, but he could not see them. It seemed to him that the system combined many of the disadvantages of the trolley and accumulator. Why should they carry accumulators about on a line that was fed by a trolley wire, and why should they feed their accumulators by such an inefficient method as taking current down from a line through a trolley wheel? It seemed to him to be more reasonable to use small locomotives charged from the trolley lines, but charged while they were stationary at the beginnings of the parts of the town to which the trolley lines were not allowed. He had welcomed the accumulator cabs in the London streets. He was quite sure that these cabs were quite good enough to remain for some time, if not permanently, on the streets without any public protest that would drive them away. This was a lesson that was extremely important for the public to learn. The public had had rather severe lessons in the opposite direction which had to be corrected before there could be any practical engineering future for mechanical traction upon the crowded streets of large cities. Coming to the question of gearing, he would say that his *beau ideal* was no gearing at all, and he was tolerably certain that they would ultimately do without gearing. In any vehicle, either waggon or cab, they must have a frame which was to a certain extent elastic, and especially so if it was not running upon rails. There must be some elasticity in the frame, and this elasticity was very destructive to gearing of any kind whatever. This straining of the frame meant the straining of the relative geometrical positions of the bearings. Although some very ingenious attempts had been made to use worm gear for electric cars, the straining of the frame put this absolutely out of range of practical possibility, as this gearing required far more exact setting than was necessary in any other kind of gearing. If they had a little want of true adjustment the worm was ground to pieces. The same objection applied also, only in a much smaller degree, to spur gearing. Then he would like the members to consider the swing of the nose frame which must be allowed to joggle up and down to a certain extent. The gear between the shaft upon this swing frame and the axle produced certain kinematic and dynamic results dependent upon this to-and-fro swinging. The accelerations of velocity resulting were quite high, and that meant large accelerations of momentum, and this resulted in very severe mechanical stresses between the different parts of the gearing. He compared this to a horizontal engine in which the cylinders and the shafts were geared by spur gearing to the shaft of the driven machine, this intermediate gear being mounted upon a frame which was hinged at the driving shaft to the bedplate of the whole machine, and supported at the other end on springs. Then, if the whole frame, &c., were set oscillating there would be enormous strains brought upon the teeth of the spur gearing. If the driving shaft was fixed, and the cylinders connected to it by spur gearing were made to fly up and down through small ranges, they would run risk of breaking the teeth of their gearing. He thought chain gearing was really the only practical kind to use successfully in this class of machines. One of the best was the Renold's, which was used upon the electric cabs in London. He looked forward to further improvements in chain gearing in the direction of diminishing the pitch of the chain and increasing its breadth. With regard to the question of mechanical resistance, the resistance of drawing a carriage over a definite surface and under definite conditions was very different indeed from that of self-propulsion under the same external conditions. In ordinary railway traction the resistance in pounds per ton of locomotive was far greater than the resistance of the train that it pulled behind it. A similar difference existed between the towing horse-power necessary to draw a body through water and the horse-power that was necessary to work a self-propelling ship at the same speed under the same weather conditions. One might be three times as great as the other. He referred to the case of riding a pneumatic-tyred bicycle with the tyre well blown out and when it was flabby. The self-propelling vehicle thrust the flanges of the wheels against the rails, whilst the vehicle that was drawn by a draw-bar was steered by the draw-bar, and the rails had nothing or very little to do with the steering. There was the same difference on ordinary roads resulting in a far greater loss of power in the steering of a self-propelled vehicle. A great deal had been said about wind resistance and of the smallness of this. The wind resistance was small in the case of the vehicles they were considering, chiefly because the length of them was very small. The length of the vehicle had more to do with the wind resistance than the head surface of vehicle exposed, and the smallness of the speeds attempted with road cars also accounted for the smallness of the wind resistance. The law of wind resistance, as ordinarily stated, namely, that it varied as the square of the velocity, had been known for 40 years past to be very incorrect. It gave a far too great wind resistance for small velocities and not great enough for large velocities. He thought the following formula more suited the case :—$R = CV^1 + mV$. If the ordinary formula $R = CV^2$ and the formula cited above were compared at a velocity of $V = 10$, one obtained $m = 0{\cdot}03$ and $C = 5C'$.

Mr. E. WYTHE-SMITH said that he had tested a number of accumulators of different types under different circumstances, but had never come across any with the capacity given by Mr. Manby for the "Marchner." Mr. Manby's figure was 77lb. per kilowatt-hour, but the lightest cell he had ever come across was somewhere near 7 or 8 watt-hours per pound of cell gross weight. The results of his experiments on various types of cells led him to believe that the future cell, which would be used for traction purposes, would be a Planté cell or some modification of it. The rough usage these plates will stand placed them far ahead of the pasted cell. A good many speakers had referred to the figure of 60lb. per ton given by Mr. Epstein as the friction on ordinary roads. He had made a number of experiments of this kind with an iron-tyred phaeton. These experiments had been made on roads in the worst condition, with a view to get maximum values. Prof. Smith had suggested that the results obtained in this way were not of much value with regard to the problem of self-traction, because the value might be three times as much as was obtained, but he had made experiments in which the dragging coupling was attached to the phaeton at different heights, and found no observable difference in the pull; he therefore concluded that his results might be relied upon. The steering was effected, independently from the coupling, by hand.

——	A	B	C
Asphalte .....lb. per ton.	22	23	22
Wood (good) ..... „	22 (clean) to 29	31	30
Wood ..... „	38	...	...
Macadam (good) ... „	52	50	49
Macadam ..... „	60	51	50
Macadam (soft)..... „	97 (new)	51	54
	...	80 (new)	68

In the first column the roads were, with one exception, very muddy and in the other two columns the mud was more of the pea-soup order. The results given in the same line refer to the same road on different days.

As an instance of how the observations agreed, he might say that, going down a road and returning, the two curves would as nearly as possible tally. The distances over which they had passed to get these results were about six or seven miles, and the figures might be relied upon to about six or ten per cent. The result they got was an average of about 45lb. per ton, so that the figure given by Mr. Epstein of 60lb. would be above what might be expected in London. With regard to the greatest pull ever required, a vehicle going up a gradient of 1 in 25 on a newly-made macadam road would require a pull, (*a*) due to the incline, of 90lb.: (*b*) road friction would be about 100lb.; in addition to this there might be a wind blowing at, say, 20 miles an hour, which would give a pressure on the vehicle of 20lb. Thus on the whole vehicle they got a pressure of about 200 to 220lb. as the maximum pull ever required on a gradient of 1 in 25. Therefore, although the average pull would not exceed about 45lb. per ton, the motor might be called upon to exert as much as 200 to 220lb. in addition to that required to produce the acceleration at starting. Comparing the figures in his table with those given by Prof. Ayrton for good roads, they would notice his figures came out considerably less.

Mr. JAMES BELL said he had taken great interest in the remarks that had been made by Professor Smith. It appeared to him that, as they must have springs, the best thing was to follow the cyclists and try to insert them between the felloe of the wheel and the road. This he took it was what the pneumatic tyre essentially consisted of. He thought that if the more mechanical-inclined part of the members of the Institution would devote itself to this question, there would very shortly be a very material improvement in that admirable institution, the electric cab.

Mr. ALFRED DICKINSON (communicated) was sure that the whole of the gentlemen who had discussed this, particularly those who had advocated the use of accumulators, had done so believing in what they had advocated, but was it not difficult for those gentlemen who were largely interested in the manufacture of accumulators to avoid bias in their favour? He took it that his own experience was not exceptional. The representatives of various manufacturers had from time to time called upon him and discussed the question of accumulator traction, and a more sanguine body of men he had never met. Almost invariably each representative would claim that his battery was less bulky, of less weight, of greater efficiency, would give more rapid discharges, and stand the wear and tear of tramway working, much better than any of his competitors. It would perhaps be unwise to mention the names of the manufacturers. For the edification of a representative of a firm who recently called upon him, he ran through the claims of a few of the principal manufacturers, including his own, and demonstrated therefrom that taking as a basis the oldest established accumulator, they could, if his claim was good, get a greater efficiency, more capacity, and better results for practically less than nothing. No method of traction as an ideal system offered the fascinations of accumulator traction, but he knew from bitter experience that up to the present it had proved an illusion and a snare. Mr. Epstein, Mr. Parker, and others had discussed the question as though the whole of the difficulties of accumulator traction had been overcome. Both these gentlemen had had considerable experience in accumulator traction, and in the light of that experience it was difficult to understand their assertions that electric traction by accumulators on rails and roads could be successfully worked. That accumulators will propel cars and road vehicles was perfectly true, but it had yet to be demonstrated that they would do so commercially. That there was a large sphere of usefulness for accumulators he was prepared to admit, but in his opinion that sphere did not at the present moment embrace the successful operation under normal conditions of tramways and road vehicles. He supposed he might, without egotism, say that in the various classes of tramway traction he had had as great experience as anyone in the United Kingdom. On the Birmingham Central Tramways, to which reference had been made in the course of the discussion, he thought the batteries of nearly all the principal makers up to the present time had been tried. All the various makers knew the conditions that had to be fulfilled in respect to this system; and his recollection was that they all had, in the first instance, entered upon their responsibilities with light hearts; but each one, after a very short period of working, had found fault with everything in connection with the installation; but never had they admitted that their batteries were at fault. He was sure Mr. Parker must have forgotten the facts when he had suggested that if he had been allowed a free hand he would have made success of this line.

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What was success? If this meant satisfactory running of the cars, then this had all along been an accomplished fact; the success which was wanted was a commercial success, which left a profit to the people who invested their money in the undertakings. So anxious had the Directors of the Central Tramway Company been to make a success of this system, that even after the commercial failure of the bogie cars they gave Mr. Parker's company a free hand to build a car to meet their own design, they to guarantee (1) its satisfactory running and maintenance for 10,000 miles; (2) that the electrical horse-power used under ordinary conditions should not exceed per passenger carried that of the existing bogie cars; (3) that it should travel at the same rate of speed, be capable of running in the same service and to the same time-table as the bogie cars. It was unnecessary to say more than that the performance of that car was not sufficiently encouraging to warrant the Directors in extending its use. He took it that no one, not even a manufacturer of accumulators, was prepared to argue that accumulators could compete with a direct transmission method. That being so, to his mind it would only be beating the air to discuss the matter from that standpoint. If accumulator traction was to be a success upon tramways, it must be a system which could be placed in the hands of an ordinary driver, be perfectly reliable, and work at a cost not exceeding the present methods. Could these conditions at the present time be fulfilled by any known accumulator? He was of opinion that they would find, after impartial investigation, that the answer was a decided and emphatic "No." Everyone who had the true interests of traction at heart must long for the time when a battery would be discovered which would give such results, and if he might be permitted without offence he would suggest that it would be much better if the members of the Institution of Electrical Engineers, rather than discussing what it was possible to do with certain batteries, gave to the Institution the commercial results in actual working of such batteries. The old adage said that it was unwise to prophesy unless one knew; but he ventured to say that, if such a course was pursued, the results would not be such that there would be an all-round congratulation and hand-shaking. In his opinion the crux of this question was not the size of the car at all, but the ratio of dead weight between the carrying capacity and the battery capacity, and the result of his experience was that this was greater with a small car than with a large one. If carefully studied, the balance-sheets of the Birmingham Central Tramways Company would provide food for reflection for some of the ardent enthusiasts for accumulator traction. The average carrying capacity of the steam cars of the Company was 60 passengers, and of the accumulator cars 50 passengers. The cost from 1891 to 1895 of fuel for the steam engines averaged about 12s. per ton, and for the electric system about 8s. per ton, and yet the average cost per car-mile was for the steam engines 1·74d., and for the electric accumulator cars 1·74d. During the same period the cost for cable traction, with fuel costing the same as for the electric system, and the same carrying capacity of the cars, was 0·55d. per car-mile. The lines could have been worked by a direct system of electric traction for a little less than by cable traction. This was only one item, and that not the biggest item in the expenses of accumulator traction.

* The PRESIDENT (Sir Henry Mance) regretted that through indisposition Mr. Epstein was unable to be present to give his reply, which would be read by the secretary. With reference to what Mr. Dickinson had said in his communication, he (Sir Henry Mance) did not think that there was any dispute as to whether traction by overhead wires was not cheaper than accumulator traction; the fact was that the authorities would not allow overhead wires. There were many places in the United Kingdom to which this remark applied. With regard to Birmingham, he remembered going to see the electric tramway on several occasions soon after it commenced running, and he could agree with Mr. Parker that the cars were rather too heavy for the work; he remembered very well that the road had been pronounced to be out of truth. There was a very steep curve at one end of the line, and probably batteries then were not as good as they were now. He mentioned this because he did not think accumulator traction had had a thoroughly complete and fair trial up to the present. He remembered another experiment that was made at Barking, to which place he had made several visits. At first the cost of working was certainly much higher than horse traction, and great trouble had been experienced in consequence of the axles of the cars breaking (for which the electric company was in no way responsible, the road being in very indifferent order), but as they progressed the cost of working steadily decreased, and he had come to the conclusion that if the installation could be increased to say 18 cars instead of the 5 or 6 then in use, it could have been worked at a very fair profit. For some reasons or other, he did not know why, the North Metropolitan Tramway Company decided to discontinue the experiment.

Mr. Epstein's Paper had produced a discussion which he trusted brought them up to date as far as accumulator traction was concerned. He agreed with Mr. Epstein as to the necessity of keeping the batteries as far as possible in one, so that there could be no chance of bad contacts. A short time ago some experiments had been made at Hartlepool, where there was an overhead system, by running a car with accumulators in it just to see how it answered. The cells were perfectly satisfactory, except that in the earlier portion of the trials great trouble and inconvenience had been experienced in consequence of the contacts constantly becoming loose; of course, that had been got over now. The experiment he thought proved that the experiences on the Continent was no doubt correct. He wished Mr. Epstein had mentioned in his Paper whether the cost that he calculated per mile as the cost of accumulator traction at Hanover was calculated on the whole length of the line or only on the portion of the line on which the accumulators had been used. It seemed to him that, giving Mr. Epstein every credit for good faith, his figures were a little too favourable. There was, to his mind, a weak point in using batteries. They never knew exactly when they were charged up, and they did not know—which was still more important—when they were about to give out. He believed that in some of the American cars they had meters which registered forward during the charge and in the reverse way during the discharge, but he did not know whether that was quite satisfactory.

*Mr. EPSTEIN, in his reply, said that if devoid of any other merit his Paper could at least lay claim to having elicited a very interesting discussion. In consideration of the time already occupied he would condense his reply into as small a compass as possible. The accumulator mentioned by Mr. Manby was very interesting on account of the positive electrodes being composed of the active material alone, but although the capacity of such plates was very high it was necessary to discharge them at a very low rate, and this did not lead to very satisfactory results. After this defect had been overcome in the "Marchner" battery, it would certainly be a very decided progress, but statements with regard to accumulators possessing extraordinary qualities had been so frequent and in so many cases unfounded, that one could not help feeling somewhat sceptical in the absence of absolute proofs. As regards the accident when the whole of the town pressure of Dresden which was given as 600 volts was by mistake sent through the cells, it would have been more valuable to know what the strength of the current was. Incidentally he would remark that such an accident would not have happened if the precaution of inserting cut-outs or safety fuses in the circuit had been adopted. As regards Mr. Manby's statement that no other cell would have withstood this he would mention that many accumulators of the Planté type can be short-circuited without suffering any damage. Another statement which called for criticism was the efficiency, which he took to mean energy efficiency, and which was stated to exceed 90 per cent. Such an efficiency might be obtained in the laboratory under exceptional circumstances, but there was no accumulator in existence giving such good results in actual practice. It would be very interesting to learn the results obtained with that type of cell in the hands of some of the engineers in this country. He was afraid that the American invention mentioned by Mr. Crompton to prevent the crumbling of the material would not answer, as in time soft rubber got hard and would crack. It would seem also that the perforations, if large enough to admit the electrolyte, would also be sufficiently large to allow disintegrated material to be blown out through them. He expressed his thanks to Major-General Webber and to Mr. Manville for having referred to the Birmingham Central Tramway Company. As would probably have been noticed, he had intentionally abstained from alluding in his Paper to anything of a personal nature. He was all the more obliged to these two gentlemen for their remarks that the accumulators had not had a fair chance on the Birmingham line, and that the results should not be considered a criterion as to the merits or demerits of accumulator traction. It was a deplorable fact that the bad financial results on this line had considerably retarded the adoption of secondary batteries for traction purposes. Nothing could have been more gratifying to him than to hear that Mr. Manville's opinions corresponded exactly with his own, and this valuable support justified the hope that we should soon witness a more general adoption of batteries for traction purposes. The tractive force on ordinary level roads which he had assumed to be 60lb. would be found, on comparing figures obtained from different quarters, to be a representative fair average, and the instance which Mr. Manville had given from his own experience on a wood road, viz., 30 amperes at 80 volts taken in one of the London cabs, would be found to correspond almost exactly with the average of 2,500 watts mentioned by him. As regards the variation of speed obtained by dividing the batteries into groups which might be used in parallel or series there was not the slightest objection to this arrangement provided the sections were arranged symmetrically. Tests made by him on such an arrangement showed that the difference in the discharge of the various groups was so small as to be negligible. With regard to Prof. Ayrton's wish to know the length of the line at Hanover there were 12·8 miles of overhead conductors and 10·6 miles worked by accumulators. The charging was effected over distances varying from 1·7 to 4·8 miles, the discharge taking place over distances from 3 to 7·2 miles; but as there was not sufficient pressure at all parts of the trolley wire, a supplemental charge was given after the car had returned to the shed. Each car carried 208 cells. When the battery is switched on they are first arranged in two halves in parallel, with resistances inserted. Then the resistances are gradually cut out, and, finally, the two halves arranged in series. The discrepancy between 0·266d. and 0.4d. was easily explained. The former represents the cost of maintenance, the actual outlay, while the latter figure includes a superadded margin of safety at the rate of 6 per cent. per annum on the first total, representing depreciation common to all parts of machinery. With reference to Mr. Parker's remarks that the cells lost their capacity when subject to abnormal discharges, he knew that cells could be made to stand these discharges. Adverting to Mr. Cuthbert-Hall's remarks, he had left it to be inferred when speaking of the relation between capacity and volume of the active material that this active material did not exceed reasonable thickness. It was satisfactory to hear Mr. Swan say that the causes of past failures were remediable. As regards the interesting communication from Mr. Desmond Fitzgerald, it was instructive to learn that cells of almost identical construction, but by different makers, should differ so widely in capacity, and it was surprising that after the labours of all these years they did not find the Tommasi cell in the front rank for electric traction. With reference to the use of celluloid, his experience was that this material could not be relied upon. Sometimes it disintegrated very rapidly, and at others it lasted for years, but apart from the general questions he thought it might be safely granted that when a maker found it necessary to discover a certain material he had very good reasons for it. It was quite possible that at the time of making tests the separators might have been quite new.

A vote of thanks having been passed unanimously to Mr. Epstein for his Paper, and also to the Chemical Society for the use of their rooms for the evening, the discussion terminated.

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COUNTER E.M.F. IN THE ELECTRIC ARC.

Few physical phenomena have more successfully and persistently baffled experimental research than has the internal economy of the electric arc. Ever since the discovery was made that a certain minimum difference of potential is necessary to maintain a true arc, experimentalists have waged a sort of guerilla warfare with arcs of every kind, hoping to capture the secret of their constitution. Yet so elusive has been the secret that the most widely opposite hypotheses have been built upon the imperfect evidence hitherto obtained, rival theorists contending that there is or that there is not evidence of a counter E.M.F. in the arc; or, again, one party propounding the somewhat metaphysical idea of negative resistance as a basis of explanation, a rival party laughing the notion to scorn. Hailing from the United States has recently come an account of a research made by two earnest seekers after truth, with the laudable object of determining whether or no this alleged counter E.M.F. really does exist. The two experimenters have satisfied themselves that it does not, but it will be amusing, if not instructive, to consider the method of research they employed. The extreme precautions taken to ensure accuracy should be mentioned at the outset. A constant potential enclosed arc lamp, of the Adams-Bagnall type, was used, "to eliminate as far as possible errors due to the heat of combustion of the carbon." The lamp was placed in a sheet-iron box 4ft. square, in a room of 700 cubic ft. capacity, containing no window or transoms, and but one door. The temperature inside the box was noted, and also the temperature of the room "at two points." The arc was permitted to burn for 9·5 hours with 4·65 amperes at 119 volts, and the temperature of the box and room were found to remain constant at 38·5 and 24·75°C. respectively. The carbon-holders were now short-circuited, and the same current as before was sent through the coils of the lamp under

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the same conditions, while another current was sent through a resistance coil also within the box, the latter current being adjusted until the same steady temperatures as before were attained. Volts and amperes were again noted. By multiplying the volts and amperes read in the first part of the experiment, the "total energy" consumed by the arc lamp was found to be 553·85 watts. The watts required by the coils of the lamp were 167·4, leaving 385·95 watts used in the arc. The watts required by the resistance in the second part of the experiment were 411·8. The discrepancy is only about 6 per cent., which may be considered an allowable error in the circumstances. The authors of the communication conclude: "While we do not pretend to account for the abnormally high resistance present, we think that the experiment proves beyond doubt that the phenomenon is not due to a counter E.M.F." The method leading to so illogical a conclusion hardly merits notice, were it not that the conclusion has been accepted as final by a leading American electrical contemporary, the *Electrical World*, which, in discussing this research, makes the following observations:—

> The existence of an E.M.F., either counter or direct, means universally the transformation of electric power into some sort of energy other than heat, or *vice versâ*, the transformation of electric power into heat direct being caused only by the passage of a current through a resistance. The transformation of electrical energy in the arc into any form of energy other than heat is manifestly absurd, as no energy can be stored up in the carbons, and there is no opportunity for the delivery of a mechanical or a chemical output.

Armed apparently with precisely similar views, the experimenters went to work, and, finding by a calorimeter method of testing that the heat evolved by the arc represented an amount of energy not less than that represented by the product of electric pressure and current supplied to the lamp, they concluded that therefore there could exist no appreciable counter E.M.F. in the arc. It would be interesting to know whether the same conclusion would have been arrived at if for the arc a thermo-electric couple of negligible resistance had been substituted.

Contrary to the conclusion arrived at by our contemporary and the two experimenters, there would appear to be a considerable weight of evidence in favour of the belief in the existence of a counter E.M.F. in the arc. What proportion this E.M.F. bears to the total potential difference, and what proportion of it is furnished respectively by thermo-electric properties and by chemical polarisation, there is not sufficient evidence to warrant the forming of an opinion as yet. There are three stock reasons repeatedly advanced against the idea of a back E.M.F., viz.: (1) By all analogy and precedent in other substances experimented on, the E.M.F.s generally available from single pairs of elements, either thermo-electric or chemical, are almost incomparably smaller than the pressure required to maintain an arc; (2) if a counter E.M.F. exist, due to either cause, it should be possible to detect it, in consequence of its lag due to the persistence of the temperature of the carbons after the suppression of the main current—all attempts to detect such a back E.M.F. having failed; (3) that if a counter E.M.F. from either cause is present in the direct current it should be absent in the alternate-current arc, in consequence of the temperature inertia giving equality of temperature, and should therefore result in a greater difference between the potential difference necessary to maintain an alternate current than that necessary with a direct current arc. The two latter reasons, though at first blush very plausible, are greatly if not wholly discounted by what experiment has lately added to our knowledge of the alternate-current arc. It is only necessary to examine the simultaneous periodic curves for the light radiated from the arc and the current circulation, as given by Mr. Burnie and also by Prof. Fleming and Mr. Petavel, to be struck with the wonderful rapidity with which the light from one carbon tip (and, therefore, its temperature) varies. The difference in phase of the two curves seem to be about the one-thousandth of a second in time. Is it, therefore, likely that by any direct practical method the result of a thermal or chemical polarisation could be actually detected after the suppression of the current?

On the supposition that a substantial Peltier effect exists in the arc, the very rapid fall in temperature of the carbon tips when they become negative is explicable, since at the contact between the carbon and the vapour at the negative carbon tip there would exist a sink for, and at the positive tip a source of, heat, the carbon vapour being thermo-electrically positive to the carbons, *i.e.*, an E.M.F. would exist at each contact tending to promote a current from vapour to carbon through the contact. The effect discovered in the alternate current arc by Dr. Sahulka has an important bearing on this subject. Dr. Sahulka discovered that if a circuit be formed from a carbon electrode immersed in the arc vapour, and *either* of the main carbons of the alternate arc, a direct current will flow from either carbon through the outside auxiliary circuit to the arc vapour. In order to confirm this interesting discovery for ourselves, and further to gain an estimate of the amount of this direct E.M.F., we lately made some experiments on a 10-ampere alternate current arc (50). The result was that a direct E.M.F. was discovered of about nine volts; the voltmeter current coming indifferently from either of the main carbons through the voltmeter to the fine carbon electrode immersed in the arc vapour. It is difficult in the face of this effect to avoid the conclusion that there must exist in the arc a very appreciable back E.M.F.

It must, on the other hand, be admitted that M. Blondel's recent unsuccessful attempt to detect such an E.M.F. after the current had been suppressed has great weight against the hypothesis that such a counter E.M.F. exists. He was able by his arrangements to insert a galvanometer as a shunt to the arc in about the one six-hundredth of a second after the exciting current of the arc had been suppressed. The validity of his conclusion, however, rests on the assumption of a lag in time of any back E.M.F. that may exist, and herein lies the inherent weakness of the test. A note which M. Blondel adds to his conclusion that his experiments tend to show that no back E.M.F. exists is suggestive; he says: "If the resistance observed on passing from the crater to the arc arises . . . from a polarisation which is instantaneous and proportional to the current, such a polarisation would be indistinguishable from a resistance." Mrs. Ayrton, in her Paper "On the Relations between Arc Curves and Crater Ratios with Cored Positive Carbons," shows that the crater area increases not only with the current but also with the length of arc. This conclusion has a useful meaning, for it seems to point to the futility of investing the several terms of the expression for the potential difference across the arc with definite and isolated physical meanings. Both in the older and in Mrs. Ayrton's more recent equations there exist two terms—one a constant, the other a function of the length of arc divided by the current. There has been a disposition to interpret the last term as representing the fall of potential due to the resistance of the arc, and the first term as representing a back E.M.F. But if there is a transitional true resistance from crater to vapour, or a resistance in the vapour column, it is clear that, since the crater area increases with the length of arc as well as with the current, it is impossible to prevent some of the fall of potential due to this resistance being involved and therefore misrepresented in the first term

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of the equation if the latter is taken to represent a back E.M.F.

Considering the extreme mobility of the reactions within the arc and their subtle inter-dependence, it cannot be admitted that the weight attached to the method of measuring the true resistance of the arc adopted by Messrs. Frith and Rodgers is altogether justified, at any rate with a frequency of testing current between the limits they used. The characteristics of the alternate-current arc tend to show that some of its reactions would be quite sensitive to the ripple introduced by the superposition on the direct current of the alternating testing current.

The curves given by Prof. Fleming and Messrs. Petavel and Burnie, and also by Signor Görges are evidence of the existence of a polarising effect dependent upon the current, if, as Prof. Fleming appears to have found, the arc has to be re-established at every reversal. Simultaneous curves of current and potential difference in the alternate-current arc show that, probably in consequence of the necessity to thus re-establish the arc after reversal, the current persists at zero even while the increasing E.M.F. has already a high value, but that afterwards the current very rapidly rises to its full value, indicating the absence at that point of any counter-E.M.F. It may be possible to account for the character which the arc appears to have—as indicated by many of the curves—of self-induction at low instantaneous values, and capacity at high instantaneous values of current, by assuming a lag in the generation of the vapour column, and an increasing back E.M.F. as the carbon tips increasingly differ in temperature.

The variation of the true resistance or the back E.M.F., or both, if they are existent, in the arc, seems to have an important bearing on the phenomenon of modification which an alternate arc is found to exercise on the potential-difference wave-form and on the current wave-form, resulting from a particular form of impressed potential difference wave. For instance, it is observed that the current resulting from a flat-topped potential-difference wave, very often depending, apparently, on the conditions of the circuit and the ratio of the pressure of the arc to that of the alternator, possesses a peaked wave form; and Mr. Frith has shown that, at any rate with one type of alternator, the arc possesses the power of changing the potential-difference wave form when it is peaked into the flat-topped form, unless, in consequence of there being a resistance in the arc circuit, the initial form of pressure curve is forced upon the arc. It has been shown that the form of pressure wave which an alternator should develop for supplying arcs to get the greatest efficiency in lighting is flat-topped, and, reasoning from this, Mr. Frith concludes that an arc, if given the opportunity of doing so, will *usefully* modify the potential difference wave form of an alternator, even if the initial wave form is peaked. Mr. Frith appears, however, not to have recorded the simultaneous current curves in those cases where he found the potential difference wave had been modified to the flat-topped form—an unfortunate circumstance, for surely it depends upon the nature of the reaction whether the potential difference wave is usefully modified? If, in consequence of a periodic variation of the counter E.M.F. in the arc or of its resistance the current is influenced and reacts again on the condition of the arc, it is obvious that the beneficent reaction may be apparent and not real.

Although it seems possible to invest with an air of plausibility the theory that to pure resistance alone the fall of potential in the arc is due, there are certain reactions in the arc which it seems possible only to explain on the assumption of quite a substantial E.M.F. due to thermo-electric causes, such as the fall in potential when the negative carbon tip is extraneously heated or when its heat is conserved by means of a jacket; also the lesser potential difference necessary to maintain an alternating as compared with a rectified or direct current arc. There seems much reason for looking upon the question of the existence of a counter E.M.F. in the arc as unsettled; at any rate, it is decidedly an ineffective argument against the probability of such an E.M.F. existing to say that we have no experience of any single pairs of elements, either thermo-electric or chemical, yielding E.M.F.s comparable to the potential difference required to maintain an electric arc. It is only necessary to recall the fact that neither have we any experience, other than in the arc, of the physical properties of carbon at or near the temperature of carbon vapour at atmospheric pressure.

ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.†

BY J. ELTON YOUNG.

(*Continued from page 221.*)

Localisation of Contact.—Contact between parallel conductors, though commonly confined to overhead wires, might also occasionally occur in multiple-core cables. It is distinguished from an earth fault by signals returning through it. It may be either *perfect*, as when wires make metallic contact with each other; or *partial*, when the path between them offers resistance, not being metallic.

When a wire is in contact with another which, though parallel, does not communicate with the testing station, the fault must be treated as an earth, and localised as such by one of the preceding methods. When the ends of both wires are available the following tests can be employed:—

Method I.—Measure as a loop the resistance of the two wires in contact, first when they are freed at the distant station, and then when joined there (Fig. 38). Let the readings be W and

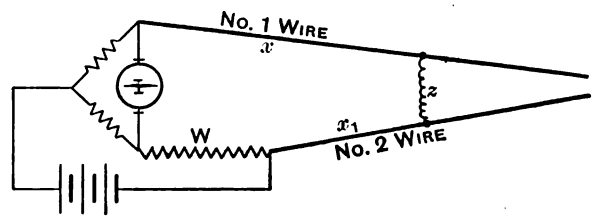

Fig. 38.

w respectively. Then if $x\ x_1$ be the distances in ohms along each line to the fault, calling $x + x_1 = X$, we have

$$X = w - \sqrt{(W - w)(L - w)}, \quad . \quad . \quad . \quad (31)$$

where L is the C.R. of the loop ascertained from records. If both wires be of the same gauge, say m ohms per mile, the distance of the contact will be

$$\frac{X}{2m} \text{ miles;}$$

if of different values per mile m and m_1 it will be

$$\frac{X}{m + m_1} \text{ miles.}$$

The resistance of the contact will be roughly

$$z = W - X.$$

Should the contact be a perfect one, having no appreciable resistance, both readings will be equal, and the distance will be either $\frac{W}{2m}$, or $\frac{W}{m + m_1}$ miles.

† *Extracted* from a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights reserved.

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Should a diversion of d miles exist, say in No. 2 wire, so that the lines are of unequal lengths, the distance of the contact becomes $\frac{X - dm_1}{m + m_1}$ miles.

This method resembles Blavier's test for an earth fault, and possesses similar properties.

Method II.—Let the distant station free one wire and earth the other, and let a balance be observed as in Fig. 39, Case A. The bridge reading, making $a = b$, will be

$$w = y - x.$$

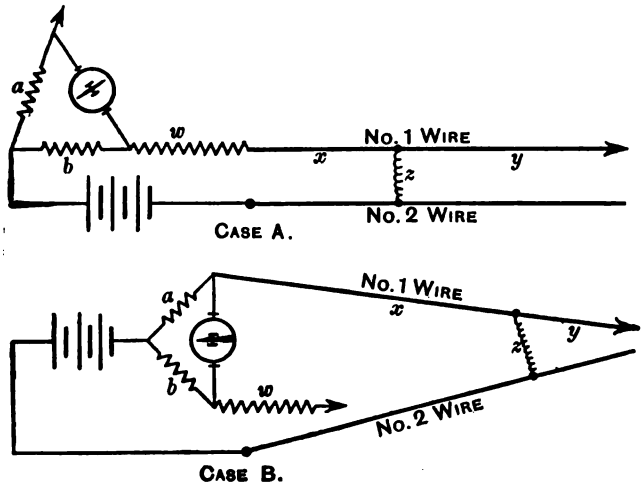

Fig. 39.

Or if balance unobtainable thus, the connections must be reversed, as in Case B. Then

$$w = x - y.$$

Also let the resistance $x + y = R$ be measured by ordinary C.R. test, disconnecting the second wire from the battery and leaving both ends of it insulated. From the two readings we get

$$x = \tfrac{1}{2}(R \pm w) \quad . \quad . \quad . \quad . \quad . \quad (32)$$

for the resistance along the first wire up to the fault, the − sign being taken in case A, the + in case B.

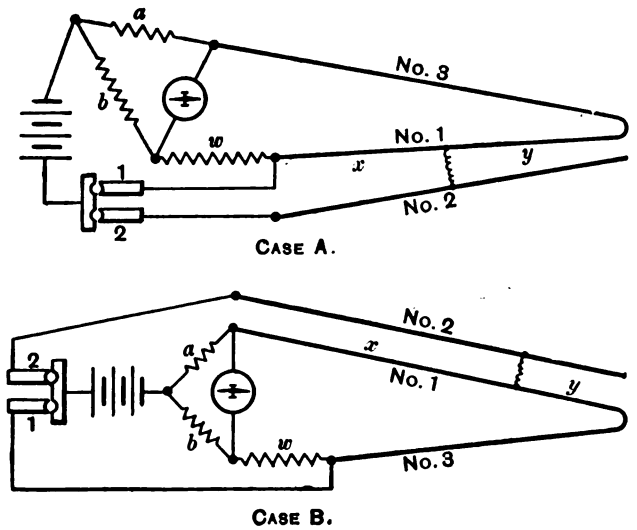

Fig. 40.

This method is generally superior to the first, but inferior to the following:—

Method III.—When a good third wire is available, let the distant station loop this with one of the pair in contact, and insulate the other; and let the testing station join up as in Fig. 40, making $a = b$. Then a loop localisation is effected, as if the contact were on earth, by observing first (plug in 1) the apparent C.R. (L) of the looped lines, and second (plug in 2) the resistance w required to be added to one of them to bring the fault to the centre of the loop.

If balance be unobtainable in case A, the loop is reversed on the bridge as in case B.

The distance of the contact will be

$$x = \tfrac{1}{2}(L \pm w), \quad . \quad . \quad . \quad . \quad . \quad (33)$$

the − sign being taken in case A, the + in case B.

The battery should be properly insulated, and the loop resistance L must always be measured with the wires in the same position as they occupy when observing w. As in loop tests for an earth fault, it is more correct to take the value of L thus observed than any value derived from records.

The results of the three foregoing tests for contact require a correction for *resultant contact*—precisely similar to that applied to the localisation of an earth for "resultant fault—" when the resistance of the contact is not small in relation to the mutual insulation resistance between the two wires, assumed to be aërial conductors. (This correction properly belongs to the ensuing chapter, but for convenience may be given at once). For this purpose it is necessary that, previous to the appearance of the fault, the wires should have been tested for the position and resistance of their "resultant contact." This is readily done by the second of the methods just described, which is superior to the first for finding the resultant contact.

Example.—Nos. 1 and 2 wires being joined up as in Fig. 39 (Case A), prior to the occurrence of contact, the resistance added to No. 1 to balance was 560 ohms. Its apparent C.R. measured at the same time was 2,320 ohms. The distance of the resultant contact along No. 1 wire was, therefore,

$$\frac{1}{2}(2{,}320 - 560) = 880 \text{ ohms.}$$

Its resistance, *i.e.*, the insulation between the wires, was found, by measuring W in Fig. 70, to be 30,000 ohms. The contact fault was localised during similar weather and temperature, and its *apparent* distance was made 1,890 ohms; whilst the insulation W between the wires was now, owing to the contact, about 2,000 ohms. The *corrected* distance of the fault was therefore—formula (34), next chapter—

$$\frac{(1{,}890 \times 30{,}000) - (880 \times 2{,}000)}{30{,}000 - 2{,}000} = 1{,}962 \text{ ohms.}$$

On a line with intermediate stations the section in contact can be localised by having one or both of the faulty wires *disconnected* at successive stations. Putting earth on is by no means to be recommended.

The causes of contacts on overhead lines are various, such as objects thrown or dropped across the wires. Metallic contact is sometimes due to the swaying of wires by wind, so that one catches in a joint in the other. The expansion of wires by heat may also bring them into contact with one another, or with a neighbouring conductor. *Weather contact* is the term applied to the resultant contact caused by leakage in damp weather. Apparent contact may arise from a bad earth, to which two or more lines are connected. Contact may occur in combination with breakage, when the broken wire falls across another: it will then usually be perfect, and the result $\frac{W}{m + m_1}$ will give the distance of the fault.

Intermittent Overhead Fault.—It not infrequently happens that an overhead fault occurs intermittently, without continuing long enough to enable tests to be made for it. When intermediate stations exist, the section of line on which the trouble occurs can be sometimes traced by *crossing* the faulty wire with another working line between two stations A and B; if the defect then shows on the other circuit it lies between A and B; if not, A B is put straight and section B C crossed instead, and so on till the fault appears on the other circuit.

Corrections of Localisation Tests.

Resultant Fault Method of Correction.—The results of the tests described in the foregoing pages are accurate if the resistance of the fault be very small relatively to the insulation resistance of the line; but when, either by reason of high fault or low insulation resistance, these qualities are of the

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same order of magnitude, the localisation becomes affected with error. On overhead wires the leakage and fault resistance may in bad weather approach each other even when the latter is fairly low. In submarine cable work it is as a rule only with *high* resistance faults that corrections become necessary: these, however, form a large proportion of the defects dealt with.

In all localisation tests for an earth the approximate resistance offered by the fault, during the measurements from which its position is calculated, should be recorded if possible. This firstly affords guidance as to whether necessity exists for applying a leakage correction—results obtained when the fault's resistance is low relatively to the insulation being sufficiently exact—and, secondly, furnishes the means of estimating the allowance required, for which it is necessary to know the resistances of the fault and of the insulation.

The problem is made plain when the leakage is considered as acting at a single point in the line, called the *natural resultant fault*, having a resistance equal to that of the insulation. This has been previously referred to in another place, where it was shown how to determine very readily the approximate position of this resultant fault during the normal condition of the line. Formula (14)—in *The Electrician* of Nov. 26, p. 160—based on the earth overlap test, gives this for a single line. The N.R.F. of a *loop* may be conveniently found by the Varley test, and affords a means for correcting the localisation of a fault in the same loop. In this case it is necessary for the N.R.F. to have been observed from the same station as that from which the fault is localised.

The theory of correction by this, which will be referred to as the "resultant fault method," is as follows: It is assumed that the N.R.F. and the real fault are together equivalent to an *apparent fault* which has a resistance equal to their joint

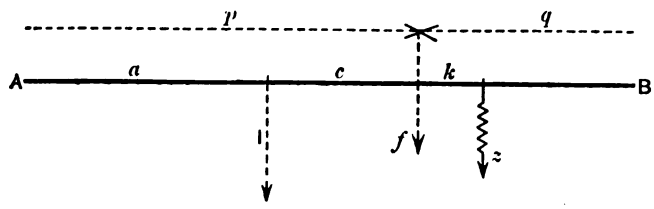

Fig. 41.

resistance, and which divides the portion of the line between them in the ratio of their resistances. It is the position of this apparent fault which is assumed to be given by the localisation. Therefore, calling (Fig. 41)

c the distance between apparent fault and N.R.F.,
k " " " " " real fault,
I the resistance of the N.R.F.,
f " " " apparent fault,
z " " " real fault,

we have, by hypothesis,

$$f = \frac{Iz}{I+z}, \text{ or } z = \frac{If}{I-f},$$

and $$k : c :: z : I, \text{ or } k = \frac{cz}{I};$$

whence $$k = \frac{cf}{I-f}$$

is the error to be added to the apparent distance of the fault from A (or deducted from its apparent distance from B). Or calling p this distance, we have (*see* Fig. 41)

Corrected distance to fault from

$$A = p + \frac{(p-a)f}{I-f} = \frac{pI - af}{I-f},$$

a being the distance of the N.R.F. from A.
Similarly,

$$\text{Corrected distance to fault from B} = \frac{qI - bf}{I-f}, \quad . \quad . \quad . \quad . \quad (34)$$

where b is the distance of the N.R.F. from B.

Example A.—The normal D.R. of a long cable being 600,000 ohms (I) at the first minute, a fault developed which reduced the insulation to 30,000 ohms (f), a minimum value below which it could not be brought during the localisation tests. These placed the fault at an apparent distance of 3,720 ohms (p). The distance of the N.R.F. from the same end of the line was known from the normal C.R. readings to be approximately 2,000 ohms (a). Hence the corrected distance of the fault was

$$\frac{(3{,}720 \times 600{,}000) - (2{,}000 \times 30{,}000)}{600{,}000 - 30{,}000} = 3{,}810 \text{ ohms.}$$

Example B: Two overland wires—Nos. 1 and 2, Fig. 42—tested for insulation every morning usually gave 24,000 ohms and 40,000 ohms respectively, their joint insulation when looped being thus 15,000 ohms (I). The N.R.F. of the loop

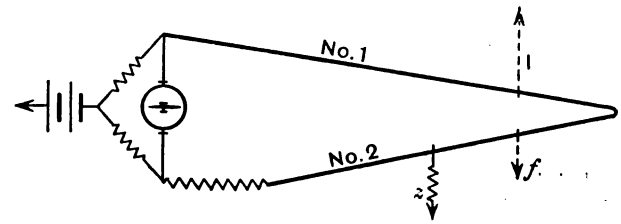

Fig. 42.

in this state of the lines was found by Varley loop test to lie roughly 1,300 ohms (a) from the No. 2 end. A partial earth occurred on No. 2 wire which reduced the insulation of the loop (measuring both wires at once) to 3,600 ohms (f). A Varley balance, made as in the figure, placed the fault at a distance of 760 ohms (p) apparently. Therefore the corrected distance was

$$\frac{(760 \times 15{,}000) - (1{,}300 \times 3{,}600)}{15{,}000 - 3{,}600} = 590 \text{ ohms.}$$

The position and resistance of the natural resultant fault at the time of localisation are necessarily often very uncertain, especially on aërial lines, but correction by a rough guess at them is preferable to none at all.

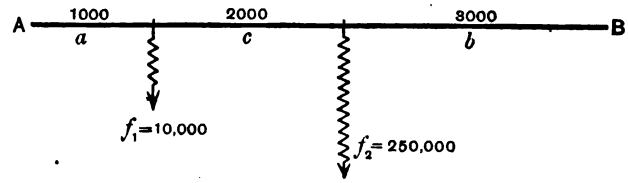

Fig. 43.

This method of correction is also applicable when the leakage, instead of being distributed along the line, acts at a single point, in other words when I, instead of a *resultant*, becomes a second *real* fault f_2—provided its resistance be high relatively to that of the line (c) between the two faults (*see* Fig. 43). Roughly, it may be stated that the correction is approximately exact only when f_2 is more than 10 times c, and ceases to be of any advantage as f_2 approaches equality with c. With such low values of f_2 it becomes necessary to allow for its interference by the method of derived circuits.

(To be continued.)

THE ELECTROLYSIS OF SOLUTIONS OF COMMON SALT.

The exact determination of the E.M.F. necessary to effect the decomposition of solutions of sodium chloride is of great importance, on account of the new industrial developments in the manufacture of alkalies and chlorine that are based upon this decomposition. The actual energy efficiency of any electrolytic cell designed for carrying out this decomposition

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on an industrial scale is calculated by aid of this theoretical value, and a small error in the latter may lead one to assume that the cell is much more successful in converting electrical energy into chemical work than is actually the case.

The subject has often been investigated. Lunge, in his "Sulphuric Acid and Alkali" (1896 edition), calculates from the thermal data that a voltage of 2·30 is requisite to decompose aqueous solutions of sodium chloride. Le Blanc has experimentally determined it and found it to be 1·95 volts. The issue of the *Zeits. f. Elektrochemie* for November 20, 1897, contains a communication from Prof. Lorenz, of the Zurich Polytechnic, upon the cause of the difference between these two values. The author in the experiments which are described in his Paper, made use of accumulators, the terminals of which were connected by a length of tightly-stretched resistance wire. Sliding contacts enabled him to take the current for his experimental cell, from any two points upon this wire, and thus to obtain perfectly regular and minute variations in the E.M.F. employed. A galvanometer was connected in series and a voltmeter in parallel in the same shunt circuit. The decomposing cell was a cylindrical or U-shaped vessel, while the electrodes consisted of bright platinum wires, the upper portions of which were fused into small glass tubes. Special measurements showed that the expression iw might be neglected in the equation $e = E - iw$, in which e = the back E.M.F., or decomposition value, E = the E.M.F. actually used as measured at the cell terminals, i = the current strength, and w = the resistance of the electrolyte.

With the apparatus described above the author made twenty determinations with solutions of sodium chloride varying within wide limits of concentration. The mean of these gave a value of 1·95 volts, thus confirming the accuracy of Le Blanc's experiments.

The author points out that the conditions of these determinations differ from those obtaining when a solution of sodium chloride is electrolysed. In the former case the current passes in intermittent throbs, and is of infinitely small intensity; in the latter case the current employed is a continuous one, and it is generally a measurable quantity. The sodium hydrate formed at the cathode in the former case is, therefore, much less in amount that in the latter. The voltaic series differs in the two cases, and may be represented symbolically as below:—

(1) $\quad Pt \mid H_2 \mid NaCl \mid Cl_2 \mid Pt$

(2) $\quad Pt \mid H_2 \mid NaOH \mid NaCl \mid Cl_2 \mid Pt$

The calculation of the E.M.F. represented by the first series is difficult, as the value of the relationship between the hydrogen ions and a neutral sodium chloride solution is not known.

The calculation of that of the second series is more easily carried out, and yields a value of 2·23 volts, *i.e.*, one closely agreeing with that found by experiment. The determination of the separate potentials is effected by opposition to a normal electrode. In order to obtain conditions exactly similar to those found in practical electrolysis, the sodium hydrate solution may be diluted with a concentrated sodium chloride solution, instead of with water. When the degree of concentration of the sodium hydrate solution has been reduced in this manner to $\frac{1}{100000}$ of the normal solution, it will be found that the back E.M.F. has fallen to very nearly the value 1·95, thus showing that chemically the decomposition has passed from that represented by series (2) to that represented in series (1).

It is therefore evident that when a solution of salt is decomposed in an electrolytic cell, the back E.M.F. is at the first moment only 1·95 volts, but it almost instantaneously rises to 2·10 volts, and later to 2·30 volts. This rise is due to the formation of sodium hydrate at the cathode, and to the part played by the molecules of this compound in the current conduction. The study of the further changes in the value of this back E.M.F. that result when hypochlorites and chlorates are present in the cell, is now the subject of a special investigation in the electro-chemical laboratory of the Zurich Polytechnic.

THE ELECTRICAL EQUIPMENT OF THE MATHIESON ALKALI WORKS AT NIAGARA FALLS.*

BY J. R. HASKIN.

The district surrounding the great power-house of the Niagara Falls Power Company is rapidly being covered with large and substantial factory buildings, where processes requiring large amounts of power are being applied commercially. The plants of the Carborundum Company and the Pittsburg Reduction Company were the first on the ground, while the latest addition, and at the same time one of the largest, is the works of the Mathieson Alkali Company. This Company has heretofore carried on its work in Saltville, Va., making bleaching powder and various other chemicals.

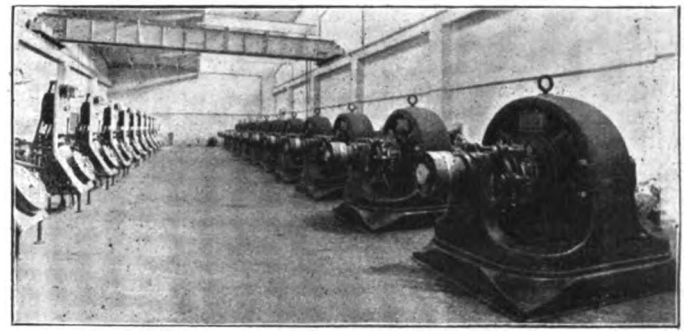

FIG. 1.—Rotary Transformers at the Mathieson Alkali Works.

This article will not attempt to describe the chemical processes nor the details involved in the work, but will give a few facts concerning the electrical machinery. The entire electrical equipment has been supplied by the Westinghouse Electric and Manufacturing Company, and makes a very striking appearance. The transformer room is 125ft. long and 40ft. wide, and adjoins the cell room on the north side, extending the whole length of the latter, and separated from it by a brick wall. In the main room the cells, extending in uniform rows north and south, are connected up in ten separate sets. Corresponding to these sets and installed in a long line in the transformer room are eleven rotary transformers (Fig. 1), each converting 200 H.P. from about 120 volts,

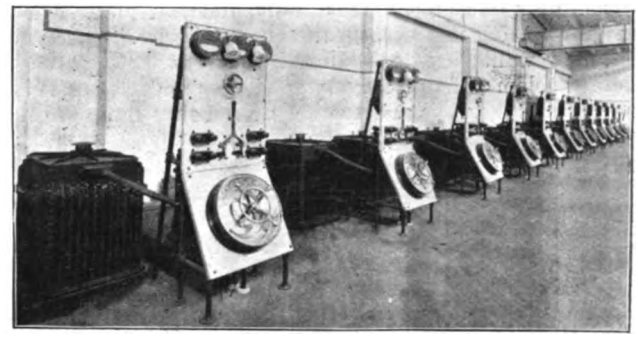

FIG. 2.—Switch Gear and Static Transformers at the Mathieson Alkali Works.

alternating to about 200 volts direct current. These "rotaries" are of the regular Westinghouse standard type, and are similar to a number of others which are being operated in the factories located in the adjoining power district.

This long line of machines, each one a repetition of the other in every detail, presents quite an unusual sight. Three uniform lines extend the length of the room, the static transformers forming one, the switchboards in front of them another (Fig. 2), and on the opposite side of the room the rotary transformers form the third. Through them 2,000 H.P. is converted from 2,200 volts alternating, at 25 cycles, to about 200 volts direct current.

* From the *Electrical World* of November 27, 1897.

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While it is necessary to keep the voltage proportional to the number of cells in use, the means provided are ample, as the controllers, which form part of the electrical equipment, give a range of 100 volts on the direct current side of the rotaries. As shown in the illustration, the controllers are mounted on the switchboards, which extend in a line along the north side of the room. On these boards are mounted also the instruments, field rheostats, main primary switches and fuse boxes. It may be mentioned that the function of the controllers is to vary the pressure supplied to the rotaries by cutting in or out sections of the primaries of the static transformers. These latter are installed to the rear of the switchboards, each set consisting of two 100 H.P. transformers, which step down the pressure from 2,200 to from about 170 to 300 volts. On the opposite or south wall are installed the main switches and circuit breakers, which control the direct current supplied to the cell room.

This completes the description of the main power units, and a few words will dispose of the remainder of the electrical equipment, which consists of 20 two-phase induction motors. They are used for a number of purposes, some furnishing power for the machine room, which is very completely supplied with lathes, drills, &c, used in making up the cells and other parts of the electrolytic equipment. Others are used in the process and to drive blowers, cranes and pumps, while two are mounted on hand trucks to be used in starting up the rotaries. This brings us to a novel method of starting up the machines, and one which has not heretofore been used in this district. Each rotary is supplied with a 10in. pulley and an idler, the armature shaft being prolonged beyond the bearing of the alternating current end for this purpose. It was intended, when starting up the plant, to pull one of the small motors, mounted on a hand truck, into proper position, belt it to the rotary, and in this way get the latter up to synchronism, the operation being repeated with each rotary in order to get the plant running. But after getting the first machine started, the idea immediately suggested itself to the engineer, Mr. Max Mauran, of using this rotary as a motor, and belting it to the next machine in the line, this operation being rendered easy by the idlers being mounted on the ends of the shafts. The method has been found to work so well that the whole plant has been started from a dead stop in 14min. This, of course, does not include throwing in the direct current switches. With machines of this size the operation is a very easy and simple one, besides saving a great deal of time in synchronising, as the slipping of the belt is just sufficient to give enough variation in speed to cause the rotary to synchronise every five to ten seconds. This is only one of the very many practical ideas that are constantly being met with in the power district. Where, however, new wants are to be found in every factory, and the whole problem differs from any previously undertaken, it is no wonder that old ways and methods are being improved upon or totally superseded with better ones.

THE LAW OF STEAM CONDENSATION.

At a meeting of the Institution of Civil Engineers held on November 30, a Paper was read on "The Law of Condensation of Steam," by Messrs. Hugh L. Callendar, M.A., and John T. Nicolson, B.Sc. In the discussion of steam-engine trials it has generally been assumed that the rate of condensation of steam on a surface was practically infinite, so that any surface in direct contact with the steam was immediately heated to the saturation temperature corresponding with the pressure of the steam. It had also been supposed that the amount of condensation under any given conditions was limited, either by the resistance of the film of condensed water to the passage of heat, or by the capacity of the metal or of the circulating water to carry off the heat. In many cases condensation was diminished by films of oil or grease, or by accumulations of air, or by any other incrustations or deposits, but these were not considered in the Paper. The authors found, on the contrary, as the result of their experiments on a steam-engine running under normal conditions, that a practically clean and dry metal surface was not immediately heated to the temperature of the saturated steam in contact with it, that the rate of condensation of steam was not infinite, but finite and measurable, and that the amount of condensation in any given case was limited chiefly by this finite rate of condensation, and could be calculated in terms of it.

The cyclical variations of temperature in the metallic walls of the cylinder, with each stroke of the engine, were measured by means of thermo-couples inserted at various distances from the inner surface. It was possible thus to deduce the amount of heat absorbed and given out by the metal, and to infer the quantity of steam condensed and re-evaporated at different points of the stroke. The temperature-cycles of the steam were simultaneously measured by a very sensitive platinum thermometer. The observations showed that the temperature of the steam in different parts of the cylinder differed in a systematic way from the saturation temperature as deduced from indicator diagrams.

In order to deduce the condensation from the observed temperature-cycles, it was necessary to determine the conductivity and specific heat of cast-iron. A series of experiments were made upon a four-inch bar of cast-iron, and the result found for the conductivity was nearly 30 per cent. smaller than generally assumed. At the lowest speed of the experiments, namely, 45 revolutions per minute, the temperature of the surface of the metal at the end of the admission period was found to be never raised higher than within 20° F. of the temperature of the steam, and the rate of condensation at any moment was simply proportional to the difference between the temperature of the steam and the surface. The numerical value found for the rate of condensation was 0·74 B.T.U. per second per square foot of surface per degree Fahrenheit of difference between the temperature of the steam and the surface. This was equivalent to the condensation of 27 lb. of steam per square foot per hour at 300° F., for a difference of temperature of 10° F. Assuming this law, the total amount of condensation at any point of the stroke could be inferred by measuring the "Condensation Areas" on the temperature-cycle diagram, *i.e.*, the areas included between the curves representing the temperatures of the steam and of the metal surface.

To compare the results thus found with the missing steam deduced from the indicator diagrams and the feed measurements, the leakage of the valve and piston was determined as nearly as possible under the conditions of running. It was found to be proportional to the difference of pressure and nearly independent of the speed through a considerable range. The usual test for leakage with the valve stationary was found to be of little or no value. From a comparison of leakage tests, it was inferred that a valve in motion, however well fitted, was subject to leakage of a definite type. The leakage took place chiefly in the form of water, by condensation and re-evaporation on the moving surfaces, and was directly proportional to the perimeter of the ports and inversely to the width of the bearing surfaces. The amount of condensation observed during the admission period in a single-acting non-condensing cylinder 10·5 inches in diameter with a stroke of 12 inches, was only 20 per cent. of the feed at a speed of 100 revolutions per minute. The smallness of this result was probably due to the early compression and the dryness of the steam supply. It was found that re-evaporation was completed very quickly, and that the walls were dry for the greater part of the cycle. It was inferred from the form of the temperature curves and from other evidence that the rate of re-evaporation was the same as that of condensation.

From the form of the law of condensation it was possible to make an important theoretical deduction with regard to cases in which re-evaporation was incomplete, and the walls remained wet throughout the whole cycle. Under these conditions the mean temperature of the walls should be the same as the time average of the temperature of the steam to which they were exposed, and the cyclical condensation was the maximum possible for the given steam cycle. If the extent of the clearance surfaces was known, this limiting value of the condensation in any case might be easily deduced from the indicator diagram. If the surfaces were dry during part of the stroke, the condensation was less than the limit, and it was necessary to know the mean temperature of the clearance surfaces in addition. Upon these views of the nature of condensation and leakage, the missing quantity of steam W in pounds per hour might be expressed by an equation of the general type. $W = S\,(t' - t°) + L\,(p' - p'')$,—where the first term represented condensation and the second term leakage, S being the equivalent clearance surface in square feet, and t' t° the mean difference of temperature, in degrees Fahrenheit, between the walls and the steam during admission reduced to one-half cut-off. L, the rate of leakage per pound difference of pressure $p' - p''$, might be taken to vary approximately as the product of the diameter and the square root of the normal piston speed, for engines of different sizes. It would appear from this formula that the effect of leakage on the performance was relatively more important in small engines and at high pressures, and that the loss due to condensation was most effectively reduced by increase of piston-speed.

As an indirect verification of this law of condensation, the temperature of the clearance surface in cases in which water was

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present in the cylinder was measured, and was found to agree with that of the mean of the steam cycle. The amount of condensation was also correctly calculated in several cases of published tests in which sufficient data were available. The rate of condensation deduced was also directly verified by an entirely different method. The experiments gave approximately the same rate of condensation, and appeared to show that the water-drops condensed on the metallic surface, owing probably to their rapid action, did not appreciably diminish the rate. Assuming it possible to estimate the condensation occurring in any given case by the method indicated, from a knowledge of the indicator diagram and of the temperature and area of the clearance surfaces, it then became possible to determine the amount of leakage under the actual conditions of running.

ON THE ELECTRICAL CONDUCTIVITY OF DISCONTINUOUS CONDUCTING SUBSTANCES.*

BY EDOUARD BRANLY.

The remarkable experiments in wireless telegraphy made by Marconi have called attention to the conductivity of discontinuous metallic substances, and to the experimental study of it first made by me in 1890 and 1891. Marconi used my tubes and filings without modifying their method of working, and even if the special mixture of the metallic powders to which he gives the preference seems advantageous, it is easy to recognise that such a complicated mixture is not necessary, and it appears to me that the sensibility must chiefly be attributed to the state of conductivity of the powder employed. Having already† stated the conditions which increase the sensibility, I have now just taken up the matter again, and have confirmed my former results by new experiments. I have recognised that the most sensitive substances are those which offer a very slight conductance as compared with that of the galvanometer, and in several cases to attain this I have exercised, by means of a weight, a pressure of from 50 to 100 grms. on a layer of filings from 1 to 2 mm. thick, enclosed in an ebonite cup between two metallic electrodes. I obtained in this manner, with a circuit made up of the powder, a Daniel cell and a sensitive mirror galvanometer, a deflection of a few millimetres on the divided scale. With mixtures of insulating and metallic powders, when the proportion of the former was great, this limiting state was only reached with enormous pressures.

As a matter of fact, I did not trouble about measuring the pressure exerted. I enclosed the metallic filings in a narrow ebonite chamber placed vertically, the filings being as usual between two metallic rods to serve as electrodes, one of which could be moved forward or backward at will by means of a screw. I turned this screw until a *very slight* conductance was established. The apparatus, which was well constructed by M. Gendron, worked most satisfactorily, It allows of rapid manipulation, enables the powder employed to be varied, and dispenses, for the purpose of experiments, with a delicate tube analogous to those used by Marconi. Sometimes it is difficult to limit to a few millimetres the scale deflection obtained on tightening the screw; but if the conductance obtained corresponds to an elongation of 50 to 100 divisions, it can be reduced by a slight shock. The needle of the galvanometer returns to zero, and then, although the conductance is O, the substance is in reality in the same condition as if it offered a slight conductance. For the moment I am not trying to synchronise the oscillator and receiver, nor to parallelise the electric radiation, as would be necessary for transmission to a great distance. I am confining myself to subjecting successively my apparatus and a tube of Marconi's alloy‡ to the same action, usually that of a spark from a small Wimshurst machine (plate 35cm. diameter) placed at a distance of 25 metres. As formerly, my filings are sifted, and the better they conduct the finer they are taken. Many metals and alloys of definite composition give very good results. Aluminium and aluminium-bronze behave well, but they are not the only ones, and it would be necessary, in order that the enumeration might be useful, to give not only the name of the metal but also the coarseness of the filings suitable and even the *age* of the filings.

In 1891§ I emphasised the properties of metallic powders surrounded by insulators and agglomerated by fusion. These properties were the same as those of metallic powders plunged in air or a rarefied gas. The variations in conductivity of these solid substances occur under the same circumstances, and they also disappear on receiving a shock or on being heated. My experiments do not appear to have been repeated. I had moreover to grope my way to a certain extent in the beginning. If Lodge had in his turn experimented with solid substances he would probably have renounced his term "coherer."*

The mixtures of filings and insulators can be varied in a variety of ways: resins and filings, shellac and filings, balsam and filings, &c. I often give these mixtures the form of pastilles of about 1mm. thickness and 2 or 3mm. in diameter. Instead of pastilles it is very convenient to use thin sheets of collodion and filings, gelatine and filings, celluloid and filings, &c. The preparation of these sheets is very simple and rapid, and allows the proportion and coarseness of the metallic grains to be varied at will. Whether pastilles or pellicles be used, they are treated in the same way as the powders. They are placed between the electrodes of the screw apparatus mentioned above, and the screw is turned until a very slight conductance is obtained. If necessary, this conductance is destroyed by a shock. The sensibility may be extremely large, equal or greater than that of the most sensitive powders.

I do not insist on the sensitisation by the first effect; this is a point of great importance mentioned several times in previous publications. Let us also note that the intensity of the shock to produce the return must be regulated. It is needless to remark that the value of the continuous current traversing the sensitive substance plays an interesting part; special effects are obtained on reducing the electromotive force to one-twentieth, one-fiftieth, and one-hundredth of that of a Daniel cell or on using thermo-electric currents. I will add that mixtures can be obtained which only remain conductors for a moment and return immediately, without requiring a shock, to their original resistance. It appears even that effect can be produced with any substances by varying the method of operating in a suitable manner.

* From the *Comptes Rendus* of Dec. 6, 1897.

† See two articles on the variations of conductivity under electrical influence in *La Lumière Électrique* of May and June 1891, Vol. XL., abstracts of which appeared in *The Electrician*, Vol. XXVII., pp. 221 and 448 A *resumé* of the principal phenomena was published in the *Bulletin des Séances de la Société Française de Physique*, 1891, pp. 135-141.

‡ I am using a tube made in London according to Marconi's instructions. It is much more sensitive than some others produced in the same way, and it was placed at my disposal by M. Ducretet.

§ *Comptes Rendus*, Jan. 12, 1891.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Dec. 17, 1897.*

A Large Electric Railway Project.—An electric railway, 82 miles in length, is projected to run between Ogden, Salt Lake City, and Provo, Utah. The road is to be built by the Utah American and Foreign Development Company, of London, which Company has undertaken the development of a large section of the country tributary to the proposed road. The district through which the road will run is said to be very rich, both agriculturally and in mineral resources. There are said to be extensive coal and iron deposits, which will be worked by the Development Company with power derived from the same system as that for the railroad. The road will be of double track, with 90lb. steel rails and an overhead conducting system. The power house will be located between Salt Lake City and Provo, the maximum distance between the power plant and either end of the line being 42 miles. The plant is designed for 20,000 H.P., and eight cross compound engines of 150 H.P. each are to be installed at the start. To each engine will be direct-coupled Stanley alternating dynamos of 750 kilowatt capacity, the currents from which will be stepped up in stationary transformers to the line voltage. The same Company has also a plan for the utilisation of the Shoshone Falls, on the Snake River, Idaho. There is available continuously at these falls some 50,000 kilowatts of power.

Sparking: its Causes and Effects.—A Paper under this title was read before the meeting of the American Institute of Electrical Engineers on the evening of December 15th, in which the author discussed the causes and effects of sparking. The most important step forward in the theories in regard to the operation of commutation and the nature of sparking, he said, was taken when the reactance of the coil under commutation was recognised as the greatest obstacle to perfect

* My tubes of filings received the name "coherers" from Lodge, and this name has been generally accepted. The expression is based on an incomplete examination of the phenomenon and on an inaccurate interpretation. I proposed the name "radioconductors," which recalls the essential property of discontinuous conductors of being *excited* by electric radiation M. Ducretet uses my various radioconductors in the apparatus he has constructed to realise "Hertzian Telegraphy" without wires.

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commutation, and the duty of overcoming this reactance was assigned to the E.M.F. set up by the cutting of the lines from the field by the coil under commutation. It was also recognised that this must be limited by the available reversal E.M.F. While this was a long step forward, it stopped just short of a complete explanation of the phenomena involved. The failure was due to the erroneous idea that injurious sparking was due to the current sparking across the gap between the brush and the receding segment by reason either of incomplete reversal of the current or of over-reversal. He then attempted to show that sparking from either of these causes may be harmless, and that the real injury is done before the segment leaves the brushes. In summing up his discussion, he stated that the deleterious effects of sparking are due to excessive local heating of the commutator contact surface causing the copper to melt and an arc to be drawn, the segments being thus disintegrated. The causes of deleterious sparking are either a too great departure from perfect commutation or too high a current density. Perfect commutation can only be practically secured by making the impedance of the coil negligible as compared with the contact resistance.

The Marconi System of Wireless Telegraphy.—At the same meeting of the American Institute of Electrical Engineers, Mr. William J. Clarke, of New York, gave a practical exhibition of the Marconi system of wireless telegraphy. The transmitting apparatus was located at the front end of the hall, and the receiving instruments at the rear. Signals were audibly transmitted between the extremities of the room, but none of the signals were intelligible to any one present, owing to the fact that the receiving apparatus was in a somewhat crude state, being the first set that had been constructed in this country. The fact that it was acted upon by the transmitted waves was evident, however. Mr. Clarke described the construction and connections of the apparatus. The United States Electrical Supply Company of this city has undertaken the exploitation of this system, and is now placing a line of apparatus on the market.

Telegraphic Addresses in Mexico.—Advices from Mexico state that new Government regulations concerning telegraphic addresses went into effect in that country on November 1st. The new law requires all business houses in the interior of the Republic using a single name as a cable address to register the same in the Direccion General de Telegrafos Federales in the city of Mexico, and pay $10 per annum for this registration.

CORRESPONDENCE.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It will probably interest many of your readers to know that a private and confidential communication which has been sent to all the members and associates, home and foreign, of the Institution of Electrical Engineers, has been very liberally responded to, so far as replies have been received. I shall, however, be glad, through the medium of your journal, to ask any members or associates who have not yet replied to be good enough to do so at their earliest convenience, and in any event to favour me with their autographs for the proposed album, if they have not already done so. For obvious reasons you will understand why I do not give details as to names in connection with this matter, but on behalf of the Executive Committee, of which I have the honour to be secretary, I remain, yours, &c., HENRY EDMUNDS.

London, Dec. 28, 1897.

TESTS FOR FAULTS IN SUBMARINE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to your editorial remarks of October 9th in connection with Mr. Schaefer's article, it would be rather misleading, in my opinion, to give quantitative comparisons of the results, by various methods, of tests taken for the localisation of the same fault or break. Each method has its own particular range of applicability; and although two or more methods may seem theoretically to satisfy the requirements in any given case, it will generally be found that special considerations, such as the fault's distance, the strength and variability of the electric current, the condition of the cable, the apparatus available, the personal equation of the man at the other end, &c., render one test in particular preferable. Training, experience, and a careful study of the tactics of cable-testing are the only true guides to a proper selection of methods—no hard-and-fast comparisons can be made nor rules given.

So with the relative merits of electric current and scale zero tests. As a general rule the former will be found best when the electric current is variable, as its value can then be observed frequently and quickly, whereas if the electric current be steady and not too strong, the latter method allows all the advantages of a null method to be obtained.

The application by Mr. Schaefer of the scale zero method to break testing is a special case, because by its use the difficulties introduced by polarisation and capacity are overcome. His method should be looked upon as a supplement to rather than as a rival of Kennelly's two-current test, since it depends entirely upon circumstances which should be preferred. I believe, however, that Schaefer's will prove the more frequently useful, because it is specially adapted to testing short ends.

The use of the mil-ammeter in cable work has led to so marked an improvement in our methods, and will play so important a part in future that I will be pardoned, I hope, for evincing a desire to establish the fact that I initiated its adoption. The necessity of it was patent to me in the later eighties, but it was not till I came across the Weston instrument that I found it possible to realise my idea.

The pattern we have on board (small size, 1 to 150 m.a.) is not well adapted to the uses Mr. Schaefer suggests for mil-ammeters in his second Paper, where the accuracy of the tests depends upon the power of measuring the ratio of the small currents we are compelled to use very correctly. We must therefore wait until an instrument capable of being more accurately read can be obtained before his suggestions can be fairly tested. The larger-sized diagonally-divided scale instrument will probably prove suitable if specially constructed for our purposes, and with due regard for the reduction of pivot-friction to a minimum.

In the meantime our Weston, which was on trial to begin with, has completely fulfilled my expectations and shown itself even more useful than was anticipated. It confirmed as a first result the suspicion that errors sometimes observed in results obtained by Kennelly's methods were largely due to changes taking place in the testing battery. These proved to be greater than they were supposed to be, and their importance will be appreciated if it is realised that each cell is practically an additional exposure introduced into the circuit and into the problem. I believe, in fact, it will be eventually found that cells obey to some extent both Kennelly's and Schaefer's laws.

For boat work a mil-ammeter, an adjustable resistance and a few cells form a very complete testing equipment, and may be used, when in consequence of bad faults or a long length of cable the sounders cease to act, as a sensitive signalling arrangement also.

Lastly, a new method of locating high resistance faults under certain circumstances has resulted from its use; but as this letter is already too long I will defer particulars of this and of many other uses to which the instrument may be put for the present.—Yours, &c., WALTER J. MURPHY.

C.s. "Amber," Aden, Dec. 14, 1897.

THE MEASUREMENT OF LOW RESISTANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The method described in your issue of last week, by Mr. R. H. Housman, for the measurement of low resistances, has all the advantages of a system of "double weighing." It is a device for eliminating the mechanical sources of error in the balance. Mr. Housman, therefore, quite properly omits from his description the details of his contacts. But incidentally he mentions that the resistance of his manganin (counterpoise) resistance has from week to week been checked, and that "the value is slowly changing."

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At a recent meeting of the Physical Society the question of the change of resistance of manganin was discussed, and Mr. Watson called attention to experiments made by the Reichsanstalt on that alloy. Those investigations prove that soft-solder, when used in connection with manganin, introduces zinc into the metal, and engenders just such resistance-variations with time as are indicated by Mr. Housman's results. May I then be allowed to make a request for more information with regard to the counterpoise resistance?

I understand that the wire is No. 18 S.W.G., it is about 9ft. long and of 1 ohm resistance. (1) For how many weeks was it under observation? (2) Was it annealed? (3) Had it any soldered joints? (4) Was it lacquered or otherwise protected? (5) What currents were used? (6) To what temperature did it attain? I am sorry to impose these interrogations upon Mr. Housman, but I think he will admit that the "permanence" of coils is as important as the accurate measurement of their resistance. His method seems to me to afford the means for investigating the two problems side by side.—Yours, &c.,

ROLLO APPLEYARD.

Dec. 29, 1897.

ELECTRIC LIFTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your report of the discussion on Mr. Ravenshaw's Paper (Electric Lifts and Cranes), I notice that Mr. Kilburn Scott mentions having designed an electric lift in which the motor is carried beneath the lift and operates through worm-gearing and screw-spindles or rack and pinion. About two years ago I designed an electric lift on similar principles, the motor being placed in a chamber beneath the lift and travelling with it and operating by means of rack and spur wheel, a rough sketch of which I still have in my possession. I showed the arrangement to one of the best known makers of olectric lifts, but an opinion was expressed, with regard to the rack, that the teeth were very likely to strip off. I also suggested at the same time a screwed spindle and revolving nut in place of the rack and spur wheel. I believe, however, that both these arrangements have been tried in America.—Yours, &c.,

F. J. WARDEN-STEVENS.

Connaught Mansions, 34, Victoria-street, S.W.,
Dec. 21, 1897.

Renovating Glow Lamps.—The *Elektrotechnische Zeitschrift* of December 23rd contains an interesting article describing the various systems which have been suggested and used from time to time for replacing the filaments in burnt-out lamps. The newest method is that due to Herr L. Becher, of Vienna. Between the socket and bulb of the lamp is a long glass neck just wide enough to allow of the introduction of the filament. Platinum wires are as usual led from the socket through the glass at one end of this neck, and are joined to nickel wires. At the other end of the neck these wires are simply cut off instead of ending in little sockets, as in the usual type of lamp. The filament is "burnt on" to two short pieces of wire held in a small glass bridge, and at the other end of these two wires are the sockets for joining them to the ends of the nickel wire. The method of fixing the socket to the lamp also differs from that usually employed. Near the end of the neck are fitted two little pins in the glass, diametrically opposite to one another, and there are slits in the cylindrical part of the socket into which the pins fit. These prevent the socket from turning, and a wire placed round the socket, between its edge and the pins, draws the socket and glass together so that they cannot be pulled apart. To insert a new filament the neck is cracked in about the middle, the old filament is withdrawn, a new one is fitted, and the neck joined again in the blow-pipe. During this process the socket becomes warm, but it is stated that owing to its special construction this is of no consequence. It is estimated that the cost of renewing a filament, including that of the necessary material, is only ¾d., but we think that this figure should be accepted with caution.

THE LAVAL STEAM TURBINE.

In further reference to the Laval steam turbines at the Stockholm Exhibition, which we recently noticed, the following additional particulars from *Engineering* are of interest. As already stated, the steam is expanded in the nozzles down to the pressure in the exhaust chamber, and since the turbine is purely an impulse one the blades may, and are, run clear of the casing. We cannot agree with the statement made by our contemporary in which the expanded steam near the nozzle is referred to as being cool. A 5 H.P. turbine with a diameter of 4in. runs at a speed of 30,000 revolutions per minute, a 50 H.P. turbine 12in. in diameter runs at 16,000 revolutions per minute, whilst the speed of a 100 H.P. turbine of 20in. diameter is 13,000 revolutions per minute. These high speeds are unaccompanied by vibration in consequence of the adoption of a flexible spindle. The following table is given showing the consumption of steam per brake horse-power for various sizes of turbine, and various steam pressures, condensing and non-condensing. The unusual difference of consumption between working condensing and otherwise which this table shows is remarkable. This, says our contemporary, is due to the greater frictional resistance which the turbine wheel experiences when running in the denser medium, which obtains when working non-condensing. In consequence it is incompatible with the best efficiency to use the same turbine indifferently, condensing or non-condensing, as a relatively larger wheel may be used is advisable when running under the former than under the latter condition. A test of a condensing turbo-generator of 33 units under steam pressure of 120lb. indicated a steam consumption of 33lb. per unit at full load; 33·2lb. at four-fifths full load; 37·3lb. at half-load and 43·5lb. per unit at quarter-load. The condenser work is included in these figures, as the turbine drove its own air-pump and was regulated by a centrifugal governor throttling the inlet steam.

H.P.	Diam. of turbine.		Initial steam pressure.											
			85·3lb. per sq. in.			113·8lb. per sq. in.			142·2lb. per sq. in.			170·7lb. per sq. in.		
	Non condensing.	Condensing.	Non condensing.	Vacuum. 25·2 in.	Vacuum. 27·6 in.	Non condensing.	Vacuum. 25·2 in.	Vacuum. 27·6 in.	Non condensing.	Vacuum. 25·2 in.	Vacuum. 27·6 in	Non condensing.	Vacuum. 25·2 in.	Vacuum. 27·6 in.
	in.	in.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
5	4	4	50·0	35·9	32·2	46·3	34·8	31·7	43·7	33·7	31·3	41·7	33·1	30·9
20	8	9	46·1	25 (	22·5	42·3	24·5	21·8	39 9	23·8	21·2	38·4	23·1	20·7
50	12	12	40 8	22·7	20·1	37·5	21·6	19·2	35·3	20·9	18·5	33·5	20·3	18·3
100	16	20	28·4	20·9	19 4	35·3	20·1	18·3	33·1	21·6	17·4	31·5	18·7	17·2

Table gives steam consumption in pounds per brake-horse-power hour.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

NOW READY.

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"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"The Electric Arc."—By Mrs. Ayrton. *In the Press.*

"Electrical Testing for Telegraph Engineers."—By J. Elton Young. *Ready shortly.*

"Armature Windings of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade. *In the Press.*

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced, and all the usual important articles, &c., which have made the book indispensable to the industry, will be brought up to date and amplified where necessary.

Tenders Invited.—The Corporation of Bradford invite tenders for the construction and delivery of two steam engines for the electricity works at Valley-road. Some particulars are given in our advertisement columns, and specifications may be obtained from the city electrical engineer (Mr. Alfred H. Gibbings), Electricity Department, Town Hall. Tenders must be sent in by *Monday, Jan. 17* to the Town Clerk (Mr. George McGuire), Town Hall, Bradford.

Tenders Invited.—The Electric Lighting Committee of the Borough of Bedford require tenders for the supply and erection of a 420 B.H.P. double-acting compound enclosed engine, and a 250 unit alternator, with stationary armature. Tenders to Town Clerk by Jan. 10.

——— The tenders required by the Electricity Supply Committee of the City of Gloucester for the supply and erection of plant, machinery and apparatus (recently advertised in our columns) have to be in to the town clerk, Guildhall, Gloucester, by Jan. 18.

——— The tenders required by the Corporation of Bootle for the supply of boilers, engines and electrical plant and apparatus for the Corporation's electricity supply undertaking (recently advertised) have to be in to the Chairman of the Watch Committee by noon of Jan. 10.

——— The Foreign Office has received a despatch from the Chargé d'Affaires in Madrid notifying that tenders are being invited for the construction and working for a number of years of a telephone system in the City of Tarragona. Sealed tenders (on forms which can be obtained from the Civil Governor of Tarragona, or at the Registry of the Direccion Generale de Correos y Telegrafos, Calle de Carretas 10, Tarragona), from whom full particulars and conditions may also be obtained), must be sent in by Jan. 11 to the Civil Governor of Tarragona. The telephone poles must be of the pattern used by the Telegraph service; the insulators must be hard burnt porcelain of the double-petticoat type, and the supports must be of galvanised iron. The wire is to be of bronze, and of at least 11/10mm. diameter, and have an electrical resistance of 54 ohms per kilometre and a mechanical resistance of 70 kilogrammes per square millimetre. Iron or steel wire may also be employed. The microphones and telephones must conform to the same conditions as those usual with the Ader No. 3. Some further particulars of the conditions of tendering can be seen (in Spanish) at the commercial department of the Foreign Office between the hours of 11 and 5. A sum of 2,000 pesetas (about £75) must be lodged with the tender, and this must be increased to 4,000 pesetas on the acceptance of the tender.

——— The Secretary for Foreign Affairs has received a dispatch from H.M. Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tenders for the construction and equipment of the line, which, with branch, is 30 miles in length. Further particulars of the conditions of the tender may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6. Tenders must be sent in by Feb. 28, 1898. Full particulars can be had of Señor Alcalde Azpeitia, Guipuzcoa, Spain.

——— The Hamburg Finance Deputation invite tenders for the supply and erection of a steam engine, three dynamos, and an exciter, &c., for the electric lighting of the free harbour. Tenders to Die Finanz Deputation, Hamburg, by Jan. 10.

Tender Accepted.—The tender of Mr. Geo. Sharpe, of Stratford, has been conditionally accepted for the erection of the municipal electricity supply station at Barking, at £2,666.

Sale by Auction.—At an early date Mr. Henry Sherley-Price (of the firm of Wheatley Kirk, Price and Goulty) will offer for sale by public auction, as a going concern, in one lot (at the Mart, Tokenhouse-yard, London), the old-established manufacturing concern known as the Projectile Company (Limited), with extensive works at New-road, Battersea, London, together with the goodwill, fixed and loose plant and machinery, stock-in-trade, stores, &c. Details of the fixed and loose plant to be disposed of at this sale will be found set out in an advertisement elsewhere, and the firms from whom particulars and conditions of sale may shortly be obtained (gratis) are also given. The works buildings are very substantially built, and are admirably placed for railway connection.

Appointments Vacant.—The Council for the Foreign Community of Shanghai require a chief municipal electrical engineer. Salary (at present rate of exchange) about £460 per annum, with quarters, coal, &c. Information from Messrs. John Pook and Co., 6, Jeffrey's-square, St. Mary Axe, E.C., to whom applications should be sent before Jan. 15 next.

——— The Government of Trinidad require an electrical engineer to examine and report upon the various electricity supply and telephone undertakings in and adjacent to the Port of Spain. Engagement three months, with option to the Government to extend to any period not exceeding twelve months. Salary, £25 per month, and half salary during voyage out, with free first-class passage out and home again on satisfactory termination of engagement. Some further particulars appear in our advertisement columns, and applications should be sent in to the Crown Agents for the Colonies, Downing-street, S.W., by Jan. 6th.

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Vacancies.—A large London electric supply company requires an experienced man to take charge under supervision of the consumers' department. See advertisement.

——— A lecture assistant is required in the physics department of the City and Guilds of London Institute, Exhibition-road, London, S.W. Salary £100 per annum. See advertisement.

Appointments.—The Electricity Committee of the Glasgow Corporation have, by 15 to 6, recommended the selection of Mr. W. A. Chamen (outdoor manager to Messrs. Crompton & Co.) to the position of chief engineer of their electric supply undertaking *vice* Mr. W. Arnot resigned. The salary attached to the post is £800 per annum. Mr. Chamen has a large field for the exercise of his energies, and his very important appointment with Messrs. Crompton and Co. will have given him exceptional opportunities for acquiring the class of experience which should be especially valuable at Glasgow. Mr. Channen is 33 years of age. The final decision of the Corporation in this matter will be made at next week's meeting.

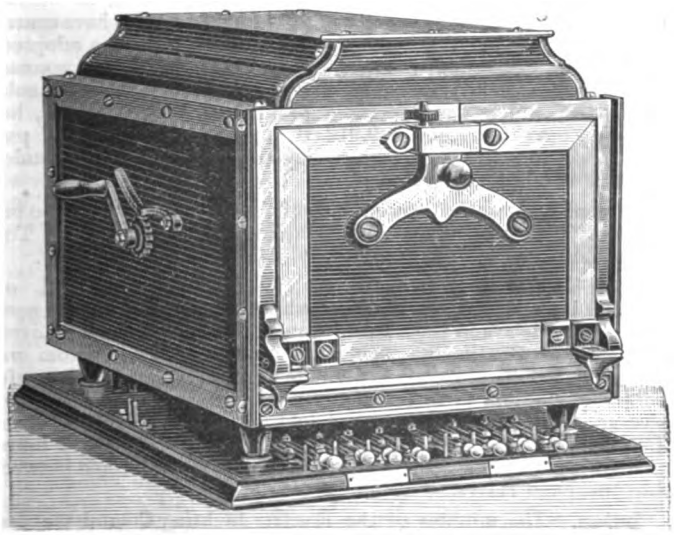
——— The Paddington Vestry have appointed Mr. W. H. Cox inspector of lighting and overhead wires, at a salary of £100 per annum, increasing by annual increments of £10 to £130.

Business Notice.—Messrs. T. H. Toy and Co. announce that on Jan. 1 they commence business at 17, South-street, Finsbury, London, E.C., as importers and dealers in all descriptions of glass and metal supplies for the electric, gas, and oil trades.

Bankruptcy.—Claims against Geo. F. Lee, electrical engineer, 40, Wandsworth Bridge-road, Fulham (lately trading as Lee and Hancock, at 111, Sydney-street, Chelsea), must be in by Jan. 8. Mr. H. Brougham, Bankruptcy Buildings, London, W.C., is trustee.

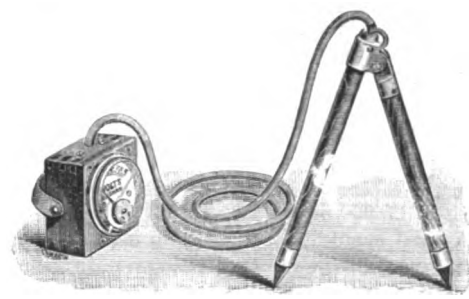
Fowler-Waring Cables.—Mr. M. J. P. O'Gorman, manager of the Fowler-Waring Cables Company, writes:—"In view of the difficulty under which English manufacturers are working, we trust you will give space for the following very brief remarks. The red, white and blue drums which have been crowding most of the railways and many of the thoroughfares of the principal towns in England, are red, white and blue not by reason of any French Republic extraction, but because these have been the Jubilee colours of this year of grace. We emphatically deny that any cables sold by us have ever been made in France or anywhere but in England."

Electric Heating and Cooking Apparatus.—Messrs. H. M. Salmony and Co. send a useful catalogue of electric cooking and heating apparatus which is claimed to be constructed on a new and protected principle, and which is claimed to be superior to any



apparatus of the kind previously on the market. Clear and simple instructions are issued in regard to the use of this apparatus, and the catalogue contains illustrations of a large number of domestic utensils which can be readily used wherever electric current is available. A new form of baking and roasting oven is illustrated herewith, for which, in addition to electrical improvements, certain interior working advantages are claimed. It is stated that the whole of the appliances have been thoroughly and practically tested under the most adverse conditions, and Messrs. Salmony and Co. feel confident they have succeeded in producing a very perfect and complete system for heating and cooking by electricity.

Portable Measuring Apparatus.—In the illustration below is shown a portable apparatus for measuring the voltage of accumulators. This is placed upon the market by the Edison & Swan United Electric Light Company. The instrument is provided with a spring control, so that it can be used in any required position. A leather strap passes over the back of the hand, and the instrument can thus be held practically in the palm of the hand whilst contact with the cells is made by an adjustable fork fitted with spears on each leg which are pressed on to the lead poles of the cell. The spears regulate all the apparatus by means of a flexible cord covered in india-rubber tubing, and the whole of the instrument and spear is painted with a non-corrosible paint to prevent damage



by acid vapours, etc. By means of this apparatus it is claimed that the separate voltage of a whole battery of accumulators can be quickly and accurately ascertained at any time.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 22 to Dec. 24, with the ports of destination:—

Argentina—Buenos Ayres, £1,114 (telegraph material); Rosario, £392. *Australasia*—Brisbane, £19; Fremantle, £40; Melbourne, £483; Sydney, £395. *Belgium*—Antwerp, £56. *Ceylon*—Colombo, £25. *Chili*—Boca, £130 (telegraph poles). *Colombia*—Santos, £52. *Denmark*—Copenhagen, £12. *Egypt*—Port Said, £50. *Gibraltar*—£2,300. *Holland*—Amsterdam, £150; Rotterdam, £30 (telegraph material). *India*—Calcutta, £213. *Italy*—Genoa, £36. *Norway*—Christiania, £16. *Russia*—Reval, £390 (including £300 telegraph material). *South Africa*—Cape Town, £136; Natal, £493; Port Elizabeth, £312. *Sweden*—Gothenburg, £49; Stockholm, £24 (telegraph material). Total, £6,917, against £3,697 on Dec. 23 and 24 last year.

Calendars, &c.—We have received from the Electrical Power Storage Company, of 4, Great Winchester-street, London, E.C., one of their ever-welcome and very serviceable desk blotting-pads. From the number of these pads which meet us in our business calls it is clear that others beside ourselves appreciate the "hardy annual" from the E.P.S. Company. The desk pad is certainly one of the best and most effective of advertisements. It is probable the demand exceeds the supply.

——— Messrs. W. H. Willcox and Co., of Southwark-street, S.E., send a useful hanging-pad calendar, the sheets of which are illustrated with the multifarious manufactures of the firm. A very large variety of up-to-date engineers' stores are shown.

Acton.—The District Council, who have decided to obtain reports from two electrical experts on the question of the erection of electricity supply works, have agreed to engage Mr. J. Kincaid to prepare one of the reports at a fee of 50 guineas.

African Trans-Continental Telegraphs.—It is announced that a deviation is to be made from the route originally planned for the line from Umtali to Tete, it being now decided that the line shall be carried from Salisbury to Umtali on to the Zambesi in the direction of Sena, and from there join the line already made and working in the British Central Africa Directorate. The line is expected to reach Karonga, North-West of Lake Nyassa, by May next.

Barking.—One or two members of the District Council who are closely identified in the gas interest are doing their utmost to retard the introduction of the electric light. At the last meeting Mr. J. N. Reeson, who is one of the managers of the Gas Light and Coke Company at Becton, moved "That, in view of the opposition to the electric lighting scheme by the ratepayers, no further action be taken in the matter." He was of opinion that gas was the cheapest illuminant for their district. Mr. Mullett moved an amendment, "That the proposition be deferred until the Barking Gas Company are asked if they are willing to supply gas at a reasonable price and to keep up a constant supply." In reply, Mr. Reeson said that the Barking Company had offered to reduce their price from 4s. 6d. to 3s. 11d., which he considered a reasonable reduction. In the course of the discussion it transpired that of the signatures to the petition which is being got up against the application of the District Council for sanction to a loan for electric lighting purposes, the name of Mr. Field (the secretary and general manager of the Gas Light and Coke Company) heads the list. Eventually the resolution was lost, only three members voting for it. At the close of the meeting the contracts for the supply of the electric lighting plant were provisionally sealed.

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Bermondsey (London).—The application of the County of London and Brush Provincial Company for a Provisional Order for this district is to be opposed, as the Vestry is itself applying for an Order.

Blockley.—This village will shortly be lighted electrically, Jan. 10 having been fixed as the date for the inaugural ceremony. There are to be 28 incandescent electric lamps, with three oil lamps, for a portion of the district. We presume the decision to retain the three oil lamps was inspired by a desire to give the residents a practical and permanent demonstration of the advantages of the electric light.

Bromley.—The alterations suggested by the Board of Trade in the deed of transfer of the Bromley Provisional Order were considered at the last meeting of the District Council. The Board require that the capital of the proposed company be subscribed to the extent of £5,000 before they approve the transfer.

Cork.—A local syndicate has been formed to undertake the "free wiring" of premises in this town.

Dock Lighting.—The Tanjan Pagar (Straits Settlements) Dock Company are putting down a plant for lighting their wharves, docks, &c., by electricity. The dynamos and steam engines, which are of American manufacture, were supplied by Messrs. Bagnall and Hilles, of Yokohama and Singapore.

Dusseldorf (Germany).—The horse tramways of this town are to be converted into electric lines.

Edinburgh.—The *N.B. Mail* states that a rumour is abroad that the necessary electrical plant for the Edinburgh tramways to the value of £100,000 has been placed in America. The Paper does not mention what Edinburgh tramways the plant is for, and as no electric tramways exists in the City at the present time it is doubtful whether the rumour has any foundation in fact.

Electrical Imports into Argentina.—According to statistics recently published, the imports of electrical machinery and apparatus into Argentina during 1896 were as follows :—

Galvanised iron wire : 16,440 tons, valued at $1,036,972 gold, of which Germany supplied 6,884 tons, Belgium 4,113, United States 2,103, France 8, England 3,332.

Dynamos (33) : valued at $9,306. Germany 18, Belgium 7, France 6, England 2.

Electric light supplies : valued at $151,745. Germany $19,978, Belgium $6,962, United States $91,871, France $5,762, Italy $2,690, United Kingdom $24,482.

Cables and wires : 62 tons, value $38,846. Germany $8,366, Belgium $3,654, United States $11,205, France $1,446, Italy $883, United Kingdom $13,462.

Incandescent lamps : 8,921 dozen, value $26,763. Germany 4,935 dozen, Belgium 845, United States 2,610, France 71, Italy 71, United Kingdom 389.

Telephone material : value $11,020. Germany $1,292, Belgium $6,888, France $485, England $2,355.

Telegraph material : value $40,540. Germany $100, Belgium $4,310, United States $230, Paraguay $1,610 ; United Kingdom $34,125 ; other countries $165.

Electricity in Dye Works.—The extensive works of Messrs. J. Pullar and Sons, dyers, of Perth and Tulloch, have been equipped throughout for the electric light, as well as for the use of electric power and heating. The firm's electrical departments have been recently largely extended, and are now equipped for both arc and incandescent lighting.

Electricity in Mining.—It is expected that the electrical installation for the supply of power to the Simmer and Jack Proprietary and adjoining mines will be completed about the end of this month.

Electricity in Printing Offices.—The proprietors of the *Rangoon Times* have decided to put in electric motors for working their printing presses. The presses will be operated by independent motors, geared directly to each press and under independent control. Messrs. Bagnall and Hilles are executing the work.

Exhibition —An effort is being made to organise an international exhibition in Edinburgh in 1899.

Fenton.—The District Council have approved the application of the North Staffordshire Tramways Company for a Provisional Order to authorise the construction of additional tramways in the district. The application of the British Electric Traction Company to the Light Railways Commissioners has also been favourably received.

Fulham (London).—The Vestry have decided to abandon their suggested electric lighting and refuse-destructor scheme. The subject has been under consideration for the past three years, and has, on various occasions, been debated at great length by the full Vestry as well as the Electric Lighting Committee. The Fulham Provisional Order was obtained this year.

Gateshead —The Town Council have received a communication from the British Electric Traction Company (which recently agreed to purchase the undertaking of the Gateshead and District Tramways Company) asking for an extension of the lease of the present tramway system for a further 21 years. Should the extension be granted it is proposed to introduce electric traction and to greatly extend the system.

Greenock.—The Police Board have decided to oppose the application of the North British Electricity Supply Company for a Provisional Order for this district.

Harbour Lighting.—Some time ago the Bo'ness Harbour Commissioners purchased plant for the electric lighting of the harbour, and the contract for erecting this plant and supplying arc lamps, standards, &c., has now been given to the Brush Company.

Hawthorn (Victoria).—An electric lighting scheme for this district has been prepared by Mr. A. J. Arnot, the city electrical engineer of Melbourne. The total capital expenditure is put at £10,000, with £2,410 for annual working expenses, interest, &c. By charging 6½d. per unit for current for private lighting an income of £3,000 per annum is anticipated. The Council have authorised the preparation of specifications and the invitation of tenders for plant, machinery, &c., capable of supplying current to 42 2,000-c.p. arcs and 4,500 8-c.p. incandescents. Tenders will be also invited to submit proposals for working the plant for a number of years.

Hotel Lighting.—The Royal Hotel, Devonport, is being wired for the electric light. The contract has been let to a local firm (Messrs. Lord and Shand), who are carrying out the work to the plans and specifications of Mr. W. H. Trentham, M.I.M.E., the consulting electrical engineer to the Torquay Corporation. Current will be supplied from a "Taunton" dynamo driven by a 20 B.H.P. "Crossley" gas engine, and a battery of accumulators will also be provided. About 300 16-c.p. lamps will be installed.

Intimidation.—Messrs. Thomas Parker (Limited), of Wolverhampton, recently had occasion to discharge two workmen for endeavouring to influence and intimidate non-society men in the employ of the firm. The two workmen (named F. Bailey and T. Godwin) summoned Messrs. Parker for damages in lieu of notice. The magistrate held that the case against Bailey had been proved, but allowed Godwin a fortnight's wages.

Keswick.—The District Council have decided to transfer their Provisional Order to the local electric lighting company for £520.

Knottingley (Leeds).—A Committee has been appointed by the District Council to obtain information as to the desirability of erecting electricity supply works, and as to the cost of the necessary plant, &c.

Liverpool.—The question of the erection of arc lamps along the route of the proposed electric tramways was considered at the last meeting of the Lighting Committee. The suggestion to have central poles for suspending the lamps in the Prince's-road was adopted, but the consideration of the proposal to erect side poles in connection with the electric tramway system was postponed until a sub-committee, which was appointed to investigate the matter, has reported. An increase of 2,912 16 c.p. lamps during the past month was announced. The electric light mains are to be extended to Duke and Byrom streets.

Lisbon.—An electric power transmission plant is about to be put down at the Naval Yard at Lisbon for the Government. The generating plant is to be supplied by Maison Breguet of Paris.

Long-Distance Telephony. — The Postmaster-General on Wednesday received a deputation which waited upon him to complain of the delays in the transmission of telegrams between Liverpool and the Continent. The Duke of Norfolk (with whom was Mr. J. C. Lamb) promised to give the suggestions made his careful consideration, and as to communication with Hamburg undertook that an additional duplex wire should be made available between Liverpool and that port. He further held out hopes that, if found practicable, telephonic communication should be established between Liverpool and Havre.

Luton.—The minutes of the Electric Lighting Committee, presented at the meeting of the Town Council last week, stated that the report of Mr. Albion T. Snell on the electric lighting question had been received and was being printed. Mr. Snell recommends the adoption of an electric lighting scheme which would entail an initial capital expenditure of £16,000, with £3,000 to complete the installation in the second year.

Oldham.—At the meeting of the Electric Lighting Committee last week a communication was received from Prof. Kennedy, consulting engineer to the Town Council, recommending the putting down of two engines and dynamos, and an additional boiler at the electricity supply station. The Committee unanimously decided to adopt Prof. Kennedy's recommendation, and resolved to invite tenders from local firms and one London firm for the engines and dynamos.

Perth (Western Australia).—At an extraordinary general meeting of the Perth Mining and Trading Syndicate on Wednesday the Chairman (Sir J. C. Browne) said that they had received and

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accepted an offer for the transfer of their Provisional Order authorising the construction of electric tramways in the city of Perth.

Parliamentary Bills.—The following electric lighting and traction bills have been lodged at the Private Bill Office of the House of Commons. The Metropolitan Electric Supply Company seek power to erect electricity generating stations on a central spot in Marylebone on the banks of the Regent's Canal, and from this point to supply electrical energy in bulk to any company, body, or person, at such price and on such terms as may be agreed. The preamble of the Bill sets out that great difficulty is experienced by companies and local authorities who supply electric current in providing sufficient electrical energy to enable them to meet the demands of consumers at certain times of the day, whilst the production by each Company and local authority of sufficient energy to meet the maximum demands involves the expenditure of large sums of practically unproductive capital, and results in the consequent enhancement of the price that has to be paid for current.

In the Bill deposited by the Liverpool Corporation, power is sought to borrow £200,000 for electric lighting purposes.

The Bill lodged by the Metropolitan District and the London, Tilbury and Southend Railway Companies, seeks powers to raise the necessary capital for the construction of the Whitechapel and Bow Electric Railway. The capital of the proposed railway has been fixed at £660,000, with borrowing powers to the extent of £220,000, and the present Bill proposes to confer power on the two companies to guarantee interest on the share capital and debenture stock of the Whitechapel and Bow Company.

The City and Brixton Railway Company's Bill seeks powers to construct an underground electric railway from the City and South London Railway at Borough High-street to Brixton Hill. The proposed line will be nearly 3¾ miles in length. It is proposed to widen the City and South London line near London Bridge station, and to construct a subway connecting with the Kennington Oval station of that line. The capital of the proposed Company is £1,200,000, with borrowing powers to the extent of £400,000. The time sought for the completion of the works is five years.

The New Cross and Waterloo Railway Company require authority to construct an underground electric railway from the Old Kent-road to the Waterloo-road. The total length of the proposed line will be over three miles, and the time sought for its construction is five years. The capital proposed to be created is given at £975,000. Borrowing powers, by debenture stock for not exceeding £325,000, are also sought. It is proposed to enter into working agreements with the L. and S. W., the Waterloo and City, and the Baker-street and Waterloo Railway Companies.

In the Bill deposited by the Manchester Carriage and Tramways Company power is sought to enable the Company to work the whole of their lines electrically. It is proposed to construct seven generating stations upon lands already in the Company's occupation. The Bill also proposes to repeal section 39 of the Manchester Suburban Tramways Act (1878) which prohibits the carrying of goods and animals on the tramways, and power is taken to convey heavy traffic, at rates set out in a schedule attached to the Bill, between the hours of eight in the evening and eight in the morning. Power is also sought to raise £100,000 additional capital, and to borrow on mortgage £25,000.

The Dundee Corporation seek power to take over the lease of the tramways from the Dundee and District Tramways Company, and to work the tramways by electric or other mechanical power. Powers are also sought to acquire land for an electricity generating station.

A Bill is being promoted by the Town Council of Aberdeen to acquire the undertaking of the District Tramways Company, and to empower the Corporation to work or lease the undertaking.

Plymouth.—The Noah's Ark Inn in this city has been entirely rebuilt, and is to be fitted throughout for the electric light. An independent plant is installed for an output of an equivalent of 140 8-c.p. lamps, a Crossley high-speed gas engine being used. The work will be carried out by Messrs. Robinson, Sadler and Co., of Plymouth.

Poplar (London).—The Electric Lighting Committee of the District Board of Works have been authorised to pay visits to the electric light stations at Hanley and Bradford for the purpose of obtaining information in connection with the proposal to establish electricity and refuse-destructor works. A communication from an electricity supply company offering to take a transfer of the Poplar Provisional Order has been referred to the Committee, as were the plans of the County of London and Brush Provincial Company, with reference to the Company's application for a Provisional Order for the district.

Stockport.—A Local Government Board inquiry was held by Col. Durnford at Stockport last week into the application of the Town Council to borrow £25,000 for electric lighting purposes. The application was supported by the town clerk (Mr. W. Hyde), Mr. T. Webb (Chairman of the Gas and Electric Lighting Committee), and the consulting engineer (Mr. J. N. Shoolbred). The Town Clerk submitted financial details, and Mr. Shoolbred presented plans and particulars of the scheme. At the outset it was intended to supply only the leading business thoroughfares of the borough with electric current. The electricity supply station buildings would cost £3,000, and the generating plant £11,200; the mains and the distributing network, £5,000; street boxes, trenching, &c., £1,500; house service meters and contingencies, £1,500; engineers' fees, parliamentary and other expenses, £2,800; total £25,000. There was no opposition.

The Strike.—The record for the week is noticeable for an informal speech made by Mr. J. McLaren, of the well-known engineering firm of McLaren and Co., Leeds, who attended a meeting of the locked-out engineers at Leeds last week. Mr. McLaren stated that for more than 20 years he had been a manufacturer of steam engines in Leeds, and that during that time his firm had paid about a quarter of a million in wages, and he assured the assembled engineers that they could carry home the profits of this very considerable business in a very small purse. Engineering firms of this country had to compete with the whole of the mechanic nations. His own firm's goods were sent to 30 different countries. English engineers had no fear of foreign competition so long as masters and workmen held together, but so soon as any violent separation of interests arose the case was widely different. He was prepared to hand over a sum of money to a local infirmary if, on the inspection of his books by a chartered accountant, selected by the Amalgamated Society of Engineers, it could be shown that his business could be profitably conducted with the men being paid 54 hours' wages for 48 hours' work. The men's first mistake was that they had put forward an exorbitant and impossible demand, and the second mistake was made in failing to rectify the matter when they had the chance. Needless to say, Mr. McLaren's remarks had not an immediate effect, but we are informed that many of the engineers present were much impressed with Mr. McLaren's evident sincerity and earnestness. Another feature of interest is a letter from the Duke of Argyll, written to a correspondent asking his lordship's views upon the failure of the Westminster conference. The noble Duke says:—

> I have only one suggestion—more knowledge of the natural laws which determine "value" in all things, "labour" not excepted. As far as I can see, the demand made by the employers as to the exclusive control of the management of their enterprises is an absolutely just demand and necessary, and if the refusal of the employed does really turn on this they are fighting against nature and against justice. Braincraft is the governing power in all industrial enterprises, and all attempts to make it subject to handcraft, which falsely monopolises the title of labour, must end in discomfiture and in disaster to all concerned. If this law cuts at the root of trades unionism, as the leaders allege, so much the worse for trades unionism, because it is a natural law, which any man can see who exercises his reason dispassionately. But trades unionism can do, and has done, much when properly directed, without entering on the unnatural crusade into which it has been seduced by misleading leaders.

Yesterday the result of the second ballot of the engineers was announced. The questions submitted for the approval or disapproval of the men were the acceptance or rejection of the revised proposals of the masters as to management, &c., and a further issue was the views of the men upon the proposal of their representatives at the Conference on the subject of a 51 hours' week. In both cases the vote was an overwhelming majority in the negative. For the masters' proposals generally 1,041 only voted; against, 54,933. On the 51 hours' question 42,080 disapproved, against 8,515 for the proposal. The chief feature of these figures beyond the overwhelming character of the vote against all proposals for a compromise is the considerable falling off in the total poll. Against nearly 70,000 votes taken on the first ballot at the beginning of December only 56,000 were recorded in yesterday's figures, showing a total falling-off of 14,000 votes. This is, doubtless, partially accounted for by the Christmas holidays, but shows, we think, that a large body of the men are wavering. It is stated that the masters have decided to abandon all hope of any settlement of the dispute, and have decided to open their works to all competent workmen willing to take employment under the conditions ruling before the strike and lock-out. We shall be surprised if the considerable falling-off in the total poll in the last ballot does not prove a warning to the men's leaders that a considerable section of the engineers are disposed to accept the old conditions, recognising that their trade must permanently suffer if the present dispute continues a moment longer. It is, we think, only for a fairly large body in any one district to decide to return to their employ for such a movement to have a very general effect upon the men out of work. The leaders of the men can, however, point to the important fact that very large sums of money are being received from all parts of the world in support of the men's cause, and this is, we think, the main incident likely to protract the struggle. The result of the meeting of representatives of about 150 trades unions may have a decisive effect upon the course to be adopted by the men, but as a set-off the Employer's

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Federation, in acknowledging the receipt of the figures of the ballot, announce that "the truce is now at a end," and it is not, therefore, likely that they will be found to lack resources for a continuance of the dispute. A large and representative gathering of the members of the Employers' Federation was held at York yesterday, at which the proposals of the members at the Conference were unanimously approved, as "while affording employers the freedom which is necessary to manage their business, the proposals do not in any way interfere with the proper functions of trade unions."

Ventnor.—The District Council have passed the plans of the electricity supply station proposed to be erected in this town by the Ventnor Electric Light and Power Company.

Workhouse Lighting.—The Swansea Guardians have appointed a committee to consider and report upon the advisability of lighting the workhouse electrically.

The West Derby Guardians, at their meeting on Wednesday, decided upon putting down an electric light installation for the lighting of their Mill-road establishment, at an estimated cost of £7,000.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published s compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

November 19, 1897.

27,129. A. L. C. NODON, L. A. BRETONNEAU and P. D. SHÉR. Edinburgh. A new or improved electrolytic method of and apparatus for saponification.*

27,130. C. B. KING, Junr. London. Improvements in electrically illuminated signs.

27,153. W. R. COMINGS. London. Improvements in boxes and fittings for electrical conduits.

27,156. S. Z. DE FERRANTI and J. ATHERTON. London. A method of renewing incandescent electric lamps.

27,165. J. W. TOWNSEND. London. Improvements in electrical storage batteries or accumulators.

27,178. W. M. MORDEY. London. Improvements in dynamo brushes.

November 20, 1897.

27,183. C. BRANZELL, C. ELLISON, S. G. PETERSON, A. FRINDSHÖM, J. SUNDELL, MONSOS AND LARSON, A. C. ANDERSON, and W. WYSTROM. Kingston-on-Thames. Improvements in lightning arresters and cut-outs applicable to telegraph apparatus.

27,208. A. E. TANNER. Manchester. Improvements in ceiling roses and similar fittings for electric light service.

27,261. J. PRICE and J. JOHNSON. Birmingham. Improvements in covers, caps and lids for closing the entrances of gas, sewer, telephone and electrical supply shafts and holes, gulleys and the like.

27,271. H. C. GOVER and C. F. PROCTOR. London. Improvements in holders for electric glow lamps.

November 22, 1897.

27,303. C. A. BAKER. London. Improvements in prepayment electricity meters.

27,345. G. JAEGER and H. BENDER. Berlin. Improvements in sockets for incandescent lamps.*

27,346. G. JAEGER and H. BENDER. Berlin. Improvements in sockets for incandescent lamps.*

27,357. C. BRAULT. London. Means to be employed for charging a small number of accumulator elements from high voltage electric currents.

27,366. J. GUTMANN. London. Improvements in electrical switches.

27,372. C. E. MÜLLER and R. F. HURRAN. London. Improvements in the construction of the glass bulbs of electric incandescent and other lamps.

27,374. W. LANGDON-DAVIES. London. Improvements in the construction of transformers, choking coils and similar electric appliances.

27,380. G. M. SELLICK. London. Improvements in and relating to electrical cut-outs and fittings.

27,387. A. MARTIN. London. Electro-therapeutic exercising apparatus. (Date applied for under Patents, &c. Act 1883, sec. 103, 10th May, 1897, being date of application in France.)

27,398. A. EWALD and M. FRIEDLAENDER. Liverpool. An improved means for indicating the duration of conversations in public telephones.

November 23, 1897.

27,428. H. S. RIANT. London. Improvements in and connected with electric furnaces for the production of calcium carbide and other substances.

27,430. G. CAMERON. Glasgow. Improvements in fixed and portable electrically-driven circular sawing, moulding, rebating, planing and surfacing machinery.

27,433. G. H. NISBETT and D. BATES. Liverpool. Improvements in electric cables.

27,451. E. R. DALE. Salisbury. Improvements in fastenings for boxes for electric accumulators and the like.

27,483. P. SPIES, W. H. NEWALL, and A. W. SHOUT. London. Improvements in connection with electric arc lamps.

27,474. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in the method of and means for regulation of alternating-current systems. (C. P. Steinmetz, United States.)*

27,495. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in starting devices for alternating-current motors. (W. J. Foster, United States.)*

27,496. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in dynamo electric machines of the inductor type. (C. P. Steinmetz, United States.)*

27,508. O. MARSH. London. Improvements in and connected with the extraction of gold by electrolysis.

27,509. J. MÖHRLE. London. A new and improved meter for electric current.

27,542. A. S. NEWMAN and NEWMAN and GUARDIA (LIMITED). Improvements in kinematograph apparatus.

27,543. J. D. GOULD. London. Improvements in electric cables.*

27,544. C. W. PRICE and J. D. GOULD. London. Improvements in automatic electro-mechanical circuit closers.*

27,551. J. W. SWAN and A. C. HYDE. London. Improvements in means to be employed in the electrolysis of salts

November 24, 1897.

27,598. G. BYNG. London. Improvements in electrical fusible cut-outs.

27,619. R. NORDMANN. Brussels. Improvements in incandescent electric lamps.

November 25, 1897.

27,672. C. A. OWEN. Dublin. An improvement in the application of heat (by gas, electricity, or any other source of heat controllable by a tap or switch) to the sterilisation of water, whereby the process is rendered noiseless and automatic.

27,683. W. H. LANE. Staines. Improvements in and connected with electrical storage batteries.

27,695. S. E. FOSTER. Birminghani. An improved switch for the making and breaking of high voltage electric currents.

27,706. J. E. HARTLEY and H. E. HARTLEY. Birmingham. Improvements in barrelling electro-metallic depositing apparatus.

27,707. J. E. HARTLEY and H. E. HARTLEY. Birmingham. Improvements in rotative electro-metallic depositing apparatus.

27,712. A. HIRSCH. London. Improvements in electrodes for use in connection with apparatus for welding and soldering by means of electricity.

27,714. J. JOHNSTON. London. Improvements on those systems of electric tramways and railways in which current is collected from two insulated conductors (positive and negative), such improvements being in connection with crossings and turn-outs.

27,715. G. S. HINGLEY. Birmingham. Improvements in incandescent electric lamp globes and in the manufacture of the same.

27,725. H. LEITNER. London. Improvements in the construction of accumulators.

27,749. W. J. DAVY and G. T. DAVIES. London. Improvements in arc lamps.

27,765. T. SPENCER, London. Improvements in electric arc lamps.*

November 26, 1897.

27,805, A. WATSON. Birmingham. Improvements in electric lamp holders.

27,806. A. WATSON. Birmingham. Improvements in electrical switches.

27,807. A. WATSON. Birmingham. Improvements in and in the manufacture of switches for electrical purposes.

27,837. H. WHITE and R. C. GRAHAM. Clapham. Improvements in electrical indicators for use on public and other vehicles.

27,844. F. N. HAWARD and H. H. CASS. London. An apparatus for gripping and removing or placing in their holders electric incandescent lamps, globes and other articles.

27,845. J. D. F. ANDREWS. London. Improvements in arc lamps and in magnet winding for same and other purposes.

27,861. H. EDMUNDS. London. Improvements in electric cables.

27,875. A. SOAMES. London. Improvements in electric lifts.

27,888. C. S. BRADLEY. London. Electric furnaces.*

November 27, 1897.

27,926. J. CARR. Bradford. Improvements in cable or conductor ways and connections therefor for underground electric traction.

27,940. M. ORBAN. Brussels. Improvements in electric batteries.

27,970. A. W. SMITH. London. Improvements in dynamos and motors. (Date applied for under Patents, &c., Act, 1883, Sec. 103, May 3, 1897, being date of application in United States.)

27,973. C. CLARK. London. Improvements in charging secondary batteries or accumulators.

27,982. W. ROWBOTHAM. London. Improvements in primary batteries

27,995. V. A. FYNN. London. Improvements in or connected with devices for protecting electric circuits and apparatus from injury by excessive electrical potential due to lightning or other cause.

November 29, 1897.

28,023. A. JACKSON. Stoke-on-Trent. An improvement on the ordinary "tumbler" switch for use with the higher voltage electric current.

28,024. J. H. TUCKER. Birmingham. Improvements in electrical switches.

28,028. F. A. WILKINSON. Bournemouth. Improvements in and relating to automatic transformer switches.

28,116. H. C. GOVER, C. F. PROCTOR, and W. G. PIPKINS. London. An improvement in holders for electric glow lamps.*

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November 30, 1897.

28,159. S. WATKINS. Wolverhampton. Means for use in lighting railway cars or carriages by electricity, and for regulating the current for the same. (The American Railway Electric Light Company, United States.)*
28,225. J. M. BROWN. London. Improvements in electric railways.*
28,238. W. D. G. O'HALLORAN. London. An improved coupling for electric light fittings.
28,242. P. J. R. DUJARDIN. London. Improvements in or relating to negative plates for secondary batteries.
28,246. H. C. GOVER and W. MÜLLER. London. An improvement in safety electric fuses.*
28,254. H. M. SALMONY. London. Improvements in electric switches.
28,268. J. TIMAR. London. Current collectors for electric railways with overhead wires.*

December 1, 1897.

28,325. C. C. ALLINGHAM and W. FENNELL. London. Improved means for attaching lead-covered electric cables to connection-boxes.
28,338. F. J. SATCHWELL. London. Improvements in pumps for exhausting electric incandescent lamps.
28,350. J. E. LIARDET. London. Improvements in and relating to dynamos and electric motors.
28,351. C. HEAP and T. ODDY. London. Improvements in and relating to electric lamps for cycles.
28,362. E. M. GRANT. London. Improvements in the method of and means for transmitting electric currents in railway and tramway systems.
28,382. H. H. LAKE. London. Improvements in and relating to commutator brush carriers for electric machines. (Compagnie de l'Industrie Electrique, Switzerland.)

December 2, 1897.

28,414. A. FORD-LLOYD and A. E. MONDEY. Southampton. Improvements in or relating to electric indicator fittings.
28,457. L. HIGGINBOTTOM, J. H. HINDLE and T. MANNOCK. London. Improvements in apparatus for regulating and controlling electric motors.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

24,574. HOWELL. Microphones.
25,170. DE KILDUCHEVSKY. Loud-speaking, long-distance telephone.
26,267. CROMPTON and FOX. Enamelling processes for electric heating apparatus.
26,677. SNELL, GROVE, and HILLS. Electric switches for use in connection with electrically-propelled vehicles and locomotives, and for other purposes.
27,053. HOLIDAY. Insulator device for carrying vertical or other similarly suspended electric cables.
27,167. O'KEENAN. Electrical batteries.
27,207. PENNINGTON. Electric ignition of charges in explosion engines.
27,482. WATSON. Incandescent electric lamp-holders.
27,588. HAWKINS. Insulating material for electric conductors.
27,695. HAWKINS. Insulation of electric conductors.
27,903. SCHARF. Electrical glow lamps.
28,101. SINCLAIR. Means for lighting by electricity and incandescence.
28,443. STILL and COWAN. High-tension electric fusible cut-outs.
28,764. HURTER AND UNITED ALKALI COMPANY (LIMITED). Apparatus for use in electrolysis, more especially intended for use in the electrolysis of zinc chloride.
28,884. BLACKBURN and SPENCE. System of electric distribution for combined lighting and traction plants.
29,120. WALLER. Conduits for electrical traction.
29,121. WALLER. Electrical fittings for conduits adapted to electrical traction.
29,472. JACKSON and Co. (LIMITED) and LEWIS. Electric switches.
29,831. SIEMENS BROS. AND CO., LIMITED (Siemens and Halske). Current collectors for electric railway or tramway cars with overhead conductors.

1897.

88. JULIEN. Cathodes employed in galvano-plastic or electrotyping processes.
488. MARSHALL. Dynamo-electric machines and electromotors.
11,051. THEERMANN. Ceiling roses for electrical purposes.
18,161. SAYER. Electric and other motor vehicles.
18,430. PESCETTO. Manufacture of electric accumulators.
19,380. GRIFFITHS. Conduits for electric or cable tramways or railways.
20,493. BRADLEY. Transmission of energy by alternating currents.
20,913. CUTTING and CUTTING. Machine for painting electric casing and the like.
21,054. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED (Hewlett). Surface-contact electric railway systems, electric cars and their equipment, and automatic switches for use therewith.
21,100. LAKE (Fairbanks). Alternating electric current generators.
21,195. BADGER. Continuous-current dynamo-electric machine.
21,951. HEFTMANN. Electrical alarms.
22,023. IMRAY (Bergmann). Electric arc lamps.
22,032. ADOLPH. [Detachable securing mechanism for electric incandescent lamp shades.
22,217. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED (Thomson). Shielding devices for electric meters.
22,521. HORRY. Electric furnaces.

BOOKS RECEIVED.

"Fortschritte der Elektrotechnik." By Dr. Karl Strecker. Year 1895 : part 3. (Berlin : Julius Springer. Price 5 marks.)

"Lockwood's Builders', Architects', Contractors', and Engineers' Price Book for 1898." Edited by F. T. W. Miller. (London : Crosby Lockwood and Son.) Price 4s.

"Annuaire de L'Observatoire Municipal de Montsouris," for 1898. (Paris : Gauthier-Villars et Fils). Price 2fr.

"Elektrische Bahnen," 1897-1898. (Berlin : Union Elektricitäts-Gesellschaft.)

COMPANIES' MEETINGS AND REPORTS.

Amazon Telegraph Company (Limited).

The third ordinary general meeting of this Company was held at the offices, Blomfield House, London Wall, E.C., yesterday (Thursday) under the presidency of Mr. W. S. Andrews.

The SECRETARY (Mr. R. M. Cunningham) having read the notice convening the meeting,

The CHAIRMAN said the report, which had been in the shareholders' hands for the past week, would have made them acquainted with the position of affairs, and the accounts which accompanied the report gave a clear statement of the financial position of the Company. It would be seen that communication had been re-established with their chief station at Manáos at the end of November last, and that the revenue therefore, only represented the income from an incomplete system. The repair of other interrupted sections of their line was now proceeding; otherwise the Company's cables were in good working order. The directors were fully aware of their responsibilities to the shareholders, and their great desire was to make a more flourishing statement of accounts possible, and he was sure they were doing and would do all in their power. The Company were taking now nearly £300 a week, as well as the subsidy, and from November they had been earning profit. He then proposed—

"*That the report and accounts to June 30, 1897, now submitted be, and the same are hereby approved and adopted.*"

Mr. GEORGE KEITH seconded the motion.

Questions were asked by shareholders, to which the Chairman replied, and the question was then carried uanimously.

The CHAIRMAN then moved the re-election of Mr. John Coppen as a Director, which was seconded by Lord RICHARD H. BROWNE, and carried unanimously.

The CHAIRMAN moved the re-election of Mr. D. H. Goodsall as a Director of the Company, and Mr. G. KEITH seconded, and carried unanimously.

Mr. COLE moved the reappointment of Messrs. Deloitte, Dever, Griffiths and Co. as auditors of the Company at a salary of 50 guineas, which was seconded by Mr. BAILEY, and carried.

Mr. COLE, in proposing a vote of thanks to the Directors and Secretary, said it was disappointing that the report was not as satisfactory as it might be, but this was due to causes beyond human control. Of course the shareholders were disappointed, and were disposed to put the blame on to the Directors, but he was sure those gentlemen had worked very hard, and were not to blame.

Mr. BAILEY seconded the motion, which was carried unanimously.

The CHAIRMAN, in reply, said he had to thank them on behalf of his co-Directors and the Secretary for their kind vote, and he was sure every effort would be made to produce the best possible results from their complete working.

Electrical Copper Company (Limited).

The first annual ordinary meeting of this Company was held on Wednesday, Mr. H. M. Matheson presiding.

The SECRETARY (Mr. Keith Anstruther) read the notice calling the meeting.

The CHAIRMAN said: Gentlemen, I am glad that we are able to meet you before the close of the year to present our first annual report and the accounts to June 30th last. Our Company being an industrial one, with machinery of a very special character, it cannot have surprised our shareholders that some longer time has been required to get into working order than we at first anticipated. You are aware that, besides the experimental works in the neighbourhood of Paris, we undertook to erect works in England, where at least 30 tons of manufactured copper could be turned out weekly, so as to give the trade the most complete assurance of the satisfactory results of using the process, the patents for which this Company had secured. For these works Widnes was chosen as the best site, for good commercial reasons. All our time and energies have been devoted to the preparation of these works. Difficulties have been met and overcome, defects in the plant have had to be remedied, economies have been introduced, the utmost efficiency has been aimed at and secured, and I have pleasure in saying that our Widnes works are now turning out copper sheets in execution of orders to the complete satisfaction of customers, whose only desire is to obtain larger quantities. The quality of the copper has been pronounced by all to be very superior, and a series of tests made by the eminent firm of J. Kirkaldy and Son have demonstrated its exceptionally high mechanical properties. In a very few weeks' time we shall have 30 tanks in operation at Widnes, which will enable us still further to reduce costs and to bring them to a point that will ensure profitable working. And I am able to inform

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you that several important firms are anxiously waiting for this to enable them with confidence to go forward to work our process under licences. At the Brunoy works, which were at first merely experimental, excellent work is being done in the manufacture of special sheets suitable for engravers and other purposes. In the course of the work carried on at Brunoy certain additional mechanical details have been elaborated and covered by supplemental patents, and so far as we know nothing has been neglected by us to place the business of the Company in the very best position to realise a profitable result to our shareholders. The balance-sheet which we present does not, I think, require much explanation. You are aware that the subscribers to the preference shares of £100,000, issued in May, 1896, undertook to subscribe the remaining 50,000 preference shares prior to June 30th last, but as the money was not required, the fulfilment of this obligation was postponed until December 31st. The £50,000 has, however, since been taken up and paid in full as an addition to the working capital. I do not think I need detain you further. We confidently expect to call you together at a rather earlier period in the coming year, and, unless we are mistaken, to be able then to present to you accounts which will exhibit results of which none of us shall need to be ashamed. I now beg to move—

"*That the report and accounts, as now submitted, be received and adopted.*"

Mr. ROBERT M. MOIR seconded the motion, which was agreed to without discussion.

The auditors (Messrs. Turquand, Youngs and Co.) having been re-elected, the proceedings terminated with a vote of thanks to the Chairman, proposed by Mr. MEYER and seconded by Mr. SYMONS.

Great Horseless Carriage Company (Limited).

An extraordinary meeting of this Company was held on Wednesday, at Coventry, Mr. H. J. Lawson presiding.

The CHAIRMAN, in the course of his opening remarks, said public opinion had undergone a great change during the past twelvemonths on the future of the motor-driven vehicle. After referring to many successful runs made in various parts of the country, he said the Directors had been twitted on the enormous amount of money being spent on perfecting the electric cab. But the ten or twelve thousand pounds they had spent on the electric cab had produced the London electric cab. It was the first time in the history of the world that electric cabs had been put upon the streets to take traffic, which these cabs had done to the satisfaction of everyone. They had the sole right to build these cabs, and they had received orders for 75 London electric cabs from a company a week or two ago. All the cabs the Company wanted were supplied from their Coventry works, or else they had to consent to the order being given elsewhere. Fifty cabs were being built under their patents and licence by another firm, because they were not ready to do that work. Their vans were also being used in London, and were giving satisfaction. It was only 13 months since they started, and the shareholders could hardly expect much more. They had now more orders than they could turn out, and the Daimler Company was booked up for all next year. They had 260 cars in hand. There were one or two other makers who had succeeded in making cabs, but they would be pleased to run their cabs against any other make in the world. Having plenty of money and plenty of work, the shareholders might wonder what was the necessity for the scheme of reconstruction which they were now asked to consider, for notwithstanding their enormous expenses, they had been earning a profit. The company, which would, if the reconstruction scheme were approved, take the place of the Great Horseless Carriage Company, would have the advantage of paying a dividend on a much smaller sum than this Company would do if they continued on the present lines. With regard to the money spent on experimenting, he did not think it had been wasted, as it had taught them a great deal.

Resolutions were then approved for reconstructing the Company, Mr. Baker, of Chiswell House, Finsbury-pavement, London, E.C., being appointed liquidator in the voluntary winding-up of the old Company. The name of the newly-constituted company did not transpire.

London Electric Omnibus Company (Limited).

The Ordinary general meeting of this Company was held yesterday at Winchester House, Major S. Flood Page presiding.

The CHAIRMAN read the notice calling the meeting, and said: I am glad that the time has come when it is my duty to discuss with you the affairs of this Company. We postponed holding the meeting until almost the end of the legal period allowed us because it was our desire, when we met you, to be in a position to say that we had made an alliance with one Company for building omnibuses, and with another for the manufacture of accumulators. I am pleased to be able to say that a Company called the Electric Street Car Manufacturing Syndicate has come into existence, and that I have been summoned to a meeting of the Board at Wolverhampton on Wednesday next for the purpose of allotting the shares. We have been confronted with great difficulties, owing to not having proper premises. The amount of capital at the disposal of the Directors not being sufficient to enable us to commit the Company to the expenditure necessary for the purchase or lease of suitable premises we have had to contract for the several portions of the omnibuses with various firms in different parts of the kingdom, the engineer then putting the parts together in London under great difficulties in the cramped and insufficient premises at our disposal. I think the shareholders must all be disappointed that more progress has not been made, but though that may be the case I would point out that real progress has been made. The first step in that progress is that we have solved the whole of the manufacturing problem. As the Directors' report states, "The Directors have during several months past been negotiating for, and assisting in the formation of the Electric Street Car Manufacturing Syndicate which was registered on the 3rd inst.; a contract has been made between this Company and the Syndicate by which, among other things, it has been agreed that Major Flood Page should accept a seat on the Board of the Syndicate, and Mr. Thomas Parker, Managing-Director of Thomas Parker Limited, Wolverhampton, shall accept a seat on the Board." Another proof that we have made progress is that this is the only company in England, if not in Europe, which has got an electric omnibus to run along the streets without rails. We have now one omnibus which holds 26 passengers, and, as our engineer (Mr. Radcliff Ward) points out, the technical difficulties in successfully producing a large vehicle, such as the roomy and luxurious omnibus belonging to this Company, are far greater than in the case of small vehicles carrying only a few passengers. Then we have another omnibus, carrying ten passengers, which was licenced by the police yesterday, for the purpose of traffic in the streets. The 26-passenger omnibus will almost certainly be licenced by the police during the next week or two and, in addition, we have another 26-passenger omnibus partly built. The Electric Street Manufacturing Syndicate have nearly completed their first omnibus for us, and in the course of a very short time we shall have, I hope, at least one 26-passenger, one 10-passenger and one 16-passenger electric omnibus running in the streets of London. With regard to the Sola accumulator, I do not intend to launch out into any extravagant praise of it, and we never have been guilty of declaring that we have a better accumulator than anybody else, but what we say is, that in the Sola accumulator we have an accumulator admirably adapted for our purposes. I regret that Mr. Spagnoletti, our consulting electrical engineer, is confined to his bed with influenza, but he has sent me a report on the Sola accumulator, in which he says that the tests of it have been most satisfactory, and he is as sure as he can be that we have a good accumulator. As the accounts show, the Company has no debentures and practically no debts, and I believe the foundation of a successful business has been laid. All that is required is that the shareholders should work together, that a comparatively small amount of money should be provided for the immediate purposes of the business, and that there should be some alteration in some of the details of the Company. There is no reason for panic, least of all for winding-up the Company, as has been suggested. If the vendor and his associates had paid the money due on his partly-paid shares the Company would have had ample funds for immediate requirements. It is for you to determine whether you will keep the business in your own hands or let somebody else profit by what has been already done. The Directors are willing that a committee of shareholders should be appointed to consult with them on the position and requirements of the Company. I now move that the report and accounts for the period from May 18, 1896, to November 30, 1897, be adopted.

Mr. HENRY FOX seconded the resolution.

Mr. SCHULTZ CURTICS complained of the delay which had taken place in getting omnibuses on the streets, and pointed out that the prospectus led them to believe that the system of electric street traction, as acquired by this Company, was a proved success and not an experiment. He blamed the Board for going to allotment on so small a capital.

Mr. CONDICT was opposed to the Company manufacturing accumulators instead of omnibuses. He thought if any of the directors were interested in the success of the Sola accumulator they should resign.

Captain STEWARD questioned the wisdom of Mr. Parker joining the board in view of his relations with a company with which this Company would have transactions.

The CHAIRMAN, in reply, said the Board had taken steps to sell the Sola accumulator to a syndicate, but owing to a claim made by the trustee in Mr. W. Marshall's bankruptcy all progress for the formation of the Sola Syndicate had been stopped temporarily. He could assure them that the Directors had had an anxious time in looking after the Company's affairs, and if it were the wish of the shareholders they would readily resign their positions.

The resolution was carried.

It was afterwards resolved that Col. Turnbull, Mr. Hayden, Mr. Scrymgeons, and Mr. Condict should constitute a committee to consult with the Directors on the position and requirements of the Company, and report to the shareholders within 60 days.

NEW COMPANIES, STATUTORY RETURNS, &c.

WILLIAM COATES AND SON (LIMITED).—This Company was registered in Dublin on Dec. 22, with a capital of £25,000 in 2,500 shares of £10 each, to acquire and take over as a going concern the business now carried on in Belfast by William Coates and Son, electrical engineers, copper and brass-founders, millwrights, &c. The first directors: are W. T. Coates, W. C. Macann and E. S. Dashwood.

ELECTRIC HANSOM CAB AND CARRIAGE SYNDICATE (LIMITED).—This Company was registered on Dec. 11, with a capital of £2,000, in £1 shares, to establish and carry on the business of manufacturers and proprietors of electric and other motor cabs, hansoms, &c., generators of and dealers in motive power, proprietors of charging stations, &c. The subscribers are:—S. Harmer, W. Hall, R. C. Neighbour, H. E. Greville, J. S. Jarvis, T. W. Precious, and G. Hickson.

EUROPEAN ELECTRIC FINANCE COMPANY (LIMITED).—This Company was registered on Dec. 22, with a capital of £5,000, in £1 shares (of which 2,000 are Deferred), to enter into an agreement with Mr. Hermann Lands-

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berg to acquire rights, concessions and privileges from any governments, local authorities, or otherwise, and to construct, equip, maintain and work any electric lighting and power works, railways tramways, telegraph lines and public works of all kinds. The subscribers are: F. L. Burnside, F. Wyatt, W. N. Morrison, A. Powles, S. G. Benge, C. J. Kneller, and A. S. Jacques.

NEW ZEALAND ELECTRIC LIGHT AND TRACTION COMPANY (LIMITED).—This Company was registered on Dec. 20, with a capital of £5,000, in £100 shares, to acquire, develop, and deal with any rights, concessions and privileges relative to the supply of electricity in New Zealand or elsewhere, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, electrical apparatus manufacturers, &c. The first subscribers are: J. A. Kelman, J. Rowell, W. Lewis, S. C. Brady, David Slutor, H. R. Savory, and W. W. Paine.

OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY (LIMITED).—This Company was registered on Dec. 18, with a capital of £80,000, in £10 shares, to acquire the powers and privileges conferred by the Oldham, Ashton-under-Lyne, Hyde and District Electric Tramways Order (1896), and to construct, equip, maintain and work the tramways authorised by the said Order. The subscribers are: L. Atherley-Jones, Q.C., M.P., Albert R Monks, James Devonshire, electrical engineer, Emile Garcke, electrical contractor, Stephen P. W. d'A. Sellon, civil engineer, Charles Walmsley, and Harold S. Hodgson. The first directors are: Emile Garcke, A. R. Monks, L. A. Atherley-Jones, Ald. Robert Whittaker, J.P., and Ald. Thomas Heginbottom, J.P.

SHANNON ELECTRIC POWER SYNDICATE (LIMITED).—This Company has been registered in Dublin, with a capital of £12,000, in £1 shares, to carry on the business of electricians, mechanical engineers and suppliers of electricity for lighting, heating or motive power purposes.

TURRELL MOTOR MANUFACTURING COMPANY (LIMITED).—This Company was registered on Dec. 23, with a capital of £10,000, in £1 shares, to enter into agreements with Harry J. Lawson and Charles M. Turrell and the British Motor Company (Limited), and to carry on the business of motor and motor car manufacturers, carriage builders, &c.

ANDERSON ELECTRICAL TRACTION SYNDICATE (LIMITED).—The statutory return to Nov. 2 states that out of a capital of £5,000, in £1 shares, 4,020 shares have been taken up and 2,010 issued as paid, while £2,010 has been received on the others.

AURORA ELECTRIC LIGHTING AND DISTRIBUTION COMPANY (LIMITED).—The annual return to Oct. 20 has been filed. The capital is £25,000 in £1 shares, and 5,935 have been taken up; 5,000 have been issued as paid, and the full amount has been paid on the others.

AUTOMATIC TELEPHONE COMPANY (LIMITED).—The statutory return to Nov. 12 has been filed. The capital is £100,000, in 5s. shares, of which 270,326 have been taken up; 226,296 are considered as paid, and 3s. per share has been called on the remainder, resulting in the receipt of £2,579. 6s., and leaving £4,025. 4s. in arrears.

BRITISH INSULATED WIRE COMPANY (LIMITED).—The statutory return to Aug. 30 has been filed. The capital is £400,000, divided into 40,000 Preference and 40,000 Ordinary shares of £5 each. 20,000 Preference and 39,400 Ordinary have been taken up, and 5,530 of the former and 29,375 of the latter have been issued as fully paid; £1. 10s. per share has been called on the others.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The annual return to Oct. 1 has been filed. The nominal capital is £660,000, divided into 180,000 Ordinary and 150,000 Preference shares of £2 each; 90,000 Ordinary and 90,000 Preference shares have been taken up, and the full amount called.

CANTON (WAIPORI) MINING AND ELECTRIC POWER COMPANY (LIMITED).—The statutory return to Aug. 14 has been filed. 7 shares have been taken up and paid for in full out of a capital of £150,000 in £1 shares.

CENTRAL ELECTRIC SUPPLY COMPANY (LIMITED).—The statutory return to Oct. 22 has been filed. Seven shares have been taken up out of a capital of £200,000, in £5 shares, but no calls have been made.

CORBRIDGE ELECTRIC LIGHTING COMPANY (LIMITED).—The statutory return to Sept. 16 has been filed. The capital is £4,000, in £5 shares. Seven shares have been taken up, 10s. per share has been called, and nothing has yet been paid.

EASTON, ANDERSON AND GOOLDEN (LIMITED).—The annual return to Nov. 13 has been filed. The capital is £200,000, in 10,000 Preference and a like number of Ordinary shares of £10 each. 5,996 of the former and 10,000 of the latter have been taken up, and 12,206 have been issued as fully paid. The full amount has been called on the remainder.

EAST GRINSTEAD ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return to Nov. 3 has been filed. Seven shares have been taken up out of a capital of £15,000 in £1 shares, but no calls have been made.

MEVAGISSEY ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return to April 1 was filed on Dec. 10, when 1,132 shares were taken up out of a capital of £1,500, in £1 shares.

MELTON MOWBRAY ELECTRIC LIGHT COMPANY (LIMITED).—The statutory return to Nov. 10 has been filed. The nominal capital is £10,000, in £5 shares. Seven shares have been subscribed for, but no calls have as yet been made.

MIDLAND ELECTRIC CORPORATION FOR POWER DISTRIBUTION (LIMITED).—The statutory return to Nov. 4 has just been filed. The nominal capital is £200,000, in £5 shares; seven shares have been taken up, but no calls have as yet been made.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26⅝d. per oz. (Dec. 30). Consols (2¾ per cent.) 112$\frac{7}{16}$—112$\frac{9}{16}$ for money, 112⅞—113 for account; 2½ per cent. 105$\frac{3}{16}$—106$\frac{1}{16}$ (Dec. 30). Stock Exchange Settling Days: Consols, Jan. 3; Stocks and Shares Continuation Days, Jan. 11 and 25; Ticket Days, Jan. 12 and 26; Pay Days, Jan. 13 and 27; Mining Share Carry-over Days, Jan. 10 and 24.

BABCOCK AND WILCOX (LIMITED).—At an extraordinary general meeting of this Company at the Cannon-street Hotel, E.C., on Wednesday, the resolutions passed on the 14th inst., increasing the capital of the Company to £320,000 by creating 8,000 new Ordinary shares of £10 each, were approved.

BROCKIE-PELL ELECTRIC LAMP (LIMITED).—In our report of the meeting of the shareholders of this Company on the 20th inst., which appeared in our last issue, Lord Suffield was reported to have said "That after legal proceedings it had been settled that the Company had a right to certain lamps already manufactured when the undertaking was taken over by the Company." We are informed that this is a mistaken report of Lord Suffield's remarks, and that the Company has not been involved in any lawsuit since it was formed.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company was held on Tuesday, at which the resolutions relative to the surrender of the Founders' shares, passed at the extraordinary general meeting on the 17th inst., were confirmed.

KELVINSIDE ELECTRICITY COMPANY (LIMITED).—The annual meeting of this Company was held on Wednesday. The Chairman (Mr. J. B. Fleming) said that they were not in a position to announce a dividend, but they had turned the corner and were not far from success. The number of consumers was increasing. If they had authority to supply current in Partick he was convinced the Company would be a paying concern, and he thought they were likely to obtain the Order for that district. The Directors' report was adopted.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Thursday, Jan. 6, as a special settling day in 25,000 Vendors' shares of £10 each, fully paid (Nos. 36,473 to 61,472) of the Great Horseless Carriage Company (Limited), and the further issue of 12,500 Ordinary shares of £5 each, £2 paid (Nos. 43,342 to 55,841) of the South London Electric Supply Corporation (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Dec. 24 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,868.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Inc. or Dec.
	1897	£	£		£	£
Birmingham Tramways.	Dec. 25	3,177	+157	...	...	...
Bristol Trams & Carriage	,, 24	2,726	+587	25	65,517	+10,173
City & South London Ry.	,, 26	1,055	+ 83	26	25,115	+ 40
Dover Tramways	(5 days)24	87	...	16	1,780	...
Dublin United (Southern)	...	...	...	...	...	...
Liverpool Overhead Rly.	,, 26	1,341	+ 37	26	36,561	+ 4,833
Sheffield Tramways	,, 26	1,075	+ 34	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Dec. 22.	Price Wednesday, Dec. 29.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 25. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	3/0	Central London Ordinary	9¾ 10¼	9¾ 10¼	2 13 6	June and December	10	.
145,106	10	1/3	Do. (£6 paid)	5¾ 6	5¾ 6	3 0 0	,, ,,	5⅞	5⅛
£200,000	Stock	2½	City and South London Railway Con. Ordy.	66 68	66 68	2 15 2	January and July	67½	66
8,410	£10	5%	Do. 5% Perpetual Preference	15 16	15½ 16	3 2 6	,, ,,	...	...
£125,701	Stock	4%	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	139½	138½
54,000	10	2/3½	Waterloo and City Ordinary	12½ 13	12½ 13	2 6 1	June and December	12⅝	12⅜
37,500	10	3%	Liverpool Overhead Railway Ordinary	11$\frac{1}{16}$ 11$\frac{5}{16}$	11⅛ 11⅜	2 11 7	February & August	—	—
15,000	10	5%	Do. 5% Preference	16 16½	16 16¾	3 0 7	,, ,,	—	—
125,000	Stock	4%	Do. 4% Debenture	110 112	110 112	3 11 5	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 22.	Price Wednesday, Dec. 29.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 25. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£323,980	Stock	14/0	Anglo-American	59 61	59 61	4 14 3	Feb., May, Aug., Nov.	59½	..
£3,038,020	Stock	23/0	Do. Preferred	106 107	107¼ 10½	5 6 0	" "	107	106½
£3,038,020	Stock	5/0	Do. Deferred	12¾ 13½	13 13½	..	" "	13 1/16	12¾
£'37,400	£100	4%	*African Direct Telegraph (Red)	101 105	101 105	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	5½ 6½	5½ 6½	..	..	..	..
130,000	10	3/0	Brazilian Submarine	16 16½	16 16½	4 4 10	Mar., June, Oct., Dec.	16½	16¼
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1905)	114 118	114 118	4 5 10	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	183 188	183 188	4 5 1	Jan., Apr., July, Oct.	..	..
£353,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105 107	105 107	3 14 9	" "	106½	105¾
16,000	10	8/0	Cuba Submarine	8½ 9½	8¾ 9½	8 8 5	February and August	9¼	..
6,000	10	10%	Do. Preference 10 per Cent.	18½ 19½	18½ 19½	5 2 7	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103% 106%	103% 106%	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10¼ 10½	10¼ 10½	4 17 8	Jan., Apr., July, Oct.	10½	10 7/16
400,000	£10	2/6	Eastern	17 17½	17 17½	3 14 4	" "	17⅜	17⅛
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18 19	18 19	3 3 8	" "	18⅜	..
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	130 133	130 133	3 0 6	May and November	131½	..
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101 104	101 104	4 14 9	February & August	..	..
250,000	10	2/6	Eastern Extension	18½ 18¾	18½ 18¾	3 17 9	Jan., Apr., July, Oct.	18 7/16	18⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	132 135	132 135	2 19 3	February & August	..	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	101 105	101 105	4 17 3	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	101 105	101 105	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103 103	103 106	3 15 8	February & August	105½	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108% 111%	108% 111%	3 12 1	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	11½ 12	11½ 12	3 15 0	Jan., Apr., July, Oct.	11 1/16	11⅝
180,042	10	6%	Do. 6 per Cent. Preference	17½ 18	17½ 18	3 6 8	" "	17⅜	17½
150,000	10	5/0	Great Northern of Copenhagen	25½ 26½	25½ 26½	3 15 6	January, April, July	26¼	26¼
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	102 105	102 105	4 15 3	March & September	..	..
17,000	25	12/3	Indo-European	52 55	52 55	4 10 11	May and November	53½	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	107 110	107 110	5 9 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	107 110	107 110	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	136 141	136 141	4 5 1	" "	139½	139
15,609	10	6/0	West African Telegraph	4½ 5½	4½ 5½	5 0 0	.. ..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103 106	103 106	4 14 4	March & September	..	..
30,000	10	..	West Coast of America	¾ 1½	¾ 1½	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	107 109	107 109	3 14 9	June and December	..	..
88,321	10	1/0	West India and Panama	½ ¾	½ ¾	..	May and November	..	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7¾ 8½	7¾ 8½	7 5 5	" "	..	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5 7	5 7	8 11 5	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	107 110	107 110	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	9¾ 10½	9¾ 10½	2 18 5	May and November	10⅜	..
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½ 7¾	7½ 7¾	3 17 8	" "	..	..
33,129	7½	1/6	Do. Deferred Ordinary	2¾ 3¼	2¾ 3¼	..	" "	2⅞	..
£382,230	..	4%	Do. 4 per Cent. Debenture Stock	106 109	106 109	3 14 1	June and December	..	..
$1,164,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105 110	105 110	6 7 10	Feb., May, Aug., Nov.	..	..
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	..	..
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	3 3½	3 3½	5 14 4	August	..	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16 1/16	1/16 1/16	..	July	1/8	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2 2½	2 2½	8 0 0	October	..	..
484,597	5	3/0	National	6½ 6¾	6½ 6¾	4 8 11	February & August	6 1/16	6 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15 17	15 17	3 10 7	" "	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14 16	14 16	3 15 0	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6 6½	6 6½	3 16 11	" "	6 1/16	..
1,829,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104 109	104 109	3 5 0	June and December	..	..
171,504	1	0/4	Oriental	1/16 1/16	1/16 1/16	4 2 4	April and October	..	..
58,000	5	5/0	United River Plate	3¾ 4¼	3¾ 4¼	5 17 8	July	..	..
£146,733	Stock	6%	* Do. 5 per Cent. Debenture Stock (red.)	102 107	102 107	4 14 4	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.						
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	10⅜	11	..	March	..	..
£50,000	5	..	Do. (New Issue) £3, 10s. paid	..	..	..	..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	26 27	26 27	2 11 10	February & August	26¾	26
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17 18	17 18	3 6 8	January and July	17⅞	17½
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131 136	131 136	3 14 3	June and December	134	132½
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12½ 13½	12½ 13½	2 8 2	February & August	13½	..
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6 6½	3 6 8	" "	6½	..
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	— —	— —	— —	January and July	..	..
£36,000	5	2/6	Chelsea Electricity Supply Ordinary	10½ 11	10½ 11	3 8 2	March	..	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113 116	113 116	3 14 7	June and December	14	13½
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	13½ 14	13¾ 14	..	..	..	..
20,000	£10	6/0	Do. 6% Cumulative Preference	15½ 16	15½ 16	3 15 0	March & September	..	..
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9 10	9 10	..	..	9½	9 7/16
10,000	£5	7%	Do. 7 per Cent. Preference	11 11½	11 11½	3 0 11	March & September	11 7/16	11⅜
111,000	£5	..	London Electric Supply Ordinary	2⅜ 2¾	2⅝ 2¾	..	..	..	..
48,050	£5	..	Do. Preference	6 6¼	5⅝ 6⅛	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	18½ 19½	18½ 19½	2 16 5	April and October	19½	18¾
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	18½ 19½	18 19	..	" "	18½	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	119 123	119 123	3 13 6	June and December	..	..
6,452	10	8/0	Notting Hill Electric Ordinary	17½ 18½	17½ 18½	2 3 3	March	..	..
275,000	1	—	Rand Electric	1 1/16 1 1/16	1 1/16 1 1/16	..	—	—	—
£125,000	Stock	..	River Plate Elec. Lt. Tr'st'n, Ltd., 5% 1st Mor. Deb.	93 98	93 98	..	..	..	..
150,000	$100	2%	Royal Electric Company of Montreal Shares	145 147	145 147	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105 107	105 107	4 4 1	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	17 18	17 18	3 3 11	February & August	17⅞	17½
20,000	5	3/6	Do. 7 per Cent. Preference	10 11	10 11	3 3 6	" "	..	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	103 106	103 106	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	16 17	16 17	2 19 0	March & September	16½	16⅜
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	£3	1/6	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	—	—	2 1/16	1 15/16
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	2¼ 2⅜	2¼ 2⅜	..	—	2⅛	..
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	108 112	109 113	4 0 9	February & August	—	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	103 105	103 105	4 7 7	June and December	..	..
10,000	£10	..	British Aluminium Ordinary	..	—	—	—	102½	..
20,000	10	..	Do. 7% Cumulative Preference	..	—	—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7 8	7 8	6 5 0	June and December	—	..
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	103 113	108 113	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1¼ 1⅝	1¼ 1⅝	—	—	1⅝	..
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2 2½	2 2½	—	—	—	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	89 94	89 94	5 6 5	January and July	—	—
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 3	2½ 3	5 10 0	February & August	2 11/16	..
17,139	5	2/9½	Do. (£5 paid)	4½ 5½	4½ 5½	5 0 0	" "	4¾	..
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101 103	101 103	3 17 8	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2¼ 2½	2⅞ 2¾	4 0 0	February & August	2¾	2 7/16
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½ 3⅝	3½ 3⅝	4 3 4	August	—	—
91,196	1	10/0	Elmore's Patent Copper Depositing	½ ¾	½ ¾	..	..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	20 21	20 21	4 15 3	February & August	..	..
3,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 12 0	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 10	" "	..	..
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	23 24	23 24	4 3 4	" "	23⅞	23⅝
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103 107	103 107	3 14 9	March & September	106	..
£7,350	12	12/0	Telegraph Construction and Maintenance	36 39	36 39	4 12 4	March and July	38¼	37
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102 105	102 105	4 15 3	January and July	—	—
£22,500	£5	3/0	Willans and Robinson Ordinary	7⅜ 8½	7¾ 8½	4 4 10	April and October	—	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	6¾ 7¼	6¾ 7¼	4 2 9	" "	—	—
100,000	Stock	4½%	Do. 4½% First Mort. Debs.	105 107	105 107	3 19 6	May and November	105¾	—

* In calculating the yield on this security, allowance has been made or accrued interest, but not or redemption.

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THE ELECTRICIAN:

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NOTES.

We desire to thank all those electric supply station authorities who, by their prompt and liberal response to our request for information, have rendered us invaluable assistance in the compilation of our annual Table of Electric Supply Works of the United Kingdom, which we publish as a Supplement this week. The occasion affords us an opportunity to remark that the Table is not only larger, but relatively more complete than any hitherto published. The extensive demand for this Table, and the constant use made of it as a work of reference by engineers and others, are proof of its utility, as also, in a different sense, are the imperfect and inaccurate imitations that have offered it a crude species of "sincerest flattery." After many years of experience it has been found that the form in which this Supplement is compiled affords to the user the maximum of information combined with the greatest accuracy and convenience of reference.

A number of well-known names and inventions will be found in the list of patents now in their 14th year, which we publish in this issue. The most important of these patents are undoubtedly those relating to two types of high-speed engines which have found special favour in the eyes of electrical engineers. Notice has already been given of a petition for the extension of one (No. 6,735) of the three patents granted in 1884 to the Hon. C. A. Parsons for improvements in steam turbines; and it is reasonable to expect that Messrs. Willans and Robinson, in spite of the failure of their petition for a prolongation of the 1882 air-buffer patent, will follow a similar course with No. 13,769 (1884), which is of still greater importance, covering, as it does, the Willans central valve. Here, as in the case of the air-buffer patent, the merit of the invention might not be denied, and it would then merely have to be decided whether adequate profits had accrued to its owners.

The Gaulard and Gibbs patent which expires next month, although it relates to the construction of a type of transformer and to a method of electrical distribution, must not be confounded with the historical patent of 1882, which was revoked by Mr. Justice Kekewich, in 1890, at the instance of Mr. Ferranti, and so failed to obtain for the inventors a monopoly of almost incalculable value. A little lower down in the list comes Dr. Aron's patent for meters. The two-pendulum meter has, however, undergone so many modifications at the hands of Dr. Aron since he originally protected it that the expiry of this patent will probably be of no great commercial importance, especially in this country where the motor type of meter appears to have carried all before it. A patent taken out on May 30, 1884, for a switch with a carbon break may be mentioned as containing a broad claim covering switches on this principle, and finally Mr. C. Langdon-Davies' patent for "Improvements in Telephony" is of interest, in that it embodies his "phonopore" system of simultaneous telegraphy and telephony which was much spoken of a few years ago. It is noticeable that in his specification the translating apparatus in series with the telephone is named not "phonopore" but "electrophone," a name now appropriated to what was originally called a "theatrophone."

In our issue of December 24th we reproduced from *Electrical Engineering*, of Chicago, a list of what purported to be the number of telephones in use in various countries of the world. Our contemporary is usually well informed in matters telephonic, and we have no doubt that the figure given for the United States is correct, but in its estimate of the number of instruments in use in England it has made a grievous error, even if this figure is not intended to include the whole of the British Isles. From figures kindly furnished us by the National Telephone Company it appears that the number of exchange lines alone in Great Britain and Ireland amounts to 89,222. In addition to this the National Company maintain 15,792 private lines distinct from their exchange

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service, this latter figure representing 31,584 instruments; and there are, further, a number of subscribers who have more than one instrument on their lines, so that the total becomes 122,370 instruments for which the National Telephone Company are directly responsible. But to obtain the total number of telephones in use in the British Isles we must not neglect those erected by the Post Office, and the number of private telephone instruments sold outright by the National Telephone Company and other makers. An estimate of 10,000 Post Office telephones will, we believe, not be excessive, and although we can do little more than guess at the other item, it seems to us that the grand total would amount to something like 200,000 instead of the 75,000 given by our American contemporary.

Diplex, duplex and quadruplex systems of telegraphy are not the simplest of things to explain to the youthful mind, but we fancy Prof. Lodge drove their principles home to the intelligence of the majority of his juvenile hearers at the Royal Institution, on Saturday last. Mechanical analogies are safe in Prof. Lodge's hands, for he may be trusted not to let them run riot; and, although an admirably illustrative mechanical model failed to work at the critical moment, the analogy between its intended action and that of a system of signalling currents was made quite clear. Probably the young people, and not a few of the older ones, found it more difficult to grasp the action of the intricate apparatus used for these telegraphic systems and for high-speed working. The audience breathed more easily when they came to hear the fourth lecture, on Tuesday, which embodied a most interesting account of the rise and growth of ocean telegraphy—of the early difficulties and the heroic manner in which financiers and electrical scientists put their resources together to surmount them, and of the splendid success ultimately achieved.

Four cases of death from electric shock occurring in a single factory, in which the fatal pressure could not have exceeded 230 volts alternating, are reported in the *Elektrotechnische Zeitschrift* of Dec. 30. The name and nature of the works—except that it is a chemical factory—are purposely withheld by our contemporary, but from the facts mentioned it appears that the place, by the nature of the processes conducted there, was very damp, so that an excellent contact between the body and earth would be nothing exceptional. It is stated that the installation, which is on a 230 volt three-phase system, mesh-connected, had been put up in a thoroughly workmanlike manner, that tests had shown the insulation resistance to be high, and that at all events in three out of the four cases the pressure to which the victim was subjected did not exceed 115 volts. It seems reasonable to suppose, however, from the dampness mentioned, and from what we know of German methods of wiring, that in each case the man must have experienced the full difference of potential of 230 volts, for it is hard to believe that three, or perhaps four fatal shocks at 115 volts occurred from the same wires within a period of 16 months. That 230-volt shocks were fatal in so many instances is strange enough, especially when it is remembered after what careful consideration our Board of Trade fixed the low-pressure limit for alternating curren at 250 volts.

In the first instance the unfortunate man was standing on the ground bare-footed, and turning the winch to wind an arc lamp to the top of its post. A terminal of the lamp came in contact with the pulley at the top of the post, and the workman received a fatal shock. In the second case the victim leant out of a window and purposely caught hold of a wire outside; in the third case a wire had become unscrewed, and its end came in contact with the unearthed pipe which contained it, the shock being received from the pipe; and, in the fourth case, contact appears to have been made with a faulty flexible conductor or lamp-fitting. Where deaths have occurred from low-pressure shocks it has usually been considered that they were due not to an exceptionally good contact alone, but that the weak state of the health of the individuals contributed considerably to the effect of the shock. We have here, however, actual experimental data, from which, with a few details as to the precise nature of the works, it should be an easy matter to decide if the processes carried on in the factory in question are such as to induce a state of health particularly susceptible to a stoppage of the heart's action through shocks, or if the phenomena are to be ascribed merely to exceptionally good contacts. In either case the moral appears to be: Use earthed concentric water-tight systems of wiring and extremely low pressures in chemical works.

A New French Electrical Laboratory.—The Chamber of Deputies has passed a resolution for the creation of an electrical laboratory and school of mines at St. Etienne.

Personal.—We are authoritatively informed that the Glasgow Corporation yesterday unanimously decided to appoint Mr. W. A. Chamen as their chief electrical engineer, at a salary of £800 per annum. We tender Mr. Chamen our hearty congratulations.

Erratum.—In the Note on "Magneto-Optic Phenomena," on page 315 of our last issue, the name of the predictor of the phenomenon which occurs when the magnetisation of the mirror is normal to the plane of incidence of the light should read "Wind," and not "Wend."

An Electric Cab in Leeds.—An electric cab, similar to the cabs now plying for hire in London, was recently taken a number of experimental runs in Leeds by local gentlemen, with a view to test its capabilities. It is stated that a company is to be formed to place electric cabs on the streets of Leeds.

City and Guilds Technical College, Finsbury.—A special course of six lectures are announced to be given by Prof. W. E. Dalby, at this college, on "Locomotive Machinery," on Thursday evenings, at 7.30 o'clock, beginning with Thursday, the 13th inst. Some further particulars will be found in an advertisement.

Berlin Tramways.—It is announced that Imperial sanction has been granted for the conversion of the whole of the tramways at Berlin from horse to electric traction. An overhead trolley line is to be erected on two sections as soon as possible, and it is hoped to have cars running on the mixed trolley and battery system next month.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Otranto—Vallona	Oct. 11, 1897	Dec. 31, 1897
Bundaberg—New Caledonia ...	Nov. 4, 1897	—
San Thomé—Loanda	Dec. 13, 1897	—
Ceara—Maranham	Dec. 23, 1897	—
Teneriffe—St. Louis (Senegal)...	Dec. 24, 1897	—
Emden—Vigo.....	Dec. 24, 1897	Jan. 5, 1898
Para—Maranham	Jan. 3, 1898	—
Curaçao—La Guayra...	Jan. 5, 1898	—

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New Year's Honours.—Science comes off badly this year in the list of New Year's honours; but we are glad to announce that Mr. Spencer Walpole, Secretary to the General Post Office, has been appointed a K.C.B., and Mr. James Dredge, one of the editors of *Engineering*, has been made a C.M.G., in recognition of services in connection with the Brussels Exhibition.

Trolley Right-of-Way in America.—It appears from our American contemporaries that the electric railway concerns over there are much exercised by the recent decision of the New York State Court of Appeals in what is known as the Kingston traction case. This decision is to the effect that no street railway can use or cross the tracks of any other street railway without having a franchise for the use of those tracks. It is stated that an offensive and defensive alliance has been formed by several roads affected.

Cheap Thermo-Electric Power.—The *Electrical Engineer* of New York reports that Mr. H. B. Cox, the inventor of the "Cox" generator, in addressing the "Electric Potential" Club of Boston, claimed that his one horse-power thermopile was capable of furnishing current sufficient for ten 16 c.p. lamps at a cost of only a halfpenny per hour, or 0·05 pence per (16 c.p.) lamp-hour, and that, while he would not undertake to build a generator of larger capacity than 250 lamps, such a generator operated by furnace heat would be much more economical than existing plants of like capacity.

Reduction of Telegraph Rates to and from the West Indies.—The West India and Panama Telegraph Company and associated companies, on and from the beginning of this year, announce a large reduction to the rates between Europe and Jamaica. The reduction amounts to 2s. 10d. per word between Europe and Jamaica, or from 5s. 10d. to 3s. per word. The same reduction will be extended to the West India and Panama Company's stations east of Jamaica, and will also include Demerara. The tariff with the French islands of Guadeloupe and Martinique will, however, we understand, for the present remain without alteration.

The Trolhättan Waterfall Scheme.—It will be remembered that a Company was to be formed for the utilisation of the power of the Trolhättan waterfall in Sweden. The 4,685 1,000kr. (£55. 13s.) shares were all subscribed for only about a month ago, but it is already announced that the Swedish Government intends to contest the ownership of the fall. There is thus a prospect of a long and tiresome litigation, the result of which cannot be foreseen. It is probable, says the *Frankfurter Zeitung*, that the subscribers will now have their names struck off the register, as they are entitled to do according to Swedish law.

Conventional Symbols in Diagrams of Patent Specifications.—The *Electrical World* of New York states that a petition to the Commissioner of Patents has been prepared and is being circulated among the prominent "electrical attorneys," asking him to instruct the examiners of patents in the electrical divisions to work out a logical and symmetrical set of signs, to be published in an official order. The need for such a conventional set of symbols in patent diagrams is—as yet, at any rate—hardly felt by electrical engineers in this country, the diagrams being, as a rule, the part of the specification most readily intelligible to them. Perhaps, however, to the lawyers and patent agents who are familiar with legal phraseology and comma-less sentences, the comprehension of the diagrams may present greater difficulties.

Applications for Patents in 1897.—The number of applications for patents during the year 1897 was 30,936. This figure may have to be raised slightly to provide for those applications which may yet come from abroad and be entitled to bear date as of 1897, and by the sub-division of applications describing two separate inventions. The applications in 1896 numbered in the aggregate 30,194, as compared with 25,065 in 1895. In 1896 only 13,360 of the 30,194 applications were completed, the rest being allowed to lapse after the nine months' protection. The inventions comprise every class of manufacture that can be imagined, but principally engineering. Not a few of the applicants for patents are women, of whom there were nearly 700 in 1896, about 150 of these inventions relating to dress.

The "Zeitschrift für Elektrotechnik."—Our Viennese contemporary has undergone a transformation with the New Year. The size of its page has been enlarged, and it is now to be published weekly instead of fortnightly. The first number of the new series contains, besides the notes which are, we are glad to see, printed in a larger type than heretofore, a retrospect for the year 1897, a Paper by Herr Carl Wieshofer on the Thury system of power distribution, and a report of the proceedings of the Vienna Elektrotechnischer Verein. The paper, which is published under the auspices of an editing committee of this society, has also undergone a change of editors. Herr J. Kareis, who has retired after 15 years' service, is being succeeded by Dr. Sahulka. We wish our contemporary every success in its new shape.

The Conductivity of Discontinuous Conducting Substances.—Since his contribution to the *Comptes Rendus* of Dec. 6 last, published in our issue of Dec. 31st, M. E. Branly has communicated to the Académie des Sciences (*C.R.*, Dec. 27, 1897) a few more notes on the same subject. He holds that no sharp division can be made between continuous and discontinuous conductors; a discontinuous conductor composed of contiguous metallic grains surrounded by an insulating medium can be regarded as a conductor, and in a metallic block compression has reduced the insulating medium to such an extent that variations in the conductivity are only apparent under the action of heat. In visibly discontinuous conductors the insulating material maintains the conducting grains at an appreciable distance from one another, and when the proportion of the insulating material is sufficient, the variations in conductivity, instead of being persistent, as they are generally, disappear directly after they have been provoked by the spark. Finally, for a still greater proportion of the insulator the variations cease to occur even on the direct application of the most violent discharges. The latter and longer portion of the communication is devoted to drawing an analogy between the conductivity of "radio-conductors" and the conductivity of the nerves.

Another Anticipation of Marconi's Apparatus.—Prof. A. Popoff, of Kronstadt, has sent the *Elektrotechnische Zeitschrift* a reprint of an article appearing in the *Journal* of the Russian Physical and Chemical Society for January, 1896, in which the professor describes "an apparatus for detecting and registering electrical oscillations." The apparatus, which was used for registering atmospheric disturbances, consists of an iron filing coherer connected between a lightning conductor and earth, while in a local circuit is the electromagnet of an electric bell, the gong being removed and the hammer adjusted to strike against the coherer every time the latter coheres. The apparatus had been in use at the observatory of the St. Petersburg Forests Institute since July, 1895. At the conclusion of his article the author expresses a hope that his apparatus might be further perfected and used for the reception of signals sent from a distance by means of rapid electrical oscillations, as soon as a source of such oscillations was found which would develop the necessary amount of energy.

Obituary.—We regret to announce the death at Cadiz, on the morning of the 4th inst., of Mr. W. F. O'Brien. For some years past Mr. O'Brien had not enjoyed the best of health, but he had made, during his short stay at Cadiz, such marked improvement that the news of the relapse which proved fatal was received in London as an unexpected shock. A large number of our readers have met Mr. O'Brien either in business connected with telegraphic matters, or socially, and in his capacities both as a telegraph man and as a friend his loss will be deeply deplored by the large circle which appreciated his many sterling qualities. His knowledge of telegraph affairs, his grasp of every detail connected with his business, and his devotedness to the work, rendered him invaluable in the position he occupied, while his straightforward character, and his constant readiness to attend to the interests of others, secured for him many and sincere friendships. Mr. O'Brien, after serving in the Postal Telegraphs for some years, entered the employment of the Japanese Government at the moment when the development of the telegraph was first seriously commenced in Japan on the termina-

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tion of his agreement with the Japanese Government. He joined in 1875 the West Coast of America Telegraph Company. On the expiration of his term of service he returned to England and was attached to the staff of the Silvertown Company, and lent valuable services on many cable expeditions. In 1884 he was appointed traffic accountant to the West African Telegraph Company, and at the time of his death held that position in the South American Cable Company and the Spanish National Submarine Telegraph Company. He served the latter Company for 14 years, and during the last year also acted as secretary. Mr. O'Brien attended, on behalf of the companies he served, the International Telegraph Conventions of Paris and Budapest, and from the latter place returned in very bad health. He never regained convalescence. We desire to offer his family our most sincere sympathies in the great loss they have sustained.

Experiments with Steel-Nickel Alloys.—In a Paper read before the Société Internationale des Electriciens on December 8th, M. C. E. Guillaume described some experiments he had made on nickel-iron alloys. The alloys had been prepared by the Société de Commentry-Fourchambault at their Imphy steel works, being obtained in the crucibles ordinarily used for cast steel. The alloys are divided into two categories according to their properties. The former, which contain from 0 to 25 per cent. of nickel, are termed by M. Guillaume "irreversible." These lose all their magnetic properties at about 600°C., but only recover them at a considerably lower temperature, this latter temperature being lower the more nickel the alloy contains. With about 25 per cent. of nickel the return to the magnetic condition occurs below 0°C., and, as Hopkinson has shown, all the properties of the metal change at the same time. Alloys with greater percentages of nickel are "reversible." They lose their magnetic permeability gradually between two temperatures about 50°C. apart. For alloys containing from 26 to 40 per cent. of nickel these temperatures are higher the greater the proportion of this metal. The temperature at which the transformation occurs is 0°C. for 26 or 27 per cent. alloys, and for 40 per cent. alloys it borders on 300°C. M. Guillaume has also made interesting experiments on the expansion of these alloys. In the case of the "irreversible" alloys the expansion follows a complex law, the coefficient depending on the degree of transformation. The expansion of the "reversible" alloys is different in the two states and is much greater in the non-magnetic than in the magnetic state. It is considerable for an alloy containing 26 per cent. of nickel, diminishes rapidly as the proportion of nickel increases, and at 36 per cent. reaches a minimum and increases again. At this minimum the expansion is only a tenth that of platinum, and a twentieth that of brass. This very low coefficient obtains until the transformation of the alloy, which for that of minimum expansion occurs at nearly 200°C.

A Trial Accumulator Car.—A new accumulator car, says the *Elektrotechnischer Anzeiger*, was exhibited to a party of engineers and pressmen on one of the Berlin steam-tramway lines on December 18th last. It is a four-wheeled car built and equipped by Messrs. Kummer and Co., of Dresden, the accumulators being of the Ribbe type. The car is provided with 20 seats and standing room for 11 passengers, not including the driver and conductor; it weighs empty, but with its battery, 10 tons, and it is driven by a single 30 H.P. series motor. The speed regulation is effected by means of a water resistance and by series-parallel arrangements of the cells. Forty-four boxes, each containing three cells, are placed under the seats, each box measuring $7\frac{5}{8}$in. by $5\frac{7}{8}$in. by 12in. high, and weighing complete about 170lb., the whole battery weighing, therefore, about 67cwt. The boxes are sealed with covers and rubber packing, and there are tubes to lead off the gas. The cells themselves, which are said to be made of celluloid, each contain seven positive and eight negative plates, measuring 12in. by $7\frac{1}{4}$in. by $\frac{9}{64}$in. thick, with the exception of the two outside plates, whose thickness is only $\frac{3}{32}$in., the weight of the plates being 2·5 and 1·8 lb. respectively. From figures supplied by the makers the cells can be discharged in $5\frac{1}{2}$ hours, with a current density of 0·045 ampere per sq. in.; this corresponds to a current of 55·3 amperes and a capacity of 304 ampere hours, or about $8\frac{1}{2}$ amperes per lb. of plate. The normal current is, however, only 35 amperes, and the battery is intended for a whole day's work of 16 hours without being re-charged. The grid consists of a lead frame 0·14in. thick, with a perforated partition 0·04in. thick. On each side of this partition narrow strips of thin celluloid are fastened by means of celluloid solution, then comes the active material, and the latter is retained in contact with the grid by perforated celluloid plates 0·02in. thick. The celluloid strips above referred hold these celluloid plates in position. The negative plates are also provided with separating pieces of celluloid $\frac{5}{32}$in. high. It is stated that the celluloid contains but a very small percentage of sulphur, so that it does not act in any way on the lead grid, and it is said to have lasted for nearly three years in some cells made by a Paris firm.

Comparison of Steam and Electrically-Driven Cotton Mills.—In a Paper recently read before the American Society of Mechanical Engineers, Mr. W. B. Smith Whaley gave an interesting comparison of the working of two cotton mills, one driven by steam, the other by electricity. The former is geared by ropes, heavy head-gearing and large tapering shafts, as such plants are usually geared in the best practice of to-day. The steam engine is an 800 H.P. Corliss, cross-compound, built in 1895, with cylinders 20in. and 40in. by 60in. stroke, and a rope wheel 24ft. (pitch) diameter, grooved for 26 $1\frac{3}{4}$in. ropes, weighing 35 tons. During the period of comparison the mill served by the engine contained 11,776 spindles and 720 looms. All the spindles and preparatory machinery were run full, but the looms did not average more than 682 per day. The electrically-driven mill takes its power from a central supply station and distributes it through a continuous reading wattmeter to four 150 H.P. inverted motors, bolted to the ceiling in convenient positions. This mill—in operation since January 1, 1897—had in operation during the period of comparison an average of 12,448 spindles, with preparatory machinery, and an average of 356 looms out of 500 in the mill. The weight of the shafting in the steam mill is approximately 136,000lb., and in the electric mill 122,000lb. From indicator cards taken from the engine it was found that the power required to drive the shafting and belting on loose pulleys was 228 H.P.; for the 720 looms and the shafting 349 H.P. was required, and for the whole mill 595 H.P.; from their data the power required to drive one loom was found to be 0·168 H.P., and the number of spindles driven per horse-power was found to be 60. At the time the above data were obtained there were in operation in the mill 14,848 spindles, with preparatory machinery, and 720 looms. From the power chart of the electrically-driven mill the average power consumed per day was 218·2 H.P. during the period from April 1st to June 25th. During that period there were in operation, on an average, 12,448 spindles per day and 357 looms, as against the steam mill operating 11,776 spindles and 682 looms. From the data obtained from the steam-driven mill the distribution of power was found to be as follows, *i.e.*:—For the steam-driven mill, total power, 535 H.P.; looms and shafting, 340 H.P.; friction, 226 H.P.; spindles, 196 H.P.; and looms; 114 H.P. For the electrically-driven mill, total power, 418 H.P., looms and shafting, 206 H.P.; friction, 149 H.P.; spindles, 208 H.P.; and looms, 60 H.P.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TUESDAY, January 11th.

RÖNTGEN SOCIETY.

8.30 p.m. General Meeting at 11, Chandos-street, Cavendish-square, W. Paper to be read: "Practical Work with the X-Rays," by W. Webster.

THURSDAY, January 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Presentation of Premiums, to be followed by the Inaugural Address of the President, Joseph W. Swan, F.R.S.

FRIDAY, January 14th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Mechanical Draught," by R. Gordon Mackay.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

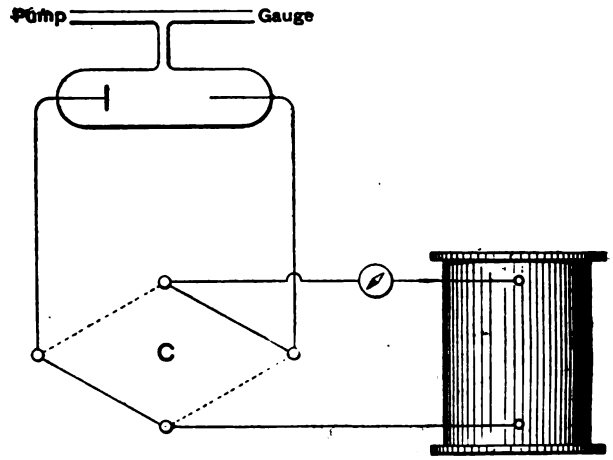
Zeeman Effect.—A. Cornu has brought his large experience to bear upon the Zeeman phenomenon, and has devised a new arrangement which shows the effect with sharp definition, and which, moreover, removes all doubt from the conclusions arrived at by Zeeman himself. In Cornu's arrangement the source of light is the flame of an oxy-hydrogen burner containing a piece of amianthus soaked in fused common salt. A vertical slit placed in the plane of the image of this source directs the beam upon a concave Rowland grating of 10ft. radius. In this manner the rays which most easily exhibit spontaneous reversal may be brought into play, and it is they that exhibit the Zeeman effect to the greatest advantage. One of these rays is observed in the focal plane of an eye-piece in which a steel needle is fixed normally to the rays. Behind the eye piece is placed a Wollaston bi-refracting prism which doubles the image of the needle. The diameter of the needle, which is of a slightly conical shape, is chosen so that the images are contiguous, thus giving two areas polarised, one along and the other across the rays of the spectrum. The rest of the field of view is traversed by the simple image of the needle. On exciting the magnetic field about the flame, and observing at right angles to the lines of force, the simple image is broadened, while of the two polarised sections one shows a doubling of the line and the other shows the simple line thinned down. A reversal of the magnetic field makes no difference. On observing along the lines of force and introducing a quarter-wave plate between the eye-piece and the bi-refracting prism a thin bright line is seen displaced towards different sides in the two sections, these displacements being reversed on reversing the field. If these reversals are made alternately in succession the effect is doubled physiologically, and becomes still more apparent. After the pattern of Fresnel's and Ampère's rules, the effects may be summarised without reference to Lorentz's electrochemical theory: The action of a magnetic field upon a ray tends to decompose it into two rays of circular vibration parallel to the currents of the solenoid. The vibrations turning in the sense of the solenoid current are accelerated, whilst those turning in the opposite direction are retarded. This purely kinematical interpretation brings out clearly the difference between the Zeeman and the Faraday effects.

[Cornu, *Journal de Physique*, December, 1897.]

Mechanism of the Faraday Effect.—Cornu has shown that a luminous ray suffers no influence from a magnetic field unless that field acts directly upon its source. This fact has an important bearing upon the theory of the relations between light and magnetism. In the Faraday effect the velocity of propagation of the ray is modified by the whirls which, according to Maxwell, constitute the magnetic field. It remains to be seen whether the energy of the ray is affected. This has been decided by A. Broca, who tested for a small change of period by means of Thoulet's liquid (known to possess a powerful rotatory polarisation), and the sixth diffraction spectrum of a Rowland grating. The result was negative. The experiment was repeated with a transparent film of iron deposited on glass by Kundt's method. But the wave-length remained constant to within $\frac{1}{10000}$th of its value. There is, therefore, no absorption of energy discernible in the Faraday effect.

[Broca, *Journ. de Phys.*, December, 1897.]

Valve Action in Discharge Tubes.—E. Hagenbach has examined the curious relation between the discharge from points and discs respectively at various pressures, which was discovered by G. Wiedemann and termed a valve action. This valve action may be used for separating electric discharges taking place in opposite directions. The apparatus used by Hagenbach is sketched in the diagram. It consists of a vacuum tube connected with a manometer and a pump. One of the electrodes is a disc, and the other a point. The current can be sent in either direction by means of the commutator C, and is measured by the ballistic galvanometer. It is derived from the secondary circuit of an induction coil and generated by a single break of the primary circuit by means of a falling weight. Eighty different pressures were employed, and the currents obtained showed characteristic variations. When the disc was the anode, the current increased until the pressure was reduced to 10mm. A minimum occurred at 0·08mm., and after that the current increased slightly until 0·0002mm., the greatest vacuum attained. This increase was probably connected with the generation of X-rays. When the point was the anode the



maximum occurred not at 10mm., but at 2·68mm., and at that point the current was over twice as strong as in the reverse direction. At very low pressures, however, the current was five times stronger with a point cathode than with a disc cathode.

[Hagenbach, *Wied. Ann.*, No. 13, 1897.]

Torsion and Magnetism.—The connection between the mechanical deformation and the magnetic properties of iron and nickel wires has been explained by G. Wiedemann and by Maxwell in different ways. The former based his explanation upon the different amounts of internal friction encountered in longitudinal and transverse deformations, giving rise to peculiar orientations of the magnetic molecules, which are supposed to have a major axis in one direction, different in iron and nickel respectively. Maxwell and Crystal reduce the phenomena to a change in the permeabilities in different directions under longitudinal strain. P. Drude has investigated the rival theories, and finds that the latter is not sufficient, since the change in the permeability depends upon two constants, as foreshadowed by Wiedemann. The second of these constants has a higher value than that assigned to it by Cantone.

[Drude, *Wied. Ann.*, No. 13, 1897.]

The Two Conductivities.—Wiedemann and Franz's law maintains that the ratio between the thermal and electric conductivities is approximately the same for all metals. Kirchhoff and Hansemann found this ratio to be constant within 5 or 6 per cent. for lead, zinc, tin and copper, but maintained that iron exceeded the ratio by about 20 to 50 per cent. F. A. Schulze has investigated this question by experimenting on six iron rods, comprising wrought iron, cast iron, and manganese steel. The thermal conductivity—always difficult to determine—was measured by making a jet of water at a certain temperature impinge upon one end of the rod and noting the instant at which a galvanometer in the circuit of a thermocouple inserted in the rod began to be deflected. The experiment was then repeated with another jet of water at a different temperature. The ratios obtained ranged from $1{\cdot}88 \times 10^3$ to $1{\cdot}4 \times 10^3$, and it is difficult to discover the law according to which the ratio varies. Schulze tried to gain some insight into it by determining the hysteresis curves of the different specimens, but could not detect any general connection between coercive force and the conductivity ratio. This is somewhat disappointing, but it must be remembered that the carbon and manganese compounds and alloys in question are not pure metals, and that Wiedemann and Franz's law may strictly hold for pure metals of isotropic structure.

[Schulze, *Wied. Ann.*, No. 13, 1897].

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STORAGE BATTERIES.*

BY E. J. WADE.

(*Continued from page 287.*)

Protected Electrodes.

All those electrodes which are contained or surrounded by envelopes or wrappings of some porous or perforated non-conducting material to assist in maintaining the active material in its place may be termed "protected" in contradistinction to those in which the usual metallic support is deemed sufficient for the purpose. Although the above term has only been introduced into storage battery nomenclature within the last few years, this type of electrode is as old as storage batteries themselves, and dates from the first practical cells that were ever constructed, the idea no doubt being taken from the porous pots and various arrangements of porous fabrics used to maintain the depolarising agents round the electrodes in primary cells.

It is evident that "protection" may be applied to almost any kind of electrode of whatever construction, but as a matter of fact its use is generally accompanied by some special modifications in the design of the metallic support or arrangement of the active material, so that it is more convenient to treat it as being an integral part of the electrodes and to deal with them in a class by themselves.

In many instances the details of the methods of protection also necessarily involve a consideration of the means used for separating or keeping the electrodes apart, the two objects frequently being served by one and the same arrangement of parts.

For example, the electrodes in Planté's original cells constructed before 1872 were separated and at the same time protected by layers of flannel pressing closely against their surfaces. This plan was afterwards abandoned in favour of ebonite strip separation, and protection has since been almost exclusively confined to electrodes of the pasted and kindred types.

Faure's first form of electrode was a porous pot which contained and held up the material round a central conductor, and in his first British patent, in 1881, he mentioned the use of layers of felt, asbestos, &c., between the electrodes (a "series" battery in this instance having flat plates coated with oxides), but more with the object of preventing splashing and producing a sort of semi-dry battery than of supporting the active material. Faure soon found, however, that his active material would not for long retain its position on the support unprotected and merely by its own cohesion and adhesion, and accordingly a few months later he patented methods of attaching porous coverings to the plates by riveting, stitching, cementing, &c. Another plan described was to merely lay the sheets of porous material on the surfaces of the plates, and then to press them closely against open-work frames or trellis of wicker placed in between, which served both as separators and to hold the protective sheets in position. This method is interesting, as being closely akin to various arrangements for protecting electrodes of very much more recent date.

Pitkin in the same year proposed to fix protective coverings to a frame of wood or ebonite surrounding the electrodes, and, in fact, all the descriptions and specifications of cells in the early eighties abound with references to and particulars of various arrangements of porous pots and plates, parchment envelopes, wrappings of flannel, felt, and so on, for both positive and negative electrodes. But hardly any of the materials then used were capable of enduring in the acid for any length of time without suffering disintegration or deterioration, and this fact, coupled with the improvements effected in the design of the metallic supports, and the better coherence and durability obtained in the active material led gradually to the almost total disuse of protection for some years. However, in 1890, or a little earlier, the ever-present need for light cells of large capacity capable of giving higher rates of discharge, and generally withstanding heavier work without depreciating too rapidly, caused attention to be once more turned to protected electrodes as a possible solution of the problem by enabling larger quantities of active material to be placed and retained against the support than could otherwise be done.

During the last few years a considerable number of protected electrodes have been designed, and some of them put to practical use on a commercial scale, while at the present time the tendency to apply protection to electrodes of almost any and every type is nearly as strong as it was 15 years ago.

Generally speaking, the later arrangements for protection are very similar to the earlier ones, and the chief advance has been in the materials employed, which are now of a more durable nature than those formerly used.

Plate and Sheet Protection.

In 1887 Vaughton proposed to use porous plates pressed hard against the surfaces of the electrodes by means of wedges between them. The metallic support consisted of a perforated plate with a raised frame all round it. In 1889 Askew and Primpelly, in a patent for a horizontal form of cell, described the use on the faces of the electrodes of asbestos sheets held apart and in position by open-work frames of interwoven leather

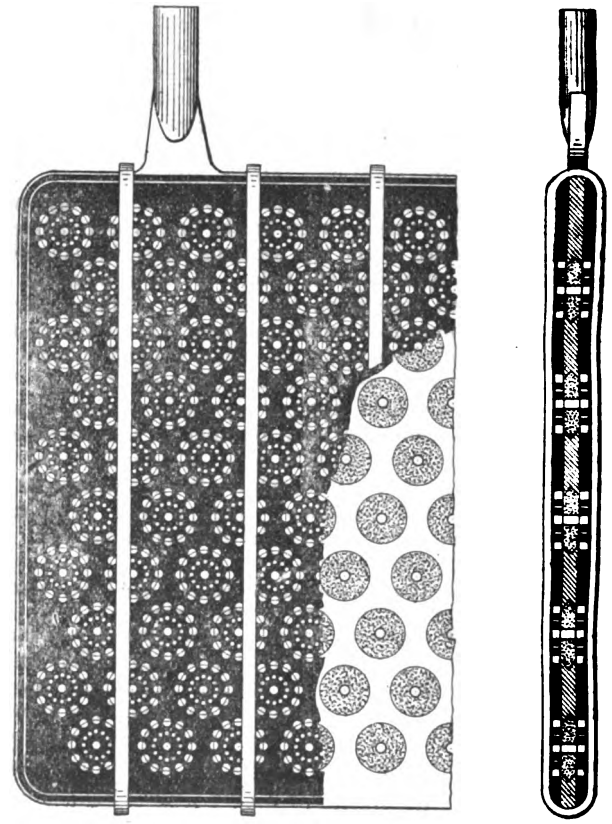

FIG. 47.

strips to allow for the circulation of the electrolyte, thus very closely following the lines of Faure's wicker-work separators. An alternative method was to use porous plates ribbed on one side or flat plates held apart by ribbed separators.

In 1891 the Hess Electric Storage Company patented a compound protection, consisting of a layer of glass wool against the face of the electrode, and itself supported by a perforated plate or grid of rubber or similar material.

In 1892 Lloyd proposed to protect the surfaces of positive plates with sheets of ebonite or other insulating material perforated with clusters of holes opposite the pellets of active material. These latter were prepared from chloride of lead and of a fair size. The sheets were held up to the faces of the plates by rubber bands. The expressed object in this instance was not merely to maintain the active material in position, but primarily to protect the support or frame from electrolytic action, it being assumed that those parts covered by the solid portions of the protective sheets will offer more resistance, and so divert the action onto the active material.

Fig. 47 shows in elevation and cross-section a portion of an electrode protected in this manner, a part of the ebonite

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sheet being removed to exhibit the construction of the plate itself. In another patent in the following year, Lloyd considerably modified the above arrangement and also introduced a form of compound protection. The positive plates were first wrapped in a sheet of woven asbestos and a perforated plate of ebonite then placed on either side. The perforations were now, however, of the same size as the pellets of active material and so arranged as to come directly over them, while the ebonite plates were of sufficient thickness

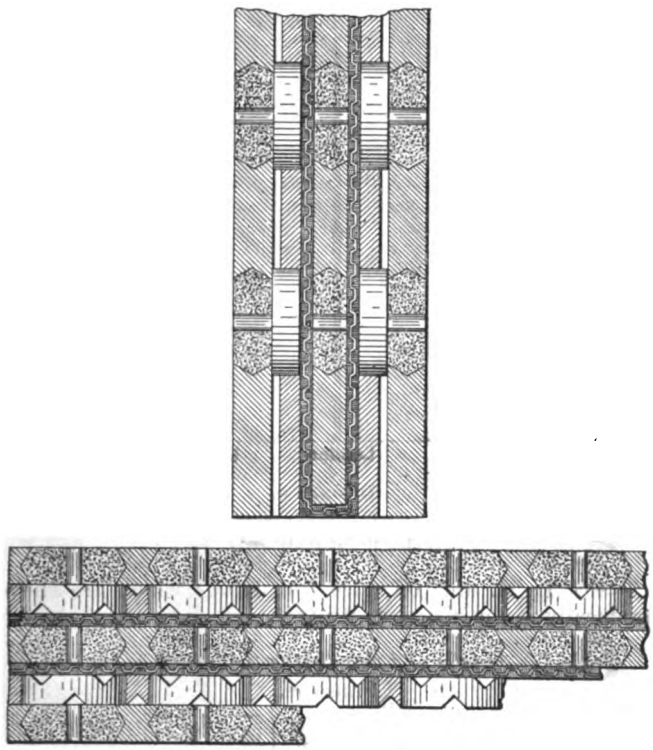

FIG. 48.

to form separators, the negatives pressing close against their other faces, but to allow for circulation of the electrolyte the ebonite was vertically grooved on both sides. Fig. 48 gives a vertical and horizontal cross-section of a positive electrode protected in this way together with the negative electrodes on either side of it. Any number of electrodes could be similarly mounted and held together in one rigid mass by means of rubber bands or other clamping devices.

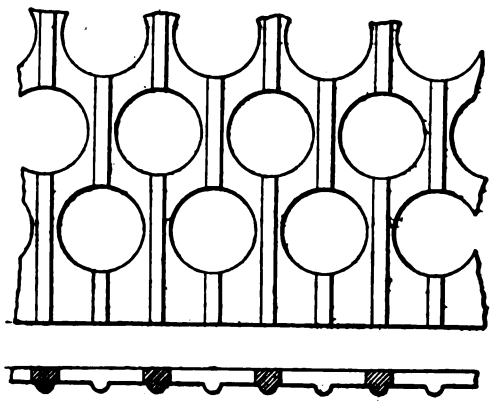

FIG. 49.

This arrangement is of interest as being the basis of the protected type of cell of the Electric Storage Battery Company, in the United States, and the Chloride Electrical Storage Syndicate, in England, and which was considerably used here at one time. The latter firm patented a modified form of separator in 1895, which allowed for a freer circulation of the electrolyte, being flat on the side towards the positive plate and asbestos sheet and ribbed on the other side. Fig. 49 illustrates a portion of the separator in elevation and cross-section.

(To be continued.)

LAMP-CONNECTION DIAGRAMS.

In order to summarise to a certain extent the statistical information given in our yearly Supplement Table of Electric Supply Works of the United Kingdom we append, as usual, a few diagrams. Diagram 1, which shows the rate of increase of the lamp connections of the London companies and municipalities since 1890, gives evidence of a very flourishing condition of affairs. Although the Metropolitan still leads in the number of lamp-connections, it was not to be expected that the enormous increase of last year would be repeated, but still an addition of 45,000 8-c.p. lamps in the year shows that the saturation limit is still very far distant. The greatest increase—50,000—can be claimed by the City of London

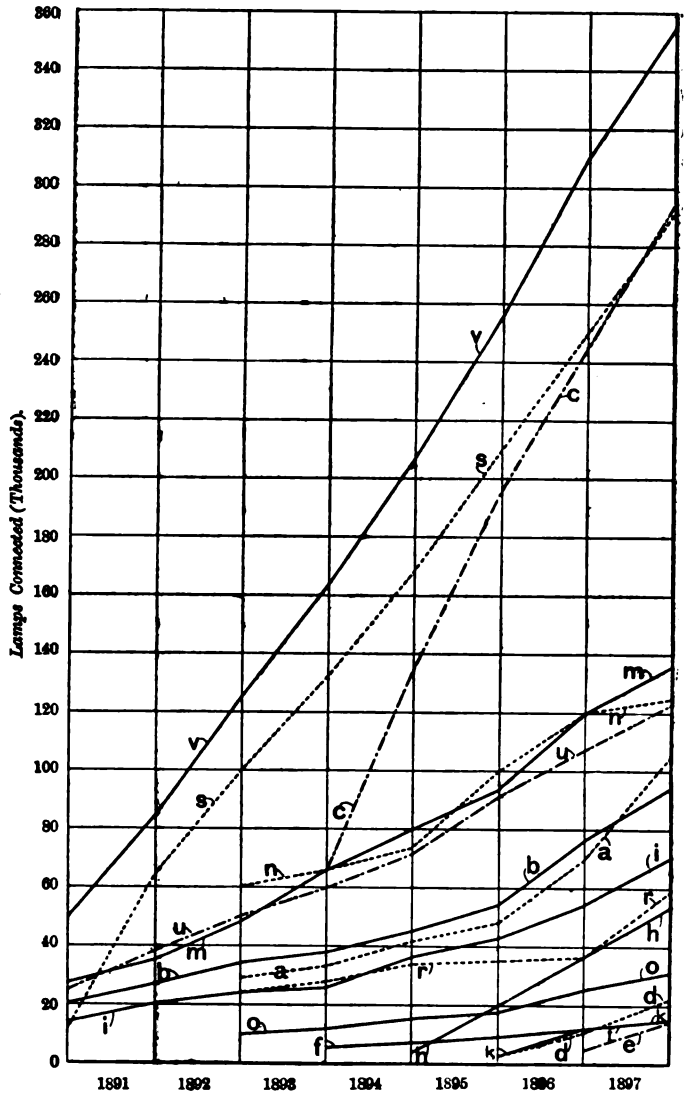

DIAGRAM 1.—*Lamp-Connections in London.*

a Charing Cross Company.	k Islington Vestry.
b Chelsea Company.	m Kensington and Knightsbridge Company.
c City of London Company.	n London Electric Supply Corpn.
d County of London and Brush Provincial Co. (Clerkenwell).	o Notting Hill Company.
e County of London and Brush Provincial Co. (Wandsworth).	r St. Pancras Vestry.
f Crystal Palace Company.	s Westminster Corpn.
h Hampstead Vestry.	u St. James' and Pall Mall Company.
i House-to-House Company.	v Metropolitan Company.

Company, its curve having already passed that of the Westminster Company, although the lamp-connection of the latter has also shown a healthy improvement. The St. Pancras curve is "looking up" again this year, and the only one which shows possibly transient signs of approaching saturation is that of the London Electric Supply Corporation. It is to be hoped that their wholesale supply will give the curve a more decided upward tnedency next year.

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Diagram 2 shows that the provinces are increasing their lamp-connection still faster than London. During 1897 the London total became 1,831,000, an increase of 369,000 since the end of 1896, the increase in the previous year having been 283,000. The total for the provinces is 2,129,000 at the end of 1897, showing an increase of 527,000 during the year, as compared with 502,000 during the previous year. The total for the whole of the United Kingdom is therefore very nearly four millions of 8 c.p. lamps or their equivalent, this number being undoubtedly considerably exceeded if private stations be taken account of.

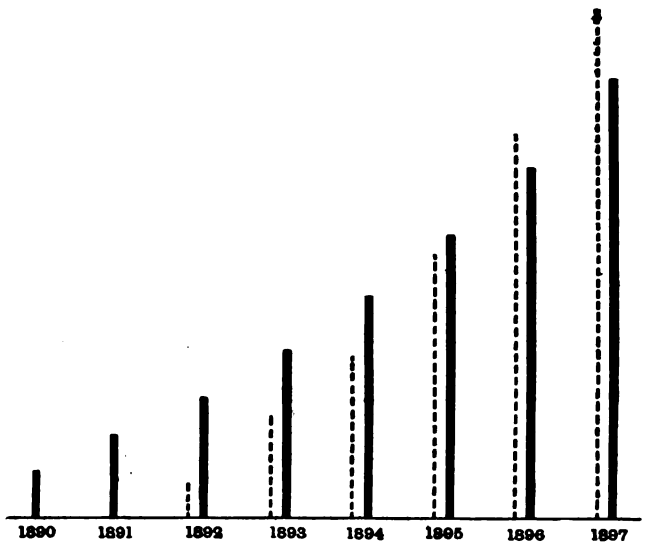

DIAGRAM 2.—Lamp-Connections of London and Provinces.

London (——————). Provinces (- - - - - - - - -).

Scale: 1in. = 800,000 lamps.

Owing to the number of stations which supply both continuous and alternating currents, we have been obliged to make a change in diagram 3 this year. The aggregate lamp-connections of the stations supplying only continuous current is, it is seen, considerably greater than that of the stations

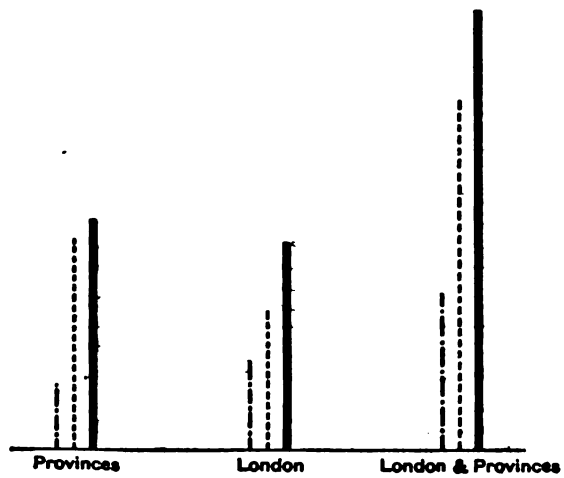

DIAGRAM 3.

Alternate-Current (– – – – – –). Continuous-Current (——————).

Alternate and Continuous (—·—·—·—).

Scale: 1in. = 800,000 lamps.

which supply nothing but alternating current; yet it is probable that more alternating current is being supplied than continuous, as the majority of the "mixed" stations have only recently adopted continuous current for special purposes. The height of the chain-dotted line for London is, for instance, almost entirely due to the Metropolitan Electric Supply Company, the continuous current connection of which is, however, but a small proportion of its total load.

Diagram 4 indicates further additions to the municipal load, especially in the provinces, new municipal stations having been opened at Harrogate, Torquay, Wakefield, and Wallasey during the year, and in London at Hammersmith.

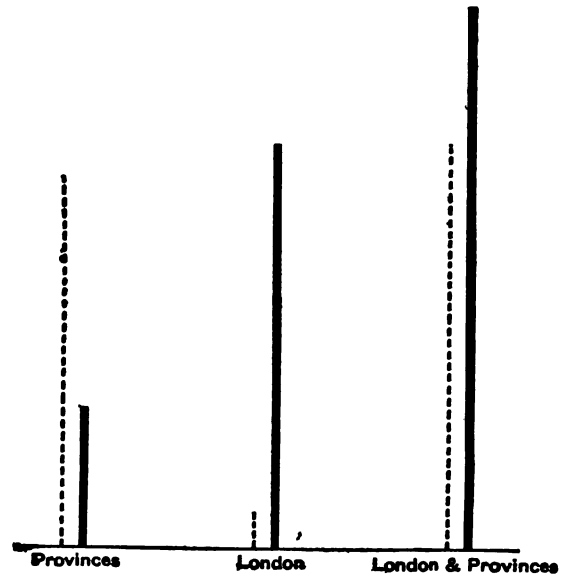

DIAGRAM 4.

Municipal (– – – – – – – –). Company (——————).

Scale: 1in. = 800,000 lamps.

Tables I., II. and III. give the figures which are shown graphically in the diagrams 3 and 4.

Table I.—*Details of Lamp-Connections in London and Provinces.*

LONDON (1,830,995)	Municipal (149,410)	1 S I S		72,693
				76,717
				none
	Companies (1,681,585)	1 S I S		798,588
				505,050
				377,947
PROVINCES (2,123,655)	Municipal (1,546,282)	1 S I S		733,554
				538,205
				274,523
	Companies (583,373)	1 S I S		229,104
				343,669
				9,600

Table II.—*Approximate Lamp-Connections of Alternating and Continuous-Current Stations.*

—	1S	S	—	Totals.
London.....	378,000	582,000	871,000	1,831,000
Provinces.....	284,000	882,000	962,000	2,128,000
Totals	662,000	1,464,000	1,834,000	3,959,000

Table III.—*Approximate Municipal and Company Lamp-Connections.*

—	Municipal.	Company.	Totals.
London	149,000	1,682,000	1,831,000
Provinces..	1,546,000	582,000	2,128,000
Totals	1,695,000	2,264,000	3,959,000

An Alternating-Current Arc Lamp with Motor Feed.—An alternating-current arc lamp, whose chief feature is that the feed is effected by a reversible asynchronous motor, is described in *l'Electricien* of December 11th. The armature of this motor is a copper disc on the same spindle as the pulley over which the band connecting the two carbon-holders passes, the weights of the two holders being balanced. There are two pairs of independent field magnets, one in shunt across the lamp terminals, and one in series. The lamp is made by the firm of Fabius Henrion, of Nancy.

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PATENTS EXPIRING IN 1898.

The following is a list of the patents of interest to electrical engineers, which, unless specially extended by recommendation of the Judicial Committee, will expire during the present year. We have decided this year to omit from our list those patents taken out in 1884 which have been allowed to lapse through non-payment of fees before their allotted life of 14 years had been completed:—

Date (1884).	No.	Name of Patentee.	Subject of Patent.
Jan. 3	551	R. Grätzel	Electrolytic extraction of metals.
Jan. 23	2,000	A. Frazer and Soc. Michel et Cie.	Water meters.
Jan. 25	2,155	W. Lockwood	Spring packing for pistons.
Jan. 28	2,285	C. Dornfeld	Holders for incandescent lamps.
Jan. 29	2,342	C. C. Worthington	Direct acting duplex engines.
Feb. 6	2,858	L. Gaulard and J. D. Gibbs.	Producing and utilising electric currents.
Feb. 8	2,927	J. B. Hannay	Preventing incrustation and corrosion in boilers.
Feb. 9	3,034	C. Hodgson	Electrically-controlled railway signals.
Feb. 11	3,090	J. Boguski	Manufacture of aluminium-bronze
Feb. 27	4,025	E. T. Truman	Electrical conductors.
Mar. 13	4,828	J. Oppenheimer	Telegraph posts.
April 1	5,777	W. L. Lowrey	Vapourising liquid for vapour engines.
April 12	6,288	F. M. Moore	Magnetic compasses.
April 16	6,414	R. Grätzel	Electrolytic extraction of metals.
April 23	6,734	Hon. C. A. Parsons	Steam turbines, dynamos & parts.
*Apr. 23	6,735	Hon. C. A. Parsons	Steam turbines; governors for turbines.
April 24	6,770	H. Aron	Quantity and energy meters.
May 13	7,668	J. S. Raworth	Current meters.
May 15	7,773	H. A. C. Saunders and A. C. Brown.	Telephone calls, alarm apparatus, &c.
May 30	8,448	E. F. H. H. Lauckert	Switch with carbon break.
June 10	8,825	H. Hughes	Preventing incrustation in boilers
June 12	8,870	J. G. Hughes	Stuffing boxes.
July 7	9,824	J. N. Taylor	Steam packing.
July 12	10,090	Stettiner Chamotte Fabrik Aktiengesellschaft.	Generators for gas manufacture; controlling feed-water; low-water alarms.
July 15	10,176	F. Walker	Liquid meter.
July 29	10,720	F. E. Elmore	Making printing and embossing rollers.
Aug. 6	10,990	C. Langdon-Davies	Improvements in telephony.
Aug. 9	11,105	L. and C. Steinmüller	Water-tube boilers and steam separators.
Aug. 13	11,241	J. Kirkaldy	Feed-water heaters.
Sept. 1	11,851	J. F. Belleville	Marine boilers.
Sept. 2	11,894	E. D. McCracken	Insulating conductors and compound conductors.
Sept. 9	12,189	C. A. Knight	Improvements in water-tube boilers.
Sept. 9	12,215	F. H. W. Higgins	Printing telegraphs.
Sept. 19	12,618	J. Kirkaldy	Supplying feed-water.
Sept. 23	12,703	E. M. Bentley and W. H. Knight.	Electric railways.
Sept. 29	12,953	G. B. Scott	Printing telegraphs.
Oct. 7	13,277	E. M. Bentley and W. H. Knight.	Electric railways.
Oct. 14	13,589	E. M. Coryell and F. M. Wheeler.	Air and circulating pumps.
Oct. 16	13,673	A. Beldam	Stuffing boxes.
Oct. 17	13,769	P. W. Willans	Central-valve engines.
Oct. 18	13,805	D. R. Cameron	Coupling between inclined axes.
Oct. 24	14,093	Soc. anon. des Mines Franco-Russes.	Multiple expansion engines.
Oct. 30	14,330	J. Smalley	Pistons.
Nov. 4	14,577	J. H. Man	Valves and valve-gear.
Nov. 7	14,723	Hon. C. A. Parsons	Dynamos and parts, electric governors.
Nov. 13	14,954	J. Radcliffe	Railway signalling instruments.
Nov. 18	15,125	T. Pickles & B. Blakey	Compressing wood for making shuttles and bobbins.
Nov. 27	15,648	W. Mather, J. Hopkinson and E. Hopkinson.	Armatures and field-magnets. [&c.
Dec. 3	15,923	N. A. Alexander	Waterproofing wood, paper, cloth,
Dec. 8	16,119	J. Tate	Stop gear.
Dec. 16	16,533	C. C. Worthington	Starting compound engines.
Dec. 16	16,534	C. C. Worthington	Draining cylinders.
Dec. 22	16,814	J. Kirkaldy	Surface condensers and heaters.
Dec. 23	16,858	C. C. Worthington	Compensating mechanism for direct-acting engines.
Dec. 30	17,023	C. C. S. Knap	Boilers.
Dec. 31	17,091	H. F. Joel	Field magnets, armatures and commutators.

* Extension petitioned for.

ELECTRIC LIGHTING NOTICES.

By comparison with the list we published on December 3rd, the following notices of application for Electric Lighting Provisional Orders show, among other things, the eliminating effect of failure to deposit the requisite £50 with the Board of Trade. The diminution in the list, however, arises also partly from the fact that in many instances in the former list the applications were to proceed by private Bills in Parliament. In the subjoined list there are 13 applications relating to metropolitan schemes, and 71 are provincial, making a total of 84 concerns projected:—

THE METROPOLIS.

District.	Name of Applicant.
Bermondsey	Vestry.
Bermondsey, Rotherhithe, Greenwich, and Lewisham	County of London and Brush Provincial Company.
Bethnal Green, Poplar and Whitechapel	County of London and Brush Provincial Company.
Hornsey	Urban District Council.
Holborn	Charing Cross and Strand Electricity Supply Corporation.
Holborn, St. Giles and Lincoln's, Gray's, Staple and Furnival's Inns	County of London and Brush Provincial Co.
Lewisham	District Board of Works.
Parish of Lewisham (portion of)	Great Western Electric Light and Power Co.
St. Giles	Charing Cross and Strand Electricity Supply Corporation.
Marylebone	Vestry.
Do.	County of London and Brush Provincial Co.
Do.	Marylebone Electric Supply Company.
Willesden	Urban District Council.

THE PROVINCES.

Airdrie	Corporation.
Aldershot	Urban District Council.
Aldrington (Hove)	Urban District Council.
Aston Manor	Urban District Council.
Barnes	Urban District Council.
Batley	Corporation.
Birkdale	Urban District Council.
Bolton	Corporation. [Extension of area of Supply.]
Brechin	Corporation.
Bridgwater	Corporation.
Bursiem	Corporation.
Chelmsford	Chelmsford Electric Lighting Company.
Chichester	Corporation.
Chislehurst	Chislehurst Electric Supply Company.
Chorley	Corporation.
Colne	Corporation.
Crewe	Corporation.
Darlington	Corporation.
Dartford	Urban District Council.
Doncaster	Corporation.
East Ham	Urban District Council.
East Stonehouse	Urban District Council.
Gravesend	Corporation.
Greenock, Port Glasgow and Gourock	North British Electricity Supply Co.
Hamilton	Corporation.
Hastings	Corporation.
Hereford	Corporation.
Ilford (Essex)	Urban District Council.
Ilfracombe	Urban District Council.
King's Norton	Rural District Council.
Kingswinford (Staffs.)	Rural District Council.
Leamington	Corporation.
Do.	Midland Electric Light and Power Company.
Leatherhead	Urban District Council.
Leigh-on-Sea	Urban District Council.
Lewes	Corporation.
Lowestoft	Corporation.
Maidenhead	Corporation.
Margam (Glam.)	Urban District Council.
Melton Mowbray	Melton Mowbray Electric Lighting Company.
Middlesbrough	Corporation.
Midlands (Walsall, Wednesbury, Wolverhampton, Darlaston, Tipton, Rowley Regis, etc.)	Midland Electric Corporation for Power Distribution.
Mitchelstown (Ireland)	Board of Guardians.
Montrose	Corporation. [area.]
Norwich	Norwich Electricity Company. [Extension of
Nuneaton	Nuneaton Electric Company.
Oldbury	Urban District Council.
Ossett	Corporation.
Partick (Glasgow)	Kelvinside Electricity Company.
Penarth (Glamorgan)	Penarth Electric Lighting Company.
Perth	Corporation.

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District.	Name of Applicant.
Peterborough	Peterborough Electric Light and Power Co.
Prescot(Huyton-with-Roby)	British Insulated Wire Company.
Preston	National Electric Supply Company.
Ramsgate	Electric Supply Corporation.
Rawmarsh	Urban District Council.
Rochdale	Corporation.
Rotherham	Corporation.
Rothesay	Corporation.
Ryde	Ryde Electric Light and Power Company.
St. Albans	Corporation.
St. Anne's (Lancs.)	Urban District Council.
Shrewsbury	Corporation.
Smethwick	Urban District Council.
Stoke-on-Trent	Corporation.
Warrington	Corporation.
West Bromwich	Corporation
Westgate-on-Sea	Isle of Thanet Rural District Council.
Weston-super-Mare	Weston-super-Mare Elec. Light & Power Synd.
Weymouth and Melcombe Regis	Corporation.
Whiston	Rural District Council.

PROJECTED LIGHT RAILWAYS.

We give below particulars of the Light Railway schemes in which electric motive power was scheduled and have been considered by the Light Railway Commission. The results of the applications will be found in the last column, and it will be seen that, while in some few instances the applications have been withdrawn by the promoters, and in others have been refused by the Commission, in the majority of cases the schemes have been sanctioned. The refusal to pass the scheme for a light railway at Taunton, on the ground of "want of jurisdiction," has led to an appeal to the Board of Trade :—

District.	Motive Power.	Promoters.	Result.
Aberdeenshire	Steam or other motive power	Ch. Forbes	Withdrawn
Cheltenham	Electricity	Thos. Nevins	Refused
Crewe and District	Electricity	British Electric Traction Company	Passed
Dartford	Electricity or other motive power	International Communications Co.	Passed conditionally
Dartford District	Electricity or other motive power	International Communications Co.	Refused
Dartford-Eynsford	Electricity or other motive power	Rt. Hon. Sir Wm. Hart Dyke, M.P.	Refused
Deptford Foreign Cattle Market	Electricity or other motive power	City of London Corporation	Withdrawn
Derby—Ashbourne	Electricity	F. J. Allbright and Others	Passed
Dudley & District	Electricity	British Electric Traction Company	Passed
Elsenham, Thaxted & Barfield (Essex)	Electricity or other motive power	.....	Passed
Flamborough-Bridlington	Electricity or other motive power	T. Whittaker	Passed
Gifford & Garvald	Electricity	.....	Withdrawn
Grimsby and Saltfleetby	Electricity or other motive power	.....	Refused
Isle of Thanet	Electricity	Isle of Thanet Light Railways Co.	Passed in modified form
Llandudno and Colwyn Bay	Electricity	George Griffiths and Others	Refused
Llandudno — Colwyn Bay	Electricity	Light Railway & Gen. Construction Co.	Postponed
Midlothian and Berwickshire	Electricity or other motive power	W. F. Dickson	Withdrawn
Norwich and District	Electricity	British Electric Traction Co.	Withdrawn
Norwich & District (No. 2)	Electricity	British Electric Traction Company	Withdrawn
Potteries District	Electricity	British Electric Traction Co.	Passed
St. George & Hanham (Bristol)	Electricity	Bristol Tramways & Carriage Co.	Passed
Taunton	Electricity	Taunton and West Somersetshire Electric Railway and Tramways Co.	Refused
Torquay — Paignton	Electricity	Western Counties Electric Railways and Tramways Co.	Withdrawn
West Hartlepool	Electricity	Hartlepool Electric Tramways Co.	Passed
West Manchester	Electricity or other motive power	E. T. Hooley and Others	Passed in modified form

NEW PUBLIC COMPANIES OF 1897.

The following are the more important limited liability companies connected with the electrical and allied industries registered during the past year, with their capital :—

	Capital.
Accumulator Syndicate	£30,000
Ackroyd and Best	25,000
Andrews (J. D. F.) and Co.	10,000
Anderson Electrical Traction Syndicate	5,000
Automatic Electric Meter Syndicate	32,000
Automatic Telephone Company	100,000
B.C. Electric Syndicate	75,000
Binko, Ridsdale and Co.	24,000
Blot (G. R.) and Co.	75,000
"Blot" Electric Accumulator	160,000
Bournemouth and Poole Electricity Supply Company	150,000
Bournemouth, Poole and District Light Railways (Electric) Co.	10,000
British Carbide Manufacturing Company	100,000
British Columbia Electric Railway Company	250,000
British Electrical Cycle and Motor Engineering Company	40,000
British Insulated Wire Company	400,000
Bromley (Kent) Electric Light and Power Company	20,000
Canton (Waipori) Mining and Electric Power Company	150,000
Cape Electric Tramways	400,000
Carbon (New) Syndicate	30,000
Cardiff and Penarth Light Railways Company	25,000
Central Electric Supply Company	100,000
Chislehurst Electric Supply Company	15,000
Chitty Dynamo and Motor Company	200,000
City of Mexico Electric Power Syndicate	5,000
Commercial Development Corporation	200,000
Coates (William) and Son	25,000
Cooke (T.) and Sons	70,000
Corbridge Electric Lighting Company	4,000
Cork Electric Tramways and Lighting Company	140,000
Craigpark Company	30,000
Crystal Electric Lamp Company	10,000
Direct West India Cable Company	120,000
Edmundson's Electricity Corporation	200,000
Electric Extension Company	50,000
Electric Fog Signal Syndicate	20,000
Electric Fur Machinery Company	3,600
Electric Hansom Cab and Carriage Syndicate	2,000
Electric Metal Working Syndicate	40,000
Electric Reduction Company	400,000
Electric Steam Syndicate	25,000
Electric Street Car Manufacturing Syndicate	25,000
Electric Supply Corporation	5,000
Electric Transformer System	15,000
Electrical Advertising Syndicate	10,000
Electrical Guarantee and Trust	250,000
Electrical Investments Trust	5,000
Electrical Pioneer Syndicate	10,000
Electrical Time Recording Company	12,000
Electrical Undertakings	10,000
Electrical Vehicle Syndicate	25,000
Electrophone	20,000
Elieson Lamina Accumulator Company	65,000
English Varley Duplex Magnet Company	10,000
European Electric Finance Company	5,000
Finchley District Electric Traction Company	10,000
Folkestone District Electric Railways Company	20,000
Folkestone Electricity Supply Company	50,000
Frederick Smith and Co., Wire Manufacturers (Limited)	100,000
French Improved Electric Glow Lamp Syndicate	2,500
Gem Dynamo Brush Company	3,000
General Electrical Company of Roumania	3,000
Gilbert Arc Lamp Company	2,000
Hampshire Light Railways (Electric) Company	1,000
Hastings, Bexhill and District Light Railways (Electric) Co.	10,000
Hateleys	25,000
Heath, Snoxell and Co.	10,000
Heath, Tizzard and Co.	2,000
Henry F. Joel and Co. and Thomas Potter and Sons United	20,000
High-power Electrolyte Syndicate	1,000
Hutchison Bros. and Co.	50,000
Improved Electro-plating Company	20,000
Indian Electric Company	1,000
Jandus Arc Lamp (Continental Patents) and Electric Company	100,000
John Dewhurst and Son	10,000
John Haynes Lighting Company	2,000
John Stephens and Son	40,000
Joseph Rhodes and Sons	50,000
London Motor Van and Waggon Company	300,000
London-Provincial Electrical Company	60,000
Lucy (W.) and Co.	12,000
Mardy Electric Light Company	2,000
Marylebone Electric Supply Company	100,000
Mauritius (Gas and Electric) Lighting Corporation	50,000
Mavor and Coulson	28,000
Mechanical Appliances Company	10,000
Melton Mowbray Electric Light Company	10,000
Mexican Electric Works	320,000
Musker (C. and A.)	20,000

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	Capital.
Midland Electric Corporation for Power Distribution	£200,000
Mont Cenis Power and Land Company	200,000
Morley Electrical Engineering Company	5,000
Mutual Electric Trust	10,000
Nalder and Hilton	20,000
National Electric Free Wiring Company	250,000
National Motor Carriage Syndicate	30,000
New Aluminium Patents	30,000
New Fowler-Lancaster	100,000
New Zealand Electric Light and Traction Company	5,000
North British Electricity Supply Company	1,000
Nuneaton Electric Company	10,000
O'Brien-Lennard Electrical Installation Company	5,000
Oldham, Ashton and Hyde Electric Tramway	80,000
Peerless Accumulator Syndicate	15,000
Penarth Electric Lighting Company	2,000
Penny-in-the-Slot Electric Supply Syndicate	50,000
Peterborough Electric Light and Power Company	10,000
Peto and Radford	10,000
Phaeton Electrical Company	1,000
Pickup (J. H.) and Co.	50,000
Thos. G. Poole	3,000
Power and Traction	10,000
Practical Primary Electric Battery Syndicate	8,000
Premier Electric Lamp Syndicate	30,000
Prism Globe Syndicate	25,000
Pullin and Shore	10,000
Railway Lighting	75,000
Railways Electric Supply Syndicate	10,000
Randall Telephone Syndicate	50,000
Rochester, Chatham, Gillingham and District Elec. Railways Co.	20,000
Rose and Bird	10,000
Ryde Electric Light and Power Company	10,000
Haynes (S.) and Company	5,000
Safety Concentric Wire Company	30,000
Sax, Slatter and Co.	10,000
Scott (W. V.) and Co.	5,000
Self-generating Electric Vehicle Light Syndicate	5,000
Shannon Electric Power Syndicate	12,000
Smithfield Markets Electric Supply Company	100,000
Spiral Globe	150,000
Stephens, Smith and Co.	20,000
Synchronome Syndicate	15,000
"Times" Electric Lamp Company	100,000
Townsend, Tamplin and Makowski	20,000
Townshend's Art Metal Company	40,000
Tudor Accumulator Company	50,000
Turbine Company	10,000
Ventnor Electric Light and Power Company	15,000
West Coast of America Telegraph Company	132,520
Westralian Electric Lighting and Supply Company	100,000
Weymouth Electric Light and Power Company	10,000
White, Jacoby and Co.	4,000
Wilson Manufacturing Company	2,000
Winchester Electric Light and Power Company	25,000
Wireless Telegraph and Signal Company	100,000
Woodlands Electric Company	1,000
Woodward Electrical Storage Battery Company	60,000
Wycombe (Borough) Electric Light and Power Company	15,000
X-Ray Syndicate	15,000

PUBLIC COMPANIES WOUND UP, DISSOLVED, &c., IN 1897.

The following are amongst the limited liability companies which have been wound up (either voluntarily or compulsorily) during the past year, the asterisk denoting that the company was wound up by order of the Court:—

Alderson's Patent Day and Night Clock Company.
Alternate-current Electromotor Syndicate.
Apostoloff Automatic Telephone Parent Syndicate.
Barnet District Electric Supply Company.
Blockley Electric Lighting and Manufacturing Company.
Blot Electric Accumulator.
Brighton and Hove Electric Light Company.
British Electric Light Company.
British Electrical Manufacturing and Engineering Company.
British and Foreign Electric and Engineering Company.
Capital and Counties Electricity Supply Company.
City of Bath Electric Lighting and Engineering Company.
Connelly Motor Company.
*Conrad, Dewey and Co.
Cottonwood Water-Power and Electric Company.
Crompton Electric Supply Company of Australia.
Denison Auto-Telegraph Machine Company.
Electrical Advertising Syndicate.
Electrical Installation Company.
Electrical Manufacturers.
Electrical Traffic Syndicate.
Electric Battery Company.
Electric Fittings, Hiring and Maintenance Company.
Electric Lamp Company.
Electricity Users' Association.
Electro-Alkali Company.
Electro-Cyanide Gold Recovery Syndicate.
Electro-Hygienic Company.
Electro-Protector Syndicate.
Electrolytic Research Syndicate.
English and Colonial Electric Light Company.
*Epstein Electric Accumulator Company.
Foreign Pilsen Electric Light and Power Company.
Fulgur Electric Lighting Company.
Gordon Electric Traction Syndicate.
Hampstead General Electric Fittings Company.
High Wycombe Electricity Company.
Hull Electric Company.
*I.E.S. Accumulator Company.
Isle of Wight Electric Lighting Company.
Joy's Patents.
Kennedy Storage Battery Company.
Leeds and London Electrical Engineering Company.
Lightning Express Railway Syndicate.
Llanelly Electric Light and Power Company.
Max Saturn Electrical Syndicate.
Mildé Telephone and Electric Company.
*New and Mayne.
New-Mayne Electric Rudder-Motor Syndicate.
Newport Electrical Engineering Company.
Port Beira Pier, Tramway and Telegraph Company.
Geo. W. Pridmore and Co.
Salt Lake and Ogden Gas and Electric Light Company.
Standard Dynamo and Motor Manufacturing Company.
Thetford Electric Light and Power Company.
*Ward Electrical Car Company.
Waterhouse Electrical Manufacturing Company.
Waterhouse Electro-Metric Syndicate.
West Australian Trunk Power and Lighting Company.
Winfields.
Zohrab and Biggs (English Patents).

THE MANAGEMENT OF BOILERS AND STEAM PLANT.†

BY A. B. MOUNTAIN.

(Concluded from page 321.)

Having decided to adopt water tube and Lancashire boilers it is necessary to arrange the fittings, and the question as to whether the boilers should be fired by hand or with mechanical stokers. Closely connected with this is the question as to what kind of fuel is to be used. It may be considered as settled that smoke in any considerable quantity will not be permitted to rise from the chimney top. With water tube boilers it is difficult to stop smoke, if hand fired, unless a very hard steam coal can be obtained. The flames rising from the fire come into contact with the cool tubes, and are to a great extent extinguished, causing smoke. If coke can be bought at a reasonable price excellent results may be obtained, and the smoke nuisance entirely removed; but coke has the disadvantage of requiring a very thick fire to stop the air rushing through, and a considerable quantity is usually thrown into the furnace when firing. This cools down the boiler, and reduces for a short time the generation of steam. Then, when the charge is being rapidly consumed, the steam is generated at a very rapid rate; if one boiler is used it therefore requires careful firing to keep a steady steam pressure, but if several boilers are used in combination it is very easy to fire alternately. If coke cannot be obtained cheaply, and the ordinary bituminous slack has to be used, it is necessary to fix mechanical stokers, otherwise there will be considerable trouble with smoke, and in the author's opinion the coking form of stoker is the only form which can be fixed to a water tube boiler with any certainty of success. The fixing of the Lancashire boiler does not require the same care as the water tube, as the flame from the fire passes over the bridge and helps to ignite any gases which may be passing away unconsumed, and as the flues are connected underneath the boiler, the flame from one fire assists in the combustion of the gases from the other fire. Mechanical stokers have, however, a great advantage over hand firing, in the fact that the class of fuel may be very considerably reduced in quality and consequently in price. It is not necessary to fix the coking form of stoker upon a Lancashire boiler; the sprinkling form of stoker will do equally well and has certain advantages. It more easily admits of the fire being forced, which in an electricity works is an important point. The heat generated

† Paper read before the Northern Society of Electrical Engineers.

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is distributed over the whole length of the bar, whereas in the coking form of stoker the heat is confined to a small portion of the fire, and the damage to the bars is considerable; and the author is of the opinion that the maintenance of the coking stoker is considerably higher than the maintenance of the sprinkling type. There are many other patent furnaces in which it is claimed exceedingly good results may be obtained. In most of these a jet of dry steam is blown through a nozzle or pipe acting as an injector, and increasing the pressure of air underneath the fire. This undoubtedly increases the rate at which the fuel may be consumed, and the steam passing through the fire forms water gas and adds considerably to the heat. If fuel of a very poor quality is to be consumed, a furnace of this type may with advantage be employed, but the author is not sure that there is not a limit to the heat which may be usefully employed in the furnace, and that harm is done to the plates or tubes if this is exceeded. From actual experience he has found damage result from such a furnace when employed in connection with a water-tube boiler.

While considering the firing of boilers it may be well to notice some of the large number of so-called smoke-consuming devices. These, in many cases, are simply arrangements for admitting a large quantity of air, which only dilutes the smoke and reduces the heat of the furnace gases, and it is well to be very careful before adopting these arrangements. Undoubtedly the results in a furnace in which coke is used can be very much improved by the admission of a secondary supply of air, but this should be supplied to the top as well as the bottom of the fire, and should, if possible, be hot, and so arranged that the air may be admitted in varying quantities. If it is proposed to adopt a furnace of this kind, having a secondary air-supply, it is advisable to fix an instrument which will indicate at any moment the condition of the gases leaving the furnace, and consequently show when the air should be admitted and in what quantity. It is no doubt unnecessary to point out that theoretically the gases leaving the furnace should consist of as much carbon dioxide as possible, together with water vapour and nitrogen. This it is, however, impossible to obtain in practice, and it will usually be found that the best results are obtained when about 20 per cent. of carbon dioxide is present, but the author would strongly urge the importance of employing any one of the many methods of recording the condition of the gases leaving the furnace. An excess of air simply reduces the temperature of the gases, and reduces the evaporative results. On the other hand, if there is not enough air the oxygen required for complete combustion is restricted, and carbon monoxide is allowed to leave the furnace without being converted into carbon dioxide.

The use of induced draught instead of forced has lately been tried in connection with marine boilers at some electricity works, with apparently satisfactory results. It is, however, questionable whether the draught induced by a fan drawing away the products of combustion at an extremely high temperature, and therefore much expanded, could not be more economically produced by a steam jet. Undoubtedly the idea of introducing hot air instead of cold is one of the causes of the success obtained with induced draught, and the author has found that this may be readily accomplished either with the water-tube or Lancashire type of boiler by forming a division in the walls of the boiler seating, through which the cold air passes on its way to the furnace. This not only heats the air, but keeps the outer wall of the seating cool, and thus prevents wasteful radiation of heat.

The subject of coal-elevating and conveying machinery, although somewhat outside the scope of this Paper, is too interesting to be passed without comment. The first question to decide is, when it will be advisable to put in elevating and feeding machinery. The author is of opinion that it should not be fixed until the work exceeds the power of three men upon the heavy shift, or, in other words, until the wages saved will go a considerable way towards paying the interest upon the capital expended. As to the most suitable arrangements for feeding the fuel to the hoppers of the stokers, this must depend to a very large extent upon the arrangement of the works, and the manner in which the fuel is delivered to the works. Whatever method is adopted, the fuel should be weighed into each hopper in the same manner as the coal in a gas works is weighed and fed into the retorts, and if ash elevating arrangements are devised, it is most desirable to know exactly the proportion of ashes per ton of fuel used. Probably the fittings attached to a boiler are the most serious cause of annoyance, and it is scarcely possible to over-estimate the importance of them. The same fittings are required for all boilers, the size depending upon the evaporative power of the boiler, and it is surprising to find the different classes which are in use. Commencing with the water gauges, there should in all cases be two on each boiler, so that the correct level of the water may be obtained. These should be so constructed that if a glass is accidentally broken, the steam and water which would rush out will be instantly stopped. The gauges should also be protected, so that the pieces of glass are not allowed to fly outwards. High and low alarm valves, and steam safety valves, should all be of ample size; no greater mistake can be made than in reducing the size of a safety valve. The main stop valve should be large, so that the steam does not have to leave the boiler at a high speed. Small valves are frequently the cause of water being carried with the steam into the steam pipes. It has been suggested by some makers of fittings that it is desirable to fix another valve adjoining the main stop valve, for the purpose of stopping the steam being admitted accidentally into a boiler in which a man might be working. There have been several accidents of this kind, and a really reliable valve for isolating purposes would be useful. Unfortunately, the steam usually leaves the boiler in short pulsations corresponding to the periods of admission to the engine, and these pulsations cause a valve to speedily knock itself to pieces, or, at any rate, to damage its face and seat so badly that it is not steam-tight. Two feed valves should be arranged for each boiler, so that any accident will not stop the supply of water, and it is of course desirable to arrange the feed pipes in the ring form, or with two distinct ways of feeding. A blow-off valve must be fixed to each boiler, and the author has found it extremely desirable to have these so arranged that they can be very easily inspected. It is very usual to connect the blow-off valve with the drain, and if this is done it is impossible to tell if the valve is leaking; and in addition to this undesirable contingency, some fatal accidents have taken place owing to the blow-off valve of each boiler being opened at the same time, allowing the steam from one boiler to get back to the other, and scald the men employed cleaning. This trouble has led to the introduction of many ingenious arrangements to avoid the danger of leaving the valve open, but in the author's opinion they should be quite unnecessary, and only add considerably to the expense and complication of the fittings, which should be devoid of as many refinements as possible. The chief trouble with high-pressure steam fittings are caused by the expansion due to the high temperature of the steam. It is very usual to see fittings quite tight with a water pressure and also with a low steam pressure, but quite unfit for employment with a pressure of 150lb. to 200lb. per square inch, and the author has found it advisable to insist upon all fittings being tested with steam to a pressure considerably above that at which they are required to work. It should be a rule in any well-managed works that all fittings should be carefully examined and cleaned at least every twelve months, and unless this is done even the best fittings will prove unsatisfactory.

Having arranged the class of boiler, method of firing and fittings, the next step is to convey the steam to the engines, and it is again evident that in an electricity works some special method must be devised so that the supply may never be interrupted by the failure of the joints, pipes, fittings, &c. Roughly summed up there are three systems in use:—

(1) The single main, with the boilers feeding in and the engines drawing out.

(2) The ring system, so arranged that any section can be disconnected.

(3) The twin system, with two ways of supplying each point.

All these methods have advantages for and against them, and it is more or less a matter of choice which should be adopted. The first, in the author's opinion, is not sufficiently safe to be employed where continuity of supply must be considered as the first requirement. The size of the main steam-pipe is also an important point: as the size increases the condensation becomes greater. It is quite possible to arrange feeders to the points where the supply is required, and by doing this reduce the size of the ring. The feeders being opened only upon heavy loads considerably reduces the condensation, which even in a small works is an exceedingly costly item. The author has found it desirable to place receivers having considerable capacity close to each engine. These act as steam dryers as well as maintaining the pressure, and as they are only in use while the engine is running, they do not therefore add considerably to the amount of condensation. It is, of course, most desirable to arrange all valves upon branches so that they stop the supply as close as possible to the main, and thus reduce the length of live pipe as well as leave the engines' cylinders cool for inspecting purposes. The pipes should be free to expand, and it is absolutely necessary either to arrange large bands or expansion joints for this purpose.

The drainage of steam pipes is a subject upon which another Paper might easily be written. There are innumerable steam traps designed to allow the water to readily flow away; but the author is surprised that the American method of dealing with this difficulty has not been more generally adopted in England, as it is most desirable to conduct the hot condensed water back to the boiler, if possible, without the help of a pump. One of the American methods employed may be very briefly described. It consists of a small pipe; the one end being connected to the steam pipe at the point from which it is desirable to drain the water, the other end being led direct to the boiler. Supposing that the boiler pressure was 150lb. per square inch, and the pressure upon the steam pipe at the point desired to be drained 145lb. per square inch, it would be necessary to allow the pipe to rise, say, 12ft. above the water level in the boiler to enable the water to return to the boiler, a

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check valve being arranged at the top of the pipe so that the water can go into but not return from the boiler.

In conclusion, the author would point out a few of the difficulties he has experienced in working with water-tube boilers, under the conditions stated in this Paper. The cracking of the brickwork seating, and consequently the admission of cold air, has been a source of considerable annoyance, and the author is not aware of any method of construction which will prevent this, although several different methods have been tried. The firebrick lining of the boilers will also require constant renewal, and the author has found large firebrick slabs placed at the side of the furnaces last much longer than brickwork, and are more easily replaced. After the boilers had been at work some time, it was found that a considerable amount of pitting was taking place. This was due to the soft condensed water, and was stopped by limewashing the whole inside of the boiler, or by admitting lime with the feed water, but if the latter course is adopted, care must be taken to admit only a small quantity of lime, or a deposit in the form of scale will form on those portions of the boiler subjected to the greatest heat.

The admission of oil with the feed water is, however, one of the most serious difficulties the author has had to overcome. There are many forms of filters which may be used. These consist generally of Turkish towelling, or cocoanut matting, wrapped round a perforated cylinder or plates, and are fixed upon the feed pipes so that the water entering the boiler is compelled to pass through the filtering medium. Another class of filter may be used, in which coke or sawdust is employed as the filtering medium, but the author has found that the great point against any form of filter fixed upon the feed pipes is that the water is passing through the filtering medium at too great a velocity, and he has found that if a filtering tank is placed under the condenser into which the hot water flows, and the water allowed to pass through a much larger area of filtering material at a very slow speed, much more satisfactory results can be obtained; but even with a duplicate arrangement, oil will find its way into the boiler in small quantities, and the boilers must be frequently cleaned. Although cleaning a boiler once every month or six weeks may entail considerable expense, it is to a large extent returned by the increased evaporation. The importance of keeping boilers thoroughly clean cannot be overestimated, and in the author's opinion this is the greatest cause of the difference in the figures obtained when testing, and this applies to all types of boilers.

The great aim of the engineer in charge of the works will be to obtain the most steam at the least cost, but unfortunately it is hardly possible to make a satisfactory comparison because the cost of fuel varies very considerably, and it may be that the engineer with a high figure for fuel is really working more economically than another engineer whose figures are much lower, owing to the fact that the price of coal depends largely upon locality. In an electricity works, owing to the very varying demand, a very large proportion of the fuel is used for banking up fires in reserve boilers. It would therefore seem advisable to employ the poorest class of fuel possible to be obtained, provided it can be delivered to the works at a very cheap rate, in preference to burning less fuel of a more expensive kind. The author has found, from careful tests, that the cost of fuel per pound of water evaporated depends almost entirely upon this question of price, and not upon quality. But if poor fuel be employed, more boilers will be required, and it may easily happen that the capital charges upon the additional boilers will outweigh the small advantage gained from the use of poor fuel.

The author would finally express his regret that he has only been able to touch upon the outskirts as it were of this important subject, which affords ample scope for deeper research and opportunities for some most interesting experiments; and although he feels that there is nothing in this Paper of which those present are not fully aware, he yet hopes that this subject which he has had the honour of bringing before them may be the means of inducing an interesting discussion upon this important question.

Electrically-Caused Fires.—The popular practice of crediting electricity with being the originator of fires of the "cause-unknown" category seems not to be confined to this country and America. At the last meeting of the French "Professional Syndicate of Electrical Industries," the president, M. F. Meyer, mentioned that certain newspapers had attributed a fire, which recently occurred in a factory at Alfort, to a short-circuit in the electric wiring. M. Mildé had made an inquiry into the circumstances and had arrived at entirely different conclusions. The President had thereupon, in the name of electrical industry, written a protest to the papers in question, and this had been duly published.

ON COHERERS AND THE USE OF THE INTERFEROMETER IN THE STUDY OF ELECTRIC WAVES.

A dissertation by G. F. Hull, bearing the above title, forms a thesis which was submitted in candidature for the degree of Doctor of Philosophy. The author, remarking the value of the interferometer as a powerful instrument in the study of light, gives the results of a research he has prosecuted with an interferometer constructed for the analysis of electric waves. He reviews the respects in which, however, electrical and light oscillations differ. In the former, theory and experiment indicate that they are always damped, while experiment has failed to detect such damping in light oscillations, although the breadth of a spectral line may be accounted for on the assumption of such damping. Another difference is that the eye, the usual detector of light radiation, although small in range, has no period of its own, and does not influence the measured wave-length, while on the other hand electrical radiation receivers have this property of influencing the measured wave-length. The question thus arises whether the radiation from a Hertzian vibrator is simple or complex, and, if sufficiently simple in general to be analysed by the interferometer, how shall the interference curve be interpreted if its form is influenced by the receiver? Instead of using Hertzian receivers in his experiments the author used the Branley or Lodge form of coherer, consisting of small nails in a glass tube filled with oil, and it seems from his experiments that such a receiver has far less influence on the interference curve than has the Hertzian form, and that his expectations have been verified that the coherer used is highly damped, but that its damping coefficient is of the same order of magnitude as that of the vibrator and consequently it influences the interference curve. The author finds that the wave-length is nearly proportional to the diameter of the sphere of the vibrator (the law being more nearly expressed by $\lambda = m(r+a)$ where m and a are constants and r = radius of sphere) but independent apparently of means of inducing the discharge or of the sparking distance. In conclusion, the author remarks that the points of difference between light and electric radiation tend to make the analysis of radiation more difficult in the case of electricity than in that of light; for there are added to the variables of the vibrator those of the receiver. However, when we find that there is present in all the interference curves for one vibrator a certain element, we are safe in saying that the element is due to an oscillation of a definite period on the vibrator; and further, the conclusions arrived at from the experiments are: that (1) The interference curves depend on both the vibrator and the receiver; (2) the influence of each varies; (3) the logarithmic decrement of the receiver is of the same order of magnitude as that of the vibrator; (4) the chief component of the radiation and the period of the vibrator may be determined from a number of interference curves; (5) this receiver could be used to analyse the radiation when the oscillations are but slightly damped; (6) the error in determining the index of refraction need not exceed 1 per cent.; (7) progress is to be looked for in obtaining (*a*) a more constant source, (*b*) a more constant, dead-beat, yet sensitive receiver.

The same investigator has been experimenting on the action of coherers, and in an article in *The Astrophysical Journal* gives his results. Without detailing the different forms of coherer experimented on and given in the article, the following facts elucidated are interesting. A coherer formed of about a dozen steel spheres in a glass tube which they just fitted was found to be very sensitive; but one in the form of a tube containing iron tacks 1cm. long in heavy paraffin oil or lubricating oil was not nearly so sensitive as the former, but was far more constant and came back with tapping accurately to zero. The result of tests to determine the influence of the dielectric resulted in the law that the more viscous the medium the less lasting is the change of resistance, and at the same time the less liable are the nails to be disturbed by the tapping-back process. A medium which will allow the change of resistance to be permanent and yet sufficiently viscous not to allow the nails to be disturbed by the tapping-back process, and such that after tapping the galvanometer returns to zero, is the one required for a quantitative receiver. A mixture of vaseline and lubricating oil was found to serve the purpose fairly well.

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office," Nos. 3, 4, 5, and 6, Vol. LXXXI. Published by authority of Congress. Washington: Government Printing Office.)

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ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.—By J. ELTON YOUNG. This work will be issued early in 1898. Some extracts from the book have already appeared in *The Electrician*, from which it will be seen that the latest practice in Electrical Testing for Telegraph work has been treated by the Author.

THE ELECTRIC ARC.—By Mrs. AYRTON. This work will shortly be published, and will contain an historical sketch of the early experiments on the electric arc, as well as the important results of recent research.

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1897.

From time to time, at the meeting of the years, it has been our pleasant duty to look backward over each year just ended, to summarise its chief events, to draw, where possible, encouragement or warning from their indications, and to glance forward into the dim perspective of the year just born. Sometimes it has been at the close of a year abounding in electrical progress and activity that this task has been performed; at other times the record has told of a slower and less important onward march; but taking the years as they have come, none can compare with 1897, chequered though its course has been, for the splendid record it has made. One supreme event, indeed, imparts to the year now closed a splendour that lifts it into pre-eminence in British history, an event transcending all other events of the year, as the brilliance of Sirius *sui generis* transcends the brightest of stars of the first magnitude, and compels immediate attention and admiration. The Diamond Jubilee of HER MAJESTY our most gracious QUEEN will make the year 1897 memorable as long as the world-wide empire of Great Britain is remembered in history. It commands the earliest and most prominent place in our present review, for, to the electrical profession, the circumstances of that event are significant of much; the permanence of its splendour lying more in its symbolism of what has been accomplished than in its more obvious fact. Nor can we, in our limited sphere of electrical interests, afford to be heedless of the national and political significance of that event; for in these respects it is the emblem of all that has developed in the past—and will render

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possible in the future—that pre-eminence of British scientific progress and British engineering of which we are justly proud. It is not merely with the year 1897 that the Diamond Jubilee is to be identified, but also and more significantly with the years made famous by the works of FARADAY and MAXWELL, of COOKE, WHEATSTONE, THOMSON, VARLEY, of HUGHES, of KELVIN, CROOKES, and a host of workers of recent years; the years when electrical science was evolved in our land from its embryonic stage to its present advanced state, when electric telegraphy grew from a scarcely practical possibility into a gigantic system enmeshing every land and enchaining "the great grey level plains of ooze where the shell-burred cables creep"; the years that have seen the development of electrical engineering as an important profession and industry, and the birth and growth of the things with which, as a profession, electrical engineers and scientists are concerned. Indeed, of all sciences, and of all branches of engineering, the electrical may, perhaps, make the strongest claim to be identified with the Victorian age. Most appropriately, therefore, did the Jubilee ceremony include in its programme an event of especial interest to telegraphers—the sending of Her Majesty's message to the ends of the earth and the returning flood of loyal congratulation.

"Hush! Men talk to-day o'er the waste of the ultimate slime,
And a new Word runs between: whispering, 'Let us be one!'"

We could have wished for the year of the glorious Diamond Jubilee a page in history all bright and untarnished—could fancy this paragon of years should be sullied by no dark, inglorious circumstance—"but not for golden fancies fron truths make room." Scanning the chequered course of the year recently ended, and noting only those events which pertain to our especial sphere, we observe standing out more darkly by contrast with a former splendour the gloomy cloudbank of the engineering strike. Over one-half of the year it has cast its dismal shadow, while on the threshold of the New Year the shadow darkens and the cloud heaps itself higher and more threateningly, portentous of sterner strife between employers and employed in the engineering trades of our land. Fortunately the strife has been bloodless, and one of the most prolonged and resolute of battles between masters and men has been fought thus far without recourse to lawlessness or violence—weapons too often, alas! the mainstay of one side or the other in previous struggles of this kind. That this unfortunate difference between the engineering firms and their men may speedily be terminated must be the wish and hope of all who have at heart the scientific and engineering prosperity of our nation; for, the direct influence of a severe blow to our engineering trades would reach further than the circle of practical men, penetrating even to the laboratories and class-rooms of our professors, where the engineers of to-morrow are in the making. Touching the motive spring of this strike, it would seem that the vital point at issue is based on the men's demand for a 48-hours' week and the employers' declaration that concession to this demand would be fatal, destroying all prospect of profit-making trade. If this declaration is founded on fact, either the men must withdraw their demand or the struggle must be prolonged "to the death."

Quite another species of Engineering Conference than has recently been held in connection with the strike was that happily inaugurated by the Institution of Civil Engineers last May, when a great variety of important topics were discussed by engineers from all parts of the country and from abroad, and a valuable impetus was given to the scientific and literary side of engineering progress. In the more materialistic progress represented by new engineering inventions the year has not been rich, though the new types of alternators brought out by Mr. MORDEY and Mr. FYNN represent a general trend of all-round improvement in the design of electrical machinery.

In the telegraphic world the most attractive items of development have been those which have clustered around the names of LODGE, BROWN, MARCONI, and the numerous workers in the field of "wireless" telegraphy. This branch of applied science has during the past year passed from the arena of the laboratory to a wider domain under the *ægis* of the company promoter, though it cannot yet be said that any satisfactory commercial development has been made that can be regarded as affording a new and trustworthy means of practical signalling over a considerable distance.

During the latter part of the year a proposal was laid before the British Government by the Eastern, Eastern and South African, and Eastern Extension Telegraph Companies to lay a cable to Australia from Land's End, *viâ* Gibraltar, Sierra Leone, Ascension, St. Helena, and Cape Town, connecting with land lines to Durban, Natal; thence by cable to Mauritius, Rodriguez Island, Cocos or Keeling Island, and Perth (Western Australia). This route is recommended in substitution for and in preference to the suggested all-British Pacific cable, which would involve one section 8,700 miles in length; as, amongst other advantages—such as duplication, triplication, and in some cases quadruplication of individual sections—it would provide for touching only at British territory, and would afford a triplicate route to South Africa and Australia. It is hoped that 1898 may see carried out some part of this extensive programme, which would add nearly 14,000 miles to existing submarine cables.

Telephonic developments during the year have included the completion of the taking-over of the trunk wire system by the Post Office. An important inquiry which took place in Glasgow, in October, and lasted eleven days, had for its object, partly, the hearing of certain complaints regarding the character of the telephone service of that city, and partly to decide whether the local system should be acquired by the City Council. Huddersfield has also shown a strong disposition to acquire municipal control over its telephone system. In May a second two-line telephone cable was laid on the London-Paris route.

Stations for the supply of current for electric light and power have been opened during the past year at several of the smaller towns, and an even greater number of provincial electric supply works are now in process of construction. These new concerns show a marked development in municipal control of the electric supply business; the municipal concerns opened in the provinces comprising those at Harrogate, Torquay, Wakefield and Wallasey, while metropolitan vestry control has been strengthened by the addition of Hammersmith to its numbers. In our colonies electric power supply has received a healthful impetus during the year by the development of a number of important schemes for the electrical transmission of water power. Among these are worthy of notice the Lachine Rapids power-utilisation plant, inaugurated last September, and the yet uncompleted plants at Chambly and Massena.

Electric traction has quite fulfilled the promise it made at the commencement of last year, though unfortunately British contracting firms have had to look with chagrin at the large proportion of plums that have fallen into the mouths of their American rivals. Most notable in this respect has been the acceptance of an American tender for the complete electrical equipment of the Central London Railway. We are not disposed, however, to regard this state of affairs as other than transient, and there is good ground for hope that ere long our own firms will rise to the occasion, and successfully

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capture the bulk of this growing industry. Of new electric tramways opened last year the lines at Leeds and Dover are of special interest, as affording examples of municipally owned and worked electric lines, in the first case the municipality owning the power station, in the second instance the power being metered from the electric supply station of a local company. These are, therefore, typical of the two directions along which municipalisation of electric tramways seems likely to progress in the immediate future. An enormous number of new lines are in various stages of projection, and quite a large percentage of these give promise of practical fruition. It is worthy of note that a decided tendency has been shown, in many instances, to construct the lines under the Light Railways rather than the Tramways Act, even though the lines scarcely seem to correspond to the usually accepted description of a light railway. Avoidance of the compulsory purchase clause in the latter Act would generally appear to be the chief reason for this course. In this connection we may point out that the Light Railway Commissioners have refused sanction to the projected electric line at Taunton, on the grounds of not conforming to the conditions laid down for a light railway, but this decision has been appealed against to the Board of Trade. Electric vehicles to run on ordinary roads have been developed to a considerable extent during last year in London, New York, and Paris. Light vehicles for from two to four passengers have been placed on hire on the streets, a number of private cars have been running trial trips, and we are now definitely promised one or more electric omnibuses to be put on the streets of London before long.

Turning from the practical and commercial to the scientific side of electrical progress, the most striking discovery of the year will probably be admitted to be that of Dr. P. Zeeman, of Amsterdam, on the widening of the D lines in the spectrum under the influence of a strong magnetic field in the vapour producing it. Prof. J. C. Bose has also imparted additional strength to the electromagnetic theory of light, by his discovery that certain crystals which polarise electric rays by unequal absorption in two directions exhibit unequal conductivities in the two directions. The mystery of the Röntgen ray is still unravelled, though many workers have laboured at it; but it is probable that the solution will be aided by the formation, last November, of a Röntgen Society in London, under the presidency of Dr. S. P. Thompson. The fraternisation between British and Canadian scientists has been cemented by the meeting of the British Association at Toronto, in August. Electrical science has been honoured by the knighthood conferred on Prof. Crookes, on the occasion of the Diamond Jubilee, and by the creation of Prof. Hughes an Officier de l'Ordre Leopold by the King of the Belgians.

Death has laid a heavy hand on the ranks of telegraphers. Early in the year died Jacob Brett, John Aylmer, Dr. Rothen, and H. C. Forde, followed later by C. W. Earle, G. G. Nicol, and Edward Graves, the latter brutally murdered in Persia. Other branches of electrical practice have suffered loss by the death of Galileo Ferraris, "the father of the Drehstrom," and of W. W. Griscom; and the commercial side of electrical engineering has lost W. S. Graff Baker. Electrical science has been deprived of Dr. Stefan Doubrava, Profs. Tomlinson and Holm, and Signor Brioschi.

A general review of the state of electrical science and industry reveals that, marred only by the single misfortune of the engineering strike, a solid front is presented in the direction of sterling progress and prosperity. We wish all concerned in that industry and science a prosperous New Year!

REVIEWS.

Whittaker's Mechanical Engineers' Pocket-Book. By Philip R. Björling. (London: Whittaker and Co., 1898.)

To be of real value an engineers' pocket-book must fulfil two essential conditions: it must cover an area of subject-matter sufficient to meet the requirements of the user in ordinary everyday practice; and it must furnish its information in the most accurate and latest form. If the work has been compiled by a well-known and experienced writer on engineering subjects, who is himself also an engineer, it gains an additional advantage. The little book before us certainly fulfils the first, if not completely the second of the two conditions stipulated; and its title-page bears the name of an author of high standing and repute. In regard to the extent of the subject-matter, there is little that any mechanical engineer is likely to require to be informed on—as to formulæ and data—that is not afforded, in greater or lesser degree, by the pages of this pocket-book. Besides the usual quantity of mathematical tables and tabulated units of weights and measures, &c., there are almost innumerable well-arranged tables of purely engineering data, relating to such matters as concern the hydraulic, steam-engine, gas engine, mining, or other mechanical engineer.

In regard to the accuracy and modernity of the information more might be learned by constant use of the book in daily life for a few weeks or months than by glancing through its pages as it lies on the reviewer's table; but we have been able to satisfy ourselves that the great bulk of the tables and formulæ are reliable and consistent with recognised practice. Unfortunately we cannot say we have failed to find anything but unimpeachable information. For instance, the formula on page 111 for the "tension of flywheel rims" takes account only of the speed and diameter of the wheel, and ignores an important factor, viz., the number of arms; there is also a vagueness about the information that "the diameter of a flywheel varies greatly according to circumstances, but it should never be such that the circumferential speed exceeds 80ft. per second." For what material and shape of wheel this rule is intended is not specified; and the reader might be led to suppose that no flywheel, of whatever shape or material, should be run faster than the speed mentioned—a quite erroneous supposition.

Annuaire pour l'An 1898. Edited by the Bureau des Longitudes. (Paris: Gauthier-Villars et Fils.)

This little handbook contains as usual a mass of useful information in a compact form, although in some respects it has not been brought quite up to date. The definition of the ohm is still that of 16 years ago, the "international" variety being evidently not yet deemed worthy of mention, and the list of determinations of v is only brought down to 1892. Some new magnetic charts of France have been added this year, and an interesting article by M. A. Cornu on the work of Fizeau.

Kalender fur Elektrotechniker. By F. Uppenborn. (Munich and Leipsic: R. Oldenbourg. 1898.)

The fifteenth yearly edition of this pocket-book has now been issued. The chief additions and alterations are in the sections devoted to alternating-currents. In order to economise space the tables furnished by manufacturers, giving particulars of stock-sizes of machines and apparatus, have been omitted this year. This omission in no way impairs the utility of the publication.

The "Mechanical World" Pocket Diary and Year-Book for 1898. (London and Manchester: Emmott and Co.)

This little book presents itself in its eleventh year of publication considerably amplified by the addition of new and useful matter, and in a much improved binding. It contains a large amount of practical information in a concise form relating to chemical engineering, together with a new section on beams and girders by W. H. Atherton, B.Sc. The numerous tables of data should prove valuable for reference.

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Lockwood's Builders' and Contractors' Price Book for 1898. (London: Crosby Lockwood and Son, 1898.)

As in the last edition of this useful price book, some 25 pages are devoted to electric lighting, and a few pages to electric bell and telephone work. Little new matter has been added, but the old matter has been revised and brought up to date.

The Automotor and Horseless Vehicle Pocket-Book of Automotive Formulæ and Commercial Intelligence for 1898. (London: F. King and Co. 1898.)

The author or compiler of this singular work modestly refrains from placing his name on the title-page, but we learn from the preface that it is George Herbert Little. We confess that the apparition of this pocket-book caused us rather a shock; we did not know before that the hardy horseman of the horseless vehicle needed a special pocket-book, but we suppose he does. Whether he can spare a pocket for it is another matter. To doom a man to carry one specimen of each of the several pocket articles alleged to be appropriate to his profession, business or favourite sport would not be the mildest form of torture conceivable; but, on the other hand, the individual is rare indeed who would delight in carrying a pocket series of the entire Bodleian library. However, given a horseless vehicle rider or automotive traveller, with a thirst for "automotive formulæ" and commercial intelligence, and a suitable pocket to carry it about in, Mr. Little's venture to supply these commodities might find an appreciative and grateful patron. "Signs of Weather" should be among the useful information for such an one, as also, if he be sentimental, might be the "Table of Moonlight Nights"; but in what conceivable circumstance will a knowledge of "The Morse Code" serve him a timely and useful purpose? We read that by "either a whistle of some kind or a bell automobilists are readily enabled by the Morse code to signal or send a message a considerable distance." Heavens! if this sort of thing is to be allowed the invasion of the earth by "automobilists" will be as terrible as that by the Martians described by Mr. H. G. Wells.

Electrical Installations, for Architects, Borough Surveyors, Civil Engineers, &c. By F. J. Warden-Stevens. (London: P. A. Gilbert Wood, 1897.)

It has been the author's aim in this book to supply architects, borough surveyors, civil engineers, "&c.," with some useful information with regard to the principles and practice of electrical installation work, and he has succeeded fairly well. Two unfortunate blunders are made on the first page of the introduction, notwithstanding. We are told that "perhaps the strongest argument in favour of electricity is its *purity* and *coolness*. It does not vitiate the atmosphere, and *has no perceptible heating effect*. . . ." The italics are ours. Other corrections here and there are also needed. For instance, it is stated that main switches are seldom used when any heavy current is flowing, and that in consequence there is no danger of arcing, and the break need not be very quick. And, again, on the subject of testing, the reader is told that the insulation should be measured between each conductor with all lamps out of the sockets and the switches on, and then between each conductor and earth with all the lamps out and the switches off; but it appears to us that earths in switches and lampholders might be overlooked with this manner of testing. The chapter on arc lamps is not as clear as it should be, and more diagrams and drawings are wanted both here and elsewhere; but, on the other hand, the chapters dealing with costs and with electric power distribution are in keeping with the character of the book. The volume does not aspire to be a complete treatise on the wiring of buildings or the erection of electrical plant, and it offers, we are glad to say, little encouragement to the class of readers for which it is written to attempt the design or execution of such work themselves. Many useful hints are given and many pertinent questions are dealt with in a lucid manner, which will be appreciated by the architectural and lay mind.

SUMMARY OF ELECTRICAL EVENTS FOR 1897.

January.

Death of Jacob Brett (9th).
Mr. Sydney Morse elected Chairman of the Electrical Trades Section of the London Chamber of Commerce (8th).
Sir Henry Mance delivered his Presidential Address to the Institution of Electrical Engineers (14th).
Formation of an Italian electrical engineering society.
Publication of the Report of the Special Committee appointed by the Governors of the City and Guilds of London Institute at the instance of the Mercers' Company. The Committee report that the work of the Central Technical College "has been eminently successful, and that the results achieved are fully commensurate with the expenditure involved."
Death of Mr. John Aylmer.
Meeting of the Municipal Electrical Association to discuss the question of the fire insurance of electric lighting stations (28th).
Toronto Electric Light Works burnt down.
Issue of a broad American patent on the "booster" system to Mr. H. Ward Leonard.
Prof. J. C. Bose reads a Paper before the Royal Society announcing the discovery that certain crystals which polarise the electric ray by unequal absorption in two directions exhibit unequal conductivities in the two directions (28th).
Dividends declared:—Yorkshire House-to-House Electricity Company, 6 per cent.; City and South London Railway Company, 1¾ per cent.; Cambridge Electric Supply Company, 5 per cent.; Coventry Electric Tramways (Limited), 8 per cent.; St. James and Pall Mall Electric Light Company, 10½ per cent.; Anglo-American Telegraph Company, £2 13s. per cent.; Liverpool Overhead Railway Company, 2⅞ per cent.

February.

Conclusion of the taking over of the telephone trunk wire system by the Government (6th).
Mordey Inductor Alternator brought out.
Death of Galileo Ferraris (7th).
Death of Dr. Rothen, Director of the International Telegraph Bureau at Berne (12th).
Discovery by Dr. P. Zeeman, of Amsterdam, of the electro-magnetic expansion of the D. lines of the spectrum.
Death of Mr. Henry Charles Forde (21st).
The action of Hookham *v.* Johnson (Perry Meter Case) commenced (26th).
Dividends declared:—Isle of Man Tramways and Electric Power Company, 8 per cent.; Newcastle-upon-Tyne Electric Supply Company, 5 per cent.; National Electric Supply Company, 2½ per cent.; Westminster Electric Supply Corporation, 9 per cent.; Cambridge Electric Supply Company, 5 per cent.; Newcastle and District Electric Lighting Company, 7 per cent.; Telegraph Construction and Maintenance Company, 15 per cent.; National Telephone Company, 5¾ per cent.; Kensington and Knightsbridge Electric Lighting Company, 7 per cent.; Hove Electric Lighting Company, 5 per cent.; City of London Electric Lighting Company, 7 per cent.: Charing Cross and Strand Electricity Supply Corporation, 6 per cent.; W. T. Henley's Telegraph Works Company, 10 per cent.; India-Rubber, Gutta-Percha and Telegraph Works Company, 10 per cent.: Northampton Electric Light and Power Company, 2 per cent.; Scarborough Electric Supply Company, 4½ per cent.; Chelsea Electricity Supply Company, 5 per cent.; Notting Hill Electric Lighting Company, 4 per cent.

March.

Paper, on the "Prevention of Fires Due to Leakage of Electricity," read before the Society of Arts by Mr. F. Bathurst (10th).
The formation of a Victorian Research Fund, proposed by the Royal Society.
Paper on "The Transmission of Power to Long Distances by Alternating Currents of Electricity," read before the Society of Arts by Mr. W. B. Esson (31st).
Electric hansoms ply for hire in the streets of New York.
Paper on "Some Cathode Ray Experiments," read before the Royal Society by Mr. A. A. C. Swinton (11th).
Dividends declared:—Birmingham Electric Supply Company, 4½ per cent.; Oxford Electric Company, 4½ per cent.; Eastbourne Electric Light Company, 7½ per cent.; Direct Spanish Telegraph Company, 4 per cent.; Sheffield Electric Light and Power Company, 7½ per cent.; Anglo-Portuguese Telephone Company, 2½ per cent.; Oriental Telephone and Electric Company, 5 per cent.; Eastern Extension Australasia and China Telegraph Company, 7 per cent.

April.

Paper read before the Institution of Electrical Engineers by Mr. A. K. Baylor, on "Some Recent Developments in Electric Traction Appliances" (8th).

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Judgment given by Mr. Justice Wills, in the Hookham meter case, in favour of Mr. George Hookham, the Perry meter held to be an infringement (10th).
Harrogate Municipal Electric Supply Station opened (15th).
Formation of the Electrical Engineers' Royal Engineers (Volunteers) gazetted (27th).
Paper read before the Royal Society, by Mr. Campbell-Swinton, on "The Production of X-Rays of Different Penetrative Values" (8th).
Canadian Niagara Power Company breaks ground (30th).
Friday Evening Discourse at the Royal Institution on "Cathode Rays," by Prof. J. J. Thomson (30th).
Dividends paid: Eastern Extension, &c., Telegraph Company, 7 per cent.; Indo-European Telegraph Company, 10 per cent.; British Insulated Wire Company, 10 per cent.; Oswestry Electric Lighting and Power Company, 3 per cent.; Norwich Electricity Company, 4½ per cent.

MAY.

Birmingham City Council decides to municipalise electric lighting.
Second telephone cable laid across the English Channel (8th).
Paper on the "Disturbance of Submarine Cable Working by Electric Tramways," read before the Institution of Electrical Engineers by Mr. A. P. Trotter (13th).
Paper "On Dynamoes," read before the Institution of Electrical Engineers by Mr. W. M. Mordey (20th).
Engineering Conference under the auspices of the Institution of Civil Engineers (25th, 27th).
Dividends declared: Western and Brazilian Telegraph Company, 2 per cent.

JUNE.

Lecture on "Signalling through Space Without Wires," delivered before the Royal Institution by Mr. W. H. Preece (4th).
Death of Mr. C. W. Earle (7th).
Death of Mr. W. S. Graff Baker (1st).
Prof. William Crookes knighted (22nd).
Shoreditch Municipal Central Station opened (28th).
M. Ader communicates to the Académie des Sciences his invention of a new form of submarine telegraph recorder (21st).
A Committee of the National Electric Light Association presents an important report on the Standard candle-power of incandescent lamps.
Dividends declared: Consolidated Telephone Construction and Maintenance Company, 2 per cent.; Callender's Cable and Construction Company, 10 per cent.; Electric and General Investment Company, 25 per cent.; United River Plate Telephone Company, 5 per cent.; Electrical Power Storage Company, 5 per cent.; Thomas Parker (Limited), 7 per cent.

JULY.

Engineering Strike commenced (3rd).
Meeting of the Municipal Electrical Association at Manchester.
Registration of the Wireless Telegraph and Signal Company, Limited, "to acquire from Signor Guglielmo Marconi certain letters patent . . . " (20th).
The St. Lawrence Power Company of Massena, U.S.A., invites subscriptions in London for the development of the St. Lawrence-Grass River hydro-electric scheme.
The Treasury appoint a Committee to consider and report upon the desirability of establishing a National Physical Laboratory.
Death of Dr. Stefan Doubrava.
Opening of the Municipal Electric Tramways between Kirkstall and Roundhay (Leeds) (29th).
Experimental air-core telephone laid in Solent.
Dividends declared: Eastern Telegraph Company, 6½ per cent.; Electric Construction Company, 6 per cent.; Globe Telegraph and Trust Company, 4½ per cent.; Direct United States Cable Company, 3 per cent.; Edison and Swan United Electric Light Company, 5½ per cent.

AUGUST.

Issue of the new edition of the Institution Wiring Rules.
Contract signed by the Government for the laying of a cable from Bermuda to Jamaica (2nd).
British Association Meeting opens at Toronto (18th).
Electric cab service inaugurated in London (19th).
Death of Mr. F. V. Andersen (16th).
Statue of Soemmering unveiled at Frankfort (8th).
Issue of the Marconi Patent No. 12,039 of 1896.
Dividends declared: Woolwich District Electric Light Company, 2 per cent.

SEPTEMBER.

Berlin-Budapest Telephone Trunk Wire opened (1st).
Dublin, Cork, Limerick telephone trunk wire opened.
Experiments in Wireless Telegraphy carried on at Dover by Postal Telegraph officials.
Opening of Hammersmith municipal electric lighting station (30th).
Opening of the Lachine Rapids Power Plant (Montreal), (25th).
Opening of the Alexandria electric tramways (14th).
Death of Mr. W. W. Griscom, of electric-motor fame.

OCTOBER.

Close of the Glasgow Telephone Inquiry after 11 days' hearing (9th).
Publication of the Board of Trade Electrical Standardising Fees (7th).
Report of a Special Committee, appointed by the Board of Trade to inquire into the existing system of ventilation of the "Underground," that the proper remedy for the present state of things is to be found in the adoption of electric traction.
Messrs. Siemens and Halske, of Berlin, celebrate their jubilee (13th).
Publication of the Final Report of the Royal Commission on electrical communication with lighthouses and light-vessels.
Lecture on "The Ferromagnetic Properties of Iron and Steel," delivered before the Sheffield Society of Engineers and Metallurgists, by Dr. J. A. Fleming (18th).
Prof. D. E. Hughes received the decoration of Officier de l'Ordre Leopold from the King of the Belgians.
Postmaster-General's Report for 1896-7 issued.
Electric Motor Van first used by Post Office for conveyance of mails (24th).
Dividends declared:—Eastern Extension, Australasian and China Telegraph Company, 5 per cent.; Brazilian Submarine Telegraph Company, 7 per cent.

NOVEMBER.

Röntgen Society inaugurated under the first presidency of Dr. S. P. Thompson (5th).
Proposal for an "All-British" cable to Australia *viâ* Cape of Good Hope, laid before British Government.
Death of Prof. Schering at Göttingen.
Death of Sir Henry Doulton (19th).
Sir Wm. Crookes elected President of the British Association for 1898.
C.s. "Silvertown" compelled to abandon the laying of the cable for the Compagnie Française des Câbles Telegraphiques, and to return to Calais.
Paper read before the Institution of Electrical Engineers by Mr. L. Epstein, on "Accumulator Traction on Rails and Common Roads" (11th).
Successful trial trip of Heilmann locomotive between Paris and Mantes (12th).
Mr. Justice Kekewich refused application in the case of Holophane Company and Others *v.* O. Berend and Company (19th).
Annual dinner of the Institution of Electrical Engineers (24th).
Second Annual Meet of the Motor Car Club in London (29th).
Anniversary Meeting and Dinner of the Royal Society (30th).
Lord Lister re-elected President of the Royal Society (30th).
Dividends declared:—West India and Panama Telegraph Company, 5 per cent.; Western and Brazilian Telegraph Company, 2 per cent.; Allgemeine Elektricitats Gesellschaft, 15 per cent.; Venezuela Telephone and Electrical Appliances Company, 4 per cent.

DECEMBER.

Engineering Conference adjourned to await vote of the Trades Unions on the proposals of the Employers' Federation (3rd).
Automobile Club of Great Britain inaugurated (8th).
Brutal murder of Mr. Edward Graves in Persia.
Curious gasoline-electric locomotive on the Heilmann principle tried on Chicago tramways.
Annual General Meeting of the Institution of Electrical Engineers. Mr. J. Wilson Swan elected president for 1898 (9th).
Extension of 10 years granted to Mr. I. A. Timmins for a patent relating to his electric railway signalling system.
Corporation of Huddersfield decided to seek powers to municipalise local telephone system.
Portsmouth Corporation unanimously decided to seek powers to work local tramways and equip them electrically.
Death of Mr. Gardiner G. Hubbard at Washington, D.C. (11th).
Death of Prof. J. Holm, at Cape Town.
Report on Leyton Gas-Engine Station, by Prof. H. Robinson, published.
Announcement of Mr. H. C. Fischer's intended retirement, next February, from the post of Controller of the Central Telegraph Office.
C.s. "Britannia" returned from the West Indies, having found bed for cable to Jamaica. C.s. "Scotia" left London with the cable on 20th.
Prof. Oliver Lodge delivered the annual Christmas lectures for juveniles at the Royal Institution, on "The Principles of the Electric Telegraph."
Clontarf section of Dublin electric tramways opened.
Niagara-Buffalo power transmission line extended by addition of three new conductors.
Death of Signor Brioschi, President of the Accademia dei Lincei.
Rupture of negotiations between the representatives of the Employers' Federation and the Amalgamated Society of Engineers.

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CORRESPONDENCE.

THE COUNTER ELECTROMOTIVE FORCE IN THE ARC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been reading with considerable interest your leader in *The Electrician* for December 31st on the above subject. Your critical discussion of the logic and processes of the American experimentalists to whom you refer seems decisive. It would be interesting to know what answer these ardent seekers after truth would make if anyone were to present to them a sealed box, with exposed terminals, containing an electromotor with a brake on the pulley, and ask to be informed whether, assuming the results of a test identical with that which they applied to the arc to be the same, one might logically conclude there was no internal counter electromotive force in the motor. The object of my letter is not, however, to slay the slain, but to point out that there is a possible source of counter electromotive force in the arc which I believe has been generally overlooked. In a thermocouple, say, of iron and copper the resultant electromotive force is not merely due to the so-called "Peltier effect" at the junction, but also to the "Thomson effect" in the body of the metals. There is an internal distributed electromotive force in the copper and iron due to the gradient of temperature in the elements. In unequally-heated copper having a fall in temperature down it this electromotive force acts from the cooler part to the hotter part; in iron, in the reverse direction.

In 1895 (*Phil. Mag.*, July, 1895) a Paper was published by Prof. Dewar and myself, in which we gave the results of a very extended series of thermo-electric experiments taken between $-200°C$, and $+200°C$. On consulting the charts given in that Paper you will see that we have given the thermo-electric curve of carbon, and it will be noticed that the *sign* of the "Thomson effect" in carbon as shown by the direction of the curvature of the thermo-electromotive force curve is the same as that of copper, only the coefficient has a much greater value.

We cannot in the absence of experimental proof conclude that at much higher temperatures the "Thomson effect" in carbon does not change sign, as is the case with iron, but if it keeps its sign, and if, moreover, intensely-heated *carbon vapour* has a "Thomson effect" in it, then there may be in this effect a possible cause for a true counter electromotive force in the arc. The positive carbon is at a very much higher temperature than the negative; probably from 1,000°C. to 1,500°C. Hence in the arc itself the gradient of temperature down the arc may be, and probably is, exceedingly large.

The unequally-heated column of carbon vapour may, therefore, perhaps behave like an unequally-heated copper rod and possess an internal electromotive force due to a true "Thomson effect" acting from the cooler to the hotter portions, or acting *against* the external electromotive force. Of course, there is no knowing, in the absence of measurements, whether this would be a fraction of a volt, or anything like the 35 volts or so required. If the above suggestion has, however, any basis in fact, it would afford a clue to the explanation of the fact that heating the negative carbon reduces the impressed voltage required to keep up the current through the arc, because that process reduces the gradient of temperature in the arc, and hence in part destroys the "Thomson effect" counter electromotive force. It also would explain the reason for the lesser electromotive force required for an alternating current arc, because the carbon when negative has just a moment before been positive, and therefore the average gradient of temperature between the two carbons is less.

In the absence of experiment there is no knowing what consequences a gradient of temperature of 1,000° to 2,000°C. per half-centimetre or so may not produce in a highly-conducting column of carbon vapour. One way in which this effect, if present, would exhibit itself would be in a reduction of the R.M.S. value of the potential difference of the carbons required to produce a given R.M.S. value of current through an alternating arc as the frequency is raised. As the frequency rises the difference in temperature between the two carbons in the middle of each phase becomes less, because each carbon has less time time to cool. As you very justly say, the experimental work on this point is not yet decisive, but the trend of the evidence is towards the proof of some internal counter electromotive force when the arc is working. The notion of a "negative resistance," discussed some time ago, is on all-fours with the idea of a "negative mass" or body whose momentum *diminishes* in the direction of the impressed force acting on it. It may be used as a mathematical artifice, but there is not the slightest warrant for it in fact.—Yours, &c,

University College, London. J. A. FLEMING.

THE MEASUREMENT OF LOW RESISTANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Appleyard's questions with regard to the preliminary treatment of the manganin ohm used for the measurement of low resistances, I may say that this was made about three years ago, and has been compared with a B.A. unit at intervals ever since. The wire was soldered on to the binding screws, but the solder contained no zinc, only lead and tin. It was then varnished and heated for some hours by passing a current through it; but the temperature was certainly not as high as is now recommended, probably not more than 75°C., so that the wire is not sufficiently annealed. This treatment was the outcome of experiments on a piece of the same wire which was kept under observation for about four months in a water-jacketed tube. The hysteresis, when subjected to temperature variations was very marked at first, but became less with continued heating. I do not think the variations are due to the soldered joints, for the same effects were observed with clamped joints and also with potential points inside the joints; moreover, some samples were much better than others, when jointed in exactly the same way. The conclusion arrived at then was that whilst most valuable as a temporary standard, it could not be relied on for permanence; but as I have not since repeated these experiments with newer samples and better annealing, I cannot be sure that this is a just conclusion.

I should like to know if manganin is now prepared without zinc, as the earlier samples certainly contained it, which may account for their behaviour.—Yours, &c.,

Birmingham, Dec. 31, 1897. R. H. HOUSMAN.

Electric Traction in Rome.—It is now, says *The Railway World*, more than a year since electric traction was introduced into Rome. The system at present, since the extensions have been completed, consists of about 14¼ miles of chiefly double-track tramway. Power is taken from the Tivoli-Rome transmission plant. The alternating current is transformed down from 4,000 to 2,000 volts pressure, and, by means of rotary transformers, the tramways are supplied with direct current at 500 volts pressure. There are three such transformers, and each have a capacity of 80 kilowatts each. To steady the demand and also meet it when the turbines at Tivoli are stopped (as they are for three hours in the evening) a battery of Tudor accumulators is used in conjunction with the transformers. The gradients are numerous and severe, amounting at certain points to 1 in 16. The curves have short radii, varying from 66ft. to 77ft., and are frequently of 90deg. Phœnix rails of girder section, weighing about 67lb. per yard are used. The gauge is standard. At each joint the rails are bonded with double copper bonds, and at intervals of 150ft. the two rails are cross bonded, while at every 500ft. the four rails are united in the same manner. The cars have a seating capacity for 16 first-class passengers and six second class, and there is space for about eight passengers upon the rear platform. All the cars are provided with Thomson-Houston equipment.

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TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published end of January next.

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System o Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"THE ALTERNATE CURRENT TRANSFORMER." Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net, 2s. 9d. post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. WADE. *In the Press.*

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will, as usual, be published at the end of January. Many new features of interest to the profession will be introduced, and all the usual important articles, &c., which have made the book indispensable to the industry, will be brought up to date and amplified where necessary. Subscription and advertisement orders, new names and addresses, and alterations to existing entries should be sent in promptly.

Tenders Invited.—The Corporation of West Hartlepool invite tenders for work in connection with their electric lighting station, including:—(1) boilers and mechanical stokers, (2) engines, dynamos, &c., (3) storage battery, (4) switchboard, (5) arc lamps. Some further particulars are given in an advertisement on another page, and copies of the specifications, &c., can be obtained from Mr. Higson Simpson, town clerk, Town Clerk's Office, West Hartlepool, to whom tenders must be sent in not later than Monday, Jan. 24. The specifications and drawings can also be seen at (but not obtained from) the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London.

——— Tenders are invited for the supply and delivery to the Bedford railway station, Bedford, of vulcanised rubber cables. Specifications, &c., can be obtained at the offices of Mr. T. S. Porter, Town Clerk, Town Hall, Bedford, to whom tenders must be sent in by Monday, the 24th inst. Some further particulars will be found in an advertisement elsewhere.

——— The Electricity Committee of the Council of the County Borough of Newport (Mon.) invite tenders for the supply and erection of the following plant for the extension of their electricity works. Mains: Trenching, troughing and cables; transformers and switch gear; and cast-iron posts for arc lamps. Plans, &c., may be obtained at the offices of Mr. Robert Hammond, consulting electrical engineer, Ormond House, Great Trinity-lane, E.C., after Monday next. Some further particulars appear in our advertisement columns, and tenders must be sent in to the town clerk (Mr. Albert A. Newman), Town Hall, Newport (Mon.), by Monday the 24th inst.

——— The Corporation of Walsall invite tenders for the construction and erection of one 250 B.H.P. high-speed vertical compound engine, and one high-tension continuous-current dynamo (2,000 volts), with spare armature. Specifications may be obtained from Mr. Alexander Wyllie, borough electrical engineer, and tenders must be sent to the town clerk (Mr. John R. Cooper), Town Hall, Walsall, by Saturday, the 22nd inst. An advertisement elsewhere furnishes some additional particulars.

——— It will be seen from our advertisement columns that the Corporation of Blackburn require tenders for a 500 kilowatt continuous-current steam dynamo and a 120 kilowatt steam alternator. Specifications, &c., may be obtained at the offices of the engineers, Messrs. Lacey, Clirehugh and Sillar, 10, Delahay-street, London, S.W. Tenders must be lodged at the offices of the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by Saturday, the 22nd inst.

——— The Corporation of Bradford invite tenders for the construction and delivery of two steam engines for the electricity works at Valley-road. Tenders by Monday, Jan. 17 to the Town Clerk (Mr. George McGuire), Town Hall, Bradford.

——— Tenders are invited for the wiring of a large clothing establishment at Kirkgate, Bradford. Particulars from, and tenders to, Messrs. Milnes and France, 99, Swan-arcade, Bradford, by the 7th inst. (to-day).

——— The Electric Lighting Committee of the Borough of Bedford require tenders for the supply and erection of a 420 B.H.P. double-acting compound enclosed engine, and a 250 unit alternator, with stationary armature. Tenders to Town Clerk by Jan. 10.

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Tenders Invited.—Tenders are invited by the Corporation of Wolverhampton for motor vans. Those firms sending in tenders for electrical vehicles must submit details of a van which carries electrical energy for 12 hours continuous work. Full particulars can be obtained of Mr. J. W. Bradley, C.E., borough engineer and surveyor, to whom tenders have to be sent by the 7th Feb.

——— The tenders required by the Electricity Supply Committee of the City of Gloucester for the supply and erection of plant, machinery and apparatus (recently advertised in our columns) have to be in to the town clerk, Guildhall, Gloucester, by Jan. 18.

——— The Marylebone (London) Guardians invite tenders for wiring and fitting the new administrative buildings of the workhouse in Northumberland-street, W. Tenders to the clerk by 17th inst.

——— The tenders required by the Corporation of Bootle for the supply of boilers, engines and electrical plant and apparatus for the Corporation's electricity supply undertaking (recently advertised) have to be in to the Chairman of the Watch Committee by noon of Jan. 10.

——— The Municipal Authorities of Braïla (Roumania) are again inviting tenders for the concession for the electric lighting of the town. Tenders are due by March 4.

——— The Municipal Authorities of Rheydt and M-Gladbach invite tenders for the construction of electric tramways in and between the two towns. Particulars from and tenders to the Oberbürgermeisteramt, M-Gladbach, Germany, by March 15.

——— The Municipal Council of Neuilly-sur-Seine (France) invite tenders for the concession for the erection and working of an electricity supply station. Tenders to La Mairie by 22nd inst.

——— The Société Immobilière d'Hamman-lif, near Tunis, require tenders for the construction of an electric tramway between Hamman-lif, Maxula-Rades and Tunis, about 16 kilometres (nearly 10 miles).

——— The Foreign Office has received a despatch from the Chargé d'Affaires in Madrid notifying that tenders are being invited for the construction and working for a number of years of a telephone system in the City of Tarragona. Sealed tenders (on forms which can be obtained from the Civil Governor of Tarragona, or at the Registry of the Direccion Generale de Correos y Telegrafos, Calle de Carretas 10, Tarragona), from whom full particulars and conditions may also be obtained), must be sent in by Jan. 11 to the Civil Governor of Tarragona.

——— Tenders are invited for the construction and working of additional electric street tramways by the Municipal Council of Berlin. Plans and particulars may be obtained from Die Städtische Verkehrs Deputation, Rathaus, III. (Zimmer 100), Berlin, on payment of 3 marks. Tenders by March 15th.

——— Tenders are required for the extension of the electricity supply station building at Burnley. Tenders to the Borough Surveyor, Town Hall, Burnley, by the 25th inst.

Offers Wanted.—An advertisement elsewhere invites offers for taking up and leave to provide and run an electric tramway to well patronised grounds now being opened to the public near London.

Tenders Accepted.—The tender of Messrs. G. W. Lummis-Paterson and Co. has been accepted for wiring the Heaton-road Wesleyan Chapel, Newcastle-on-Tyne, for the electric light. Seven tenders were submitted.

——— The Barrow-in-Furness Town Council have accepted the following tenders for the supply of plant and machinery in connection with their electric lighting scheme :—

Section A.—Boilers, pumps, steam and water pipes, tank, crane, economiser, &c. Messrs. Babcock and Wilcox (Limited).

Section B.—Engines, generators, switchboards, instruments, accumulators, motor transformers, sub-station equipments. The Brush Company.

Section C.—High and low-tension feeder, and distributor cables, house connection boxes ; and Section D.—Conduits, drawing-in boxes. The British Insulated Wire Company.

——— At the last meeting of the Derby Council the contract with Messrs. S. Z. de Ferranti (Limited) for the supply of a dynamo and engine at the electricity works at £7,132. 10s. was sealed. This amount was included in the £20,000 authorised to be expended in April last. Cable has also been ordered for extensions at a cost of £132. 14s. 2d.

——— The Gas, Water and Electrical Committee of the Wallasey Town Council have accepted the tender of Messrs. Siemens Bros. and Co. for the supply of four arc lamps, pillars, &c., for the electric lighting of Grange-road.

——— At the monthly meeting of the Eccles Town Council on Monday tenders for the supply and erection of machinery and plant in connection with their electric lighting scheme at a cost of about £9,400 were accepted. The contract for the supply of the engines and alternators has been placed with Messrs. Browett, Lindley and Co. at £4,277. Messrs. Pritchetts and Gold and Messrs. W. T. Glover and Co. are supplying the accumulators and mains at £650 and £2,850 respectively, while the contract for the supply of the boilers has been let to Messrs. Tinkers (Limited).

Sales by Auction.—Elsewhere in an advertisement will be found some particulars of the sale by auction by Mr. Henry Sherley-Price (of the firm of Wheatley Kirk, Price and Goulty) at the Mart, Tokenhouse-yard, London, E.C., on *Thursday, Jan. 27, 1898, at 2 o'clock prompt*, of the well-known and old-established concern known as the Projectile Company (Limited), with extensive works at New-road, Battersea, London, together with the goodwill, fixed and loose plant and machinery, stock-in-trade, stores, &c. The firms from whom particulars and conditions of sale may shortly be obtained (gratis) will be found in the advertisement. The works buildings are very substantially built, and are admirably placed for railway connection.

Appointment Vacant.—The Council for the Foreign Community of Shanghai require a chief municipal electrical engineer. Salary (at present rate of exchange) about £460 per annum, with quarters, coal, &c. Information from Messrs. John Pook and Co., 6, Jeffrey's-square, St. Mary Axe, E.C., to whom applications should be sent before Jan. 15 next.

Vacancy.—A lecture assistant is required in the physics department of the City and Guilds of London Institute, Exhibition-road, London, S.W. Salary £100 per annum. See advertisement.

Appointment.—We record elsewhere the unanimous selection by the Glasgow Corporation of Mr. William Ashcombe Chamen as chief resident engineer of the Corporation's electricity department. Mr. Chamen, who is only 35 years of age, thus succeeds to one of the most important stations in the kingdom where a large field of active work lies before him, and where, however physically strong and technically capable he may be, he will find scope for his abilities. There are few stations where a man of Mr. Chamen's technical experience would be able to find greater scope for his labours than at Glasgow, whose electricity supply undertaking has in the past, from several causes, somewhat lagged behind its rival Edinburgh. The causes for this are, we think, to be found mainly in the divided authority of the Corporation Committees which have had electricity supply under their control. Now that this fruitful cause of friction is removed, and the undertaking is under the *ægis* of a committee of its own, we trust that the engineer who has been unanimously selected to succeed Mr. Arnot will be allowed free scope for the application of his all-round experience to the immediate development of Glasgow's electricity supply undertaking, which development, for the second city of the Empire, has not been so rapid or so general as in the case of many less important cities.

Business Notices.—Mr. F. C. Allsop, of 97, Queen Victoria-street, London, E.C., notifies that owing to increase of business large additional premises have been taken at 126, Queen Victoria-street. Communications may be sent to either address.

——— Messrs. Harrison and O'Brien, consulting electrical and mechanical engineers, owing to increase of business, have removed their offices and testing department from 45, Victoria-street, Westminster, to larger premises at 19 and 21, Queen Victoria-street, London, E.C.

——— The Standard Electrical Engineering and Accumulator Company have removed from York-street, S.W., to Parliament Mansions, Victoria-street, London, S.W.

——— Messrs. Handcock and Dykes, consulting electrical engineers, are removing on the 29th inst., from No. 5 to No. 1, Victoria-street, London, S.W.

——— Messrs. Handley and Shanks notify that owing to increase of trade they have opened new offices and showrooms at 12, Dawson-street, Dublin. Mr. Arthur Handley, A.I.E.E., will act as manager for the Company in Dublin and neighbourhood. During the last two years the firm notify that they have erected electric lighting plant in Ireland to the extent of over 1,000 B.H.P., or the equivalent of 20,000 8-c.p. lamps.

——— Messrs. Hodges and Todd report that during the past year increase of business has necessitated the opening of premises in George-street, and cabinet works in Seaton-street, London, N.W.

Partnership Notices.—Particulars are given in an advertisement elsewhere of the dissolution of the partnership between Henry Lea and William Henry Thornbery, consulting engineers, of 38, Bennetts Hill, Birmingham. Debts due to or owing by the late firm will be received and paid by Mr. Henry Lea, who will, in partnership with his son, Frederick Mackenzie Lea, continue to practise as civil engineers, consulting mechanical and electrical engineers and valuers, under the style of Henry Lea and Son, at the above address.

——— Messrs. S. V. Clirehugh and F. A. Cortez Leigh have entered into partnership with Messrs. E. M. Lacey and A. M. Sillar as consulting electrical engineers, and the firm's offices in future will be at 78, King-street, Manchester, and 10, Delahay-street, Westminster, London. The title of the firm will be Lacey, Clirehugh and Sillar.

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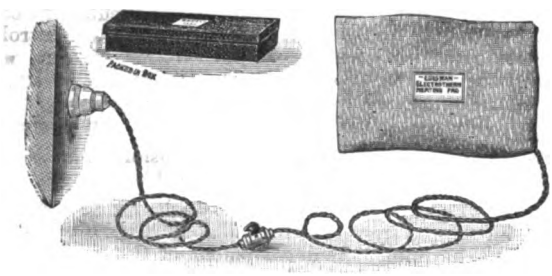
Partnership Notices.—Mr. William Henry Thornbery also notifies the dissolution of his partnership with Mr. Henry Lea, and that he has taken offices at 36, Paradise-street, Birmingham, where he continues business as consulting, mechanical and electrical engineer and valuer.

——— Messrs. C. F. Slater, S. R. Slater and F. Crossley, trading as Slater Bros., electricians, &c., 20, Baker-street, London, W., have dissolved partnership. Debts by Messrs. C. F. and S. R. Slater.

Personal.—Mr. J. P. Mosley, an old Electric Telegraph Company official, and at present postmaster of Sunderland, has just completed his 50 years of telegraph and postal service. He joined the old Electric Telegraph Company at Gateshead in 1846, and served at Bristol, York, Manchester, London, Amsterdam, and other places. On the taking over of the telegraphs by the Government he was appointed telegraph superintendent at Newcastle-on-Tyne.

Liquidation.—A meeting of the Acme and Immisch Electric Works (Limited) will be held on Feb. 4 at 2, Clement's-inn, London, W.C., to receive an account of the winding-up of the Company. Messrs. E. Wilding and James Gray are the liquidators.

The Electrotherm.—The Edison and Swan United Electric Light Company forward us particulars of the electrotherm—a new patent heating apparatus which the Company are about to introduce on the market. This apparatus is composed of wires insulated and protected by asbestos, woven into a light and flexible sheet or pad, which, when attached to the ordinary incandescent lamp socket, offers sufficient resistance to the current to produce "a constant and uniform degree of heat." It is claimed to have a special value



and efficiency in cases of rheumatism, neuralgia, pneumonia, bronchial affections, croup, bowel complaints, sluggish circulation, &c. Its simplicity, cheapness of operation, cleanliness and convenience are also urged by the makers as strong points. It is made for any voltage from 5 to 125 volts, and can be used with either direct or alternating current.

An Electric Low-Water Alarm.—An interesting type of electric low-water alarm for steam boilers is described in the *Indian and Eastern Engineer*. A standpipe is mounted on the boiler so that the mouth of its lower end is submerged by the water in the boiler except at the lowest safe-working water-level. This standtube is fitted to and brought out horizontally through the front of the boiler, and afterwards turned up to stand vertically by a bend. The vertical portion is thus exposed to the cooling action of the air. Fitted to the top of this tube is an iron-clad thermometer, into the stem of which are fused the circuit wires of a bell circuit. When the water-level in the boiler is above its lower safe limit the tube is filled with water which is comparatively cool by reason of the exposure of the tube to the cooling action of the air; when, however, the water-level in the boiler sinks below the safe limit the water in the tube runs out and the latter is filled with steam. In consequence of the higher temperature the mercury in the thermometer rises and completes the circuit of the warning bell, which is thus kept ringing till the water-level is restored to its point. The design of this alarm is good, and it should prove a reliable one and a favourite with steam engineers. The makers are Messrs. Arthur D. Studd and Co., of Montague-street, Kettering, England.

Alternating Enclosed Arc Lamps.—The General Electric Company notify us that they are now in a position to supply an enclosed arc lamp for alternating current circuits taking six amperes.

The Geipel Steam Trap.—Messrs. Geipel and Lange report a large increase in the demand for the Geipel steam trap or automatic drain cock, this contrivance being now in use in 40 of the principal supply stations, many of the prominent engineering works, and by steam users in all parts of this country, the continent, the colonies, and the United States.

The Rosa Curve Tracer.—The Davies Motor Company ask us to state that they have been using for about six months a form of alternate-current curve tracer of their own, based on the invention of Prof. Rosa, but their instrument is claimed to be "a very much more simple one."

Exhibitions.—The prospectus is issued of the Electrical and General Trades Exhibition, to be held at Bingley Hall, Birmingham, in March and April, 1898. All particulars as to space, &c., can be obtained from Mr. George Stanley, who was connected officially with many of the successful exhibitions held in London.

Reduction of Rates.—The Westminster Electric Supply Corporation have reduced their tariff for electric energy from Jan. 1, from which date the charges are: 6d. per unit for the first 4,000 units used in each year, and 4d. per unit for all in excess of 4,000. Current used for purposes other than lighting, and supplied through a separate meter, 3d. per unit. The rate hitherto has been 6d. (with discounts) for lighting, and 4d. for power. The notification of this change was received too late for insertion in the Electricity Supply Supplement we issue this week.

Rumoured Amalgamation.—We have again to refer to the rumoured amalgamation of Messrs. Easton, Anderson and Goolden (Limited), with a prominent Northern engineering establishment. In a very circumstantial manner, particulars are given in the Northern papers of this amalgamation, but we have the best of authority for stating that the rumour is "entirely unfounded."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 25 to Jan. 4, with the ports of destination:—

Australasia—Adelaide, £35; Albany, £38; Auckland, £20; Lyttelton, £408; Melbourne, £886 (including £834 telegraph cable); Sydney, £2,973 (including £1,654 telephone cable and £133 telegraph material); Wellington, £83. *Austria*—Trieste, £520 (telegraph material). *Belgium*—Antwerp, £475; Brussels, £396; Ostend, £85. *Borneo*—£1,206. *Brazil*—Rio Janeiro, £10. *British Guiana*—Demerara, £135. *Canada*—Halifax (N.S.), £158 (telegraph material); Montreal, £30. *Ceylon*—Colombo, £36. *Denmark*—Copenhagen, £153. *Egypt*—Alexandria, £143 (including £34 telegraph material); Port Said, £101. *France*—Bordeaux, £20. *Germany*—Hamburg, £33. *Gibraltar*—£242. *Holland*—Amsterdam, £85; Rotterdam, £10. *India*—Bombay, £40; Calcutta, £313. *Japan*—Hiogo, £13; Yokohama, £576. *Mexico*—Vera Cruz, £69. *North Atlantic*—3,000lb. (telegraph cable). *Norway*—Christiania, £10. *Siam*—Bangkok, £35. *South Africa*—Cape Town, £969; Delagoa Bay, £36, Durban, £506; East London, £322; Port Elizabeth, £291. *Spain*—Barcelona, £50; Pasages, £87. *Straits Settlements*—Singapore, £10. *Sweden*—Gothenburg, £20; Stockholm, £24 (telegraph material). *United States*—New York, £10. *West Indies*—Bermuda, £95,000 (telegraph cable); Jamaica, £174 (telegraph material); Trinidad, £25; Turk's Island, £14 (telegraph material). Total, £107,375 and 3,000lb. of telegraph cable, against £14,934 for the period from Dec. 25, 1896, to Jan. 5 last year.

"Cassier's Magazine."—The January issue of this magazine contains articles on "Electric Power in the Machine Shop," by E. H. Mullen; "American Cable Ways in Open Pit Mining"; "The Blight of Trade Unionism"; "Dustless Buildings"; "Carriage and Waggon Building on the Midland Railway (England)"; "An Ingenious Metallurgical Process"; "A Record in Chimney Reconstruction," and "The Largest Steamship Afloat."

Automotor and Horseless-Vehicle Literature.—A pocket-book is issued by Messrs. F. King and Co., of 62, St. Martin's-lane, London, W.C., containing a mass of information of service to those interested in automobilism. The book is divided into technical and commercial sections.

Calendars, &c.—Messrs. Street and Co., the well-known firm of advertisement contractors, of 30, Cornhill, and 164, Piccadilly, London, send the neatly-framed calendar which they have issued for a number of years. This is an excellent calendar for proprietors' and managers' offices.

The Direct United States Cable Company send a neat hanging tear-off pad calendar, with space on each leaf for memoranda and with reminder notes printed upon the sheets. A useful date remembrancer.

A neat hanging sheet calendar is to hand from Messrs. Hodges and Todd. The pad is one of the best and clearest we have seen of this kind of calendar for some time.

The National Telephone Company's annual takes the form of a new list of call offices in the metropolitan area, which has been brought up to date, and will be found of service to the many persons who have occasion to use the public telephone call offices spotted about the metropolis. The book gives no indication of any change in the arrangements for subscribers using these call offices.

An extremely useful pocket-calendar card, with movable face, is sent out by the Brockie-Pell Arc Lamp (Limited), of 97, Queen Victoria-street, London, E.C. Owing to the non-occurrence of a leap year in 1900 this handy card, which can be carried in the pocket, provides a date remembrancer up to the year 1903. We anticipate the demand will be large for this calendar.

Marriage.—Mr. Thomas Hesketh, who has just been appointed electrical engineer to the Folkestone Electricity Supply Company, was married at Holy Trinity Church, Blackpool, last week to Miss Ada Florence Dalton.

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Aberdeen.—The borough electrical engineer (Mr. A. Blackman) and the lighting inspector (Mr. Smith) have presented a report to the Gas and Electric Lighting Committee in which it is stated that in view of the increasing demand for current additional plant will be required. The Committee have, therefore, decided to invite tenders for an additional plant of from 600 to 700 H.P. The question of the improvement of the street lighting is at present engaging the attention of the Watching and Lighting Committee, and extensions of the lighting area are recommended. No scheme is to be submitted to the Council until a report has been presented by the lighting inspector as to the additional cost of the proposed extensions.

Accrington.—The Electric Lighting Committee have selected a fresh site for their electricity station. The new site, which is known as Ellison's Tenement, is more central and advantageous than the one originally selected.

Argentina.—The *Review of the River Plate* states that the imports of electrical machinery and apparatus into Argentina during the first nine months of 1897 were as follows :—

	$ gold.
Dynamos (43)	26,391
Electric light material (various)	182,689
Cable and wire (insulated)	129,872
Fittings	113,612
Incandescent lamps (31,203 doz.)	93,609
Telephone material	8,354
Telegraph material	19,698

The same organ states that "the engineering strike in England is already being felt in this country by some of the electric light companies, and it is probable that orders which were to have been placed in England will now go to the States or the Continent."

As we announced in a recent issue, the Buenos Ayres Municipal Council have sanctioned the scheme of the Belgrano Tramway Company to convert their horse tramways into electric lines. The work is to be completed within 18 months, and during the first year the Company is to supply gratis current for 30 2,000-c.p. arcs, and five lamps in the plaza in Belgrano. In return, the Company is to be absolved from payment of municipal taxes on its power stations. In the centre of the city underground conduits or accumulator cars are to be employed, but the overhead trolley system will be permitted in other thoroughfares through which the cars are authorised to pass.

Bexhill.—A Local Government Board inquiry will be held here on the 12th inst. into the application of the Urban District Council for sanction to borrow £20,000 for establishing electricity supply works.

Belfast.—The Corporation have decided, upon the recommendation of the Electric Committee, to adopt the maximum demand system of charging for electric current, as from July 1 next. The Committee have also been authorised to supply and let on hire electric motors, for which it is proposed to charge a rental of 15 per cent. on cost, to cover interest, sinking fund and depreciation.

Blackpool.—The Board of Trade have forwarded Major Cardew's report on the recent inquiry held by him as to the proposed alteration in the mode of electric traction on the Corporation tramways, and request that a suggestion by Major Cardew as to the adoption of accumulator cars may receive the consideration of the Town Council. After a brief discussion the matter was referred to the Chairman of the Tramways Committee (Mr. Brodie), the Town Clerk and the borough electrical engineer (Mr. Robert C. Quin) for consideration and report. The Council have decided to construct a tramway from Cocker-street, along Queen's Drive, Claremont Park, to the Gynn, and application is to be made to the Board of Trade to sanction the use of the overhead trolley system on the tramways from Talbot-square to the Gynn.

Brighton.—A sub-committee has been appointed to consider and report upon the question of the extension of street lighting by electricity.

Burnley.—At the meeting of the Town Council this week the Gas and Electric Lighting Committee announced that they had decided to put down additional plant at the electricity supply station, including a 450 B.H.P. high-speed compound-condensing three-crank engine. This was approved.

Cairo.—For some time past the houses in the Ismailia quarter of Cairo have been lighted electrically, current being supplied under provisional agreement by the Cairo Gas Company. It is now stated that a regular contract for a period of 30 years has been entered into, so as to include the whole of the city. Under the terms of this agreement current is to be supplied at such a rate that the cost of electric lighting shall not exceed that of gas. Another blessing has thus been conferred, by British enterprise, upon residents in "Cairo, the unclean."

Cardiff.—The Parliamentary Committee recommend the Town Council to oppose the application for permission to construct a light (electric) railway between Cardiff and Penarth.

Certificates of Origin.—It is announced that the Spanish Government have consented to suspend the operation of the new regulations in respect to certificates of origin, which were to have come into force on the 1st inst., until the 15th inst. Those interested in trade with Spain are advised to make themselves acquainted with the exact requirements of the new regulations.

Chatsworth Illuminations.—In connection with the visit of the Prince and Princess of Wales this week to the magnificent home of the Devonshire family at Chatsworth, which has been the social feature of the week, a considerable extension of electric lighting was decided upon, and Messrs. Drake and Gorham, we understand, received instructions to carry out a series of illuminations by means of a special system of reflected lights, Jandus arc lamps being employed for this purpose. A large electric search-light was placed on a platform above the roof, and the many fine fountains which ornament the spacious grounds were illuminated by projectors worked from watertight boxes placed in the centre of the fountain itself. The patent illuminating device known as the "Electro-flame," which was extensively employed during the Jubilee illuminations, was shown to great advantage in the centre of the building. The lighting proved most effective, and was much admired.

Chemical Fire Engines.—Messrs. J. E. Spagnoletti and Crookes, of Goldhawk Works, Goldhawk-road, London, W., gave on Wednesday a demonstration of the "Rex" chemical fire engine, and the demonstration will be repeated at 3:30 p.m. on Jan. 8, on the brickfield of Messrs. Axton, Adelaide-road, Uxbridge-road, W., when it is probable that Commander Wells and Sir Alexander Binnie will be present. The test to which the capabilities of the engine were put on Wednesday consisted of extinguishing a burning wooden hut of 2,000 cubic ft., coated throughout with gas tar, over which 20 gallons of petroleum were thrown, with planks and shavings inside the hut, which made a thoroughly inflammable erection. These engines are, it is said, in use in every town throughout Canada and the United States, and Liverpool in this country has already adopted them.

Chelmsford.—The applications of the Chelmsford Electric Lighting Company for a Provisional Order to enable them to supply electric current in several districts and villages in the neighbourhood of Chelmsford have been approved by the Chelmsford Rural District Council and the Broomfield and Springfield Parish Councils on condition that the wires are laid underground.

Cheltenham.—Some minor extensions of the electric-light mains were sanctioned at the last meeting of the Corporation, when it was decided to ask the Local Government Board to add £282 to the loan, sanction for which has already been applied for, to provide for the cost of extensions. The net revenue of the Electricity Department for the past quarter amounted to about £1,400, compared with £830 in the corresponding quarter of last year.

City of London.—At the closing meeting of the Commission of Sewers on Tuesday, after a parting kick at the National Telephone Company, a notification from the Charing Cross and Strand Electricity Supply Corporation of their intention to apply for a Provisional Order enabling them to supply electric current for lighting and power purposes within the City area was referred to the Streets Committee. The Commission of Sewers has now ceased to exist, the functions of that body being divided between the Court of Common Council and a new department called the Public Health Department, the latter taking over all matters relating to lighting and street work.

Derby.—The Council have instructed the Parliamentary Committee to employ an engineer to advise on the tramway question and on the proposal to purchase the undertaking of the local tramways company, who are, it seems, ready to entertain terms for the transfer of their lines.

Dewsbury.—The residents in the Oxford-road district are clamouring for a supply of electric current, and a sub-committee was appointed at the meeting of the Town Council on Monday to prepare a report upon the proposed extension of the mains.

Dublin.—The Dublin and Manchester Steamship Company propose to light Sir John's Quay by means of arc lamps.

Electric Traction in Egypt.—The Directors of the Alexandria and Ramleh Railway Company state, in their annual report to the 31st ult., that land lying between Bulkeley and San Stefano has been acquired, and a scheme whereby electricity may be introduced as the motive power on the line has been under consideration, and investigation was being made into the relative merits of the most recently introduced systems in France, Belgium and Switzerland, and the result of the inquiries will shortly be submitted. Considerable extensions of the Company's lines are also under consideration.

Finchley.—A special meeting of the Urban Council was held last week to consider the proposal to apply for a Provisional Order for the construction of electric tramways from Archway-road, Highgate, to Finchley, and an application to the Light Railway Commissioners for authority to construct a light (elec-

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tric) railway from Finchley to Hendon. Mr. E. F. Vesey Knox, M.P., attended on behalf of the promoters of the light railway scheme, and submitted particulars. He said it was proposed to adopt the overhead trolley system, and to light the roadway along the line of route at a price to be agreed with the Council; a quick service to Hampstead, and, consequently, a service to the West-end of London and an additional local service to the Great Northern Railway would be given. The fares would be 1d. per mile, and the average speed eight miles per hour. The Council could purchase the undertaking at the end of 35 years. The length of the line in the Finchley district would be about a mile and a-half, and the total cost of the tramway would be £34,000. The scheme is being considered.

Fire Alarm Indicators.—The London County Council has addressed a letter to the Vestries and District Boards of Works of London suggesting that fire-alarm indicators be placed on the public lamps.

Fort William (N.B.).—The supply of gas in this town is to be discontinued, as the gas works, which were established in 1846, are to be dismantled at the end of the current month. The town will then be entirely dependent upon the electricity supply works for public and private lighting.

German Enterprise in South America.—It is stated that the business of Señor Rufino Verala, of Buenos Ayres, has been acquired by a German syndicate, who propose to establish a German electrical company, with a capital of 20,000,000 marks, for the purpose of developing trade in Buenos Ayres and Argentina generally. The syndicate has been formed by the Allgemeine Elektricitäts Gesellschaft in conjunction with the Berliner Diskonto Gesellschaft. A similar company is being formed by Messrs. Wernher, Beit and Co., of Londen, and the Allgemeine and Union Companies of Berlin, for carrying on operations in Chili. The capital of the latter Company is to be £600,000, with debenture and loan capital to the extent of £500,000. Half the shares are held by Messrs. Wernher, Beit and Co., and the Allgemeine and Union Companies will each hold a quarter.

Henstead (Norwich).—The District Council have unanimously consented to the application of the Norwich Electricity Company for a Provisional Order for this district.

Huyton-with-Roby (Lancs.).—The District Council have decided to support the application of the British Insulated Wire Company for a Provisional Order.

Japan.—An interesting report on the state of trade in Japan has been forwarded to the Foreign Office by Mr. Byron Brenan, the British representative in that country. Mr. Brenan points out that trade is hampered by no internal and by very few and trifling export duties. No official in the country has any power or scope for illegal exactions, and flourishing banks with abundant capital have agencies in every town, and advances are made at very moderate interest. Facilities of transport have been provided both by rail and water, and postal and telegraph facilities are abundant, cheap and fairly efficient. Industrial exhibitions both national and local are frequently organised and meet with great support from the Government. These displays enable producers to see and examine the best specimens of each manufacturer or natural product, and that liberal bestowal of medals and diplomas adds a keen incentive to competition. The result of this general encouragement of trade has naturally been most marked during the past 26 years, during which period the value of the foreign trade of Japan, notwithstanding many drawbacks, has increased from 48 million to 288 million dollars. The value of the imports of dynamo electric machinery in 1896 was 681,000 yen, and of telegraph wire 6,200 yen, against *nil* and 970 yen respectively in 1890. The report states that Great Britain and British possessions have shared in the immense increase which has taken place in the imports into Japan to a large extent over all other countries put together. There is a steady demand for railway material, and the report suggests that orders can be secured by British manufacturers if opportunity is taken of certain special points in their favour. The bulk of the Government requirements in plant and material come from England, but it is urged that British manufacturers are not so accommodating as are some of her competitors for Japanese trade. Mr. Brenan advises makers of machinery to be represented by technical experts, as the principal joint-stock companies do not as a rule invite tenders publicly, and inquiries are often made from persons on the spot known to be engaged in the branch of trade for which supplies are required. The report is noticeable for its insistance upon the unreliability of the Japanese merchant in his business bargains, and the British merchant is advised to secure payment before parting with his goods. This latter contention, however, does not altogether fit in with our own experience and knowledge.

Kendal.—Messrs. Handcock and Dykes have been selected to prepare a report upon the proposal to establish electricity supply works in this town.

Leeds.—The Parliamentary Committee have appointed a sub-committee to arrange a friendly conference with the Directors of the Yorkshire House-to-House Company to discuss the proposal to purchase the Company's undertaking. The Committee's report was adopted at the meeting of the City Council on Wednesday.

Lincoln.—The Town Council have received the formal sanction of the Local Government Board to borrow £20,650 for electric lighting purposes, and it has been decided to raise the amount by the issue of Lincoln £3 per cent. stock.

Manchester.—The Tramways Committee has instructed the Town Clerk to consider and report upon the steps to be taken for the acquisition of the undertaking of the Manchester Carriage and Tramways Company within the city boundaries.

The Electricity Committee's report, recommending the erection of a large generating station on land in Stuart-street, Bradford, to supply current for working the tramways as well as for lighting purposes, was approved at the meeting of the City Council on Wednesday. Application is to be made to the Local Government Board for their sanction to the borrowing of further money for carrying out the work.

Merthyr.—Correspondence between the Board of Trade and Messrs. J. C. Howell and Co. with regard to the proposal of the latter to transfer their Provisional Order to Messrs. Crompton and Co., was discussed at Wednesday's meeting of the Merthyr District Council, and it was resolved to reply to the Board of Trade that the Council did not approve the transfer. This decision was arrived at on the understanding that a revocation of the Order would be applied for if steps were not taken to carry out its terms forthwith.

Mumbles (Swansea).—The Local Board have received an offer from Mr. W. Weaver to light a portion of the district electrically at an annual cost not exceeding that at present paid for public illumination.

Otley.—A committee has been appointed by the District Council for the purpose of collecting information as to the advisability of establishing electricity supply works in this district.

Salford.—The Town Council have decided to apply to the Local Government Board for sanction to borrow £50,000 for electric light extension purposes, in accordance with a report prepared by the borough electrical engineer (Mr. C. L. Turner). At Wednesday's meeting of the Town Council, Mr. Haworth, the chairman of the Electric Lighting Committee, gave a sketch of the progress of the electricity works. About nine months ago the Committee had an equivalent of 11,400 8 c.p. lamps connected, and at the present time they have 22,000, while there are several thousand awaiting connection. The revenue in the same period has increased from £1,005 to £1,469, and this notwithstanding the reduction of 33⅓ per cent. on the charge for current. They were connecting customers as fast as they could, but were hampered by the difficulty in obtaining delivery of additional transformers. An extension of the present plant was imperative. The Committee had very carefully considered the matter, and had come to the conclusion that the best plan would be not to extend their present station, but to build a new one in a more convenient situation for the supply of current for lighting and traction purposes. The Lighting Committee, although they were talking about lighting the principal streets of the borough electrically, could not at present be supplied with current, and the Tramways Committee had also under consideration the subject of electric traction after the leases of the present lines had fallen in, and in that case they would have to supply something like 6,000 H.P.

Ship Lighting.—The s.s. "Royston Grange," which has been built by Messrs. Workman, Clark and Co. for Messrs. Houlder Bros. and Co., of London, has been very completely lighted by electricity and fitted with electric ventilating fans. The vessel is for service between London, the Welsh coast, South America, Australia, and East and West Africa, and this has necessitated special designs and constructions to meet the varying requirements of the vessel in so many different portions of the globe. Messrs. Clarke, Chapman and Co., of Gateshead, have supplied 11 powerful steam winches for the "Royston Grange," and Messrs. J. and E. Hall, of Dartford, Kent, have put in an extensive refrigerating plant. A very complete electric lighting installation has been carried out by the Globe Electrical Company, of White Post-lane, Victoria Park, London, N.E., provision being made for 500 lights, 325 of which may be in use at one time. There are also three large arc lamps provided for use in loading and discharging cargo.

Staffordshire.—At the monthly meeting of the South Staffordshire Mines Drainage Commission on Wednesday, at Dudley, the chairman (Mr. J. B. Cochrane) referred to the scheme of the Midland Electric Corporation for Power Distribution for supplying current in their district for power purposes. The Company undertake to supply current at 1d. per unit. Many local bodies were opposing the Company's scheme on the ground that they would like to retain the power of electric supply themselves. That was reasonable enough if the authorities were prepared to supply the electric current to manufacturers at something like the same rate that the Company proposed to do it.

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The project had a most important bearing upon the work of the Commission, and the scheme for unwatering the Tipton district. They would be able to pump the water from the surface at various points by electric power, and the cost would be very small indeed compared with what it cost to pump it out of the mines. It would probably save a contemplated expenditure of between £30,000 and £40,000 in the Tipton district.

St. Helens.—In a report just presented to the Gas and Electric Lighting Committee Dr. J. Hopkinson recommends that no further extension of the electricity works be made pending the completion of the works for supplying energy for traction purposes.

Sunderland.—The electric light mains are to be extended to the workhouse at a cost of £1,200.

The Telephone in Germany.—According to the *Pall Mall Gazette*, General von Podbielski, the German Postmaster-General, is about making considerable reductions in the annual charge for the telephone, which is to be reduced from £7. 10s. to £2. 10s. per annum, with additional charges as follows: For every private conversation 1pf., business conversation 2pf., hotel conversation 3pf. The telephone, under this arrangement, will be cheaper in Germany than in any other country.

Telephone Trunk Line Extensions.—Telephone trunk communication has now been established with Banbury, Rugby, Ware, Peterhead, Banff, Elgin and Inverness.

The Bradford and Leeds Light (Electric) Railway.—A conference took place at Leeds on Tuesday between representatives of the Leeds and Bradford City Councils to consider the advisability of taking joint action in reference to the proposal to construct a light railway between Bradford and Leeds. Amongst the Bradford representatives were the city electrical engineer (Mr. A. H. Gibbings) and the city engineer (Mr. J. H. Cox). The Sheffield city engineer (Mr. T. Hewson) was also in attendance. The scheme was discussed at some length, and ultimately it was decided to co-operate in opposing the scheme on the ground that it was inadvisable that "any outside company or authority should lay down tramways or light railways in the areas within the jurisdiction of the respective Councils"; and, further, "that when the time was ripe for the construction of a through line between Bradford and Leeds the local authorities for the districts concerned would probably be prepared to unite in bringing forward a scheme of their own." The Leeds City Council on Wednesday endorsed this attitude on the part of the joint-committee.

The Midland Electricity Generating Scheme.—The General Power Distributing Company, who are promoting a scheme for the generation and supply of electric current in all towns and districts within a radius of 26 miles from Warsop, Notts., are at present busily engaged in submitting particulars to the various local authorities within this area, and in endeavouring to obtain approval of the scheme. Although many of the minor municipal bodies are disposed to favour the project, some of the more important Councils (such as Nottingham and Rotherham) who either possess, or are likely to possess in the near future electricity supply works, are against it. At a committee meeting of the Nottingham City Council on Monday, a deputation from the promoting Company, consisting of Sir Thomas Thompson, Bart., and Messrs. W. A. McArthur, M.P., E. A. Lazarus, and A. R. Monks, attended for the purpose of obtaining the Council's consent to the Bill. It was stated that the Company would have a capital of £1,000,000 (£750,000 in shares and £250,000 in debentures on loans), and they could not start operations until £125,000 had been paid up. With this money the Company proposed to purchase land at Sookholme, near Warsop, and to build works for generating electricity. The area of supply would include the city of Nottingham on one side and the city of Sheffield on the other; also part of the county of Lincoln and the whole of Derbyshire, besides all the cities, towns, and villages within the circle. The Council have appointed a special committee to deal with the matter, but the Town Clerk (Sir Samuel Johnson) has been instructed to draw up a petition against the bill.

The Telephone at Middlesbrough.—Alderman Bulmer, of the Middlesbrough Corporation, is of opinion that there should be ten times as many telephones in the town as now exist, and that this very desirable result will not be achieved until a new telephone service for Middlesborough is established. Alderman Bulmer is quite sure that if reasonable rates were charged, say half the present price, the telephone would pay well. The Council have received a prospectus from the Mutual Telephone Company, of Manchester, who express a desire to extend their service to Middlesbrough, on the ground that it is in the interest of industry, trade and social convenience. The Middlesbrough Corporation have passed a resolution asking the Company to so extend their service. This is a bit like the story of the hare—an animal which is usually caught before it is cooked.

Torquay.—The Council's consulting electrical engineer (Mr. W. H. Trentham) reported on Tuesday that practically the whole of the plant, with the exception of one engine and alternator, had been delivered, and he would be in a position after his visit this week to fix the date of the opening ceremony. The electric lighting scheme has, up to the present, cost £21,108, and with 5 per cent. for contingencies the total comes out at £22,239, whereas sanction has only been received to an expenditure of £22,300. The Town Clerk stated that about £1,800 more would be required for consumers' extensions.

The Strike.—We briefly referred in our last issue to the notification made on behalf of the employers that the truce established on the formation of the conference between representatives of the employers and employed in the engineering trades was at an end. This was followed by a letter from the same body pointing out that the conditions of freedom to employers in the management of their own works was one of the subjects before the Conference, and was not merely a proposal of the employers, but had been agreed to, with some slight modifications, by the representatives of the men. It was also pointed out as highly significant that the leaders of the allied trades, in conference assembled, offered that the men would return to work on the following Monday under these very conditions of management if the employers would agree to a 51-hours working week. This, it was urged, conclusively proved that nothing in these conditions are incompatible with the proper functions of trades unionism, and, therefore, the federated employers have resolved to strictly adhere to them in future. The workmen are invited to accept the situation and withdraw their demand for a diminution of working hours and to return to work. It is too early, however, to hope that this sound advice will be accepted. On Saturday surprise was expressed at the action taken by the Fairfield Shipbuilding Company, of Govan, who, while originally members of the Employers' Federation, withdrew at an early stage of the dispute; but it was announced on Saturday that lock-out notices had been posted by the firm affecting about 800 engineers.

The meeting of representatives of about 150 trades unions referred to in our last issue was held on Saturday, and proved a notable gathering, as the assembled 200 delegates represented probably three-quarters of a million of the trades unionists of the country. The Press were denied admission at the early stage of the proceedings, when Mr. Barnes, the secretary of the Amalgamated Society of Engineers, made an important financial statement, from which it appeared that the funds of the Society are being depleted to the extent of from £4.000 to £5,000 per week, taking fully into account the large amounts received from outside sources in support of the men's action. Loans or gifts were invited from other unions, in order that it might be shown to the employers that the trade unionists of the country were combined in support of the engineers' claims. The meeting, however, appears to have led to little practical result, except to recommend that a levy of 3d. per member from all trades' unionists should be made. It was anticipated by the sanguine mover of this proposal that an income of £12,500 per week would be realised from this levy.

Meanwhile lock-out notices continue to be posted, thus increasing day by day the number of men on the Society's books for strike relief. Each side, as is usual in disputes of this kind, claim moral victories day by day, but the fight continues. Trade is leaving the country, important engineering and shipbuilding contracts are being declined, and representatives of the Federated Employers have gone so far as to assert that the funds, so liberally provided from continental sources to enable the men to continue the struggle, are being very willingly supplied by foreign engineering firms. Mr. Alexander Siemens, at a dinner on Wednesday, announced that there was not the slightest intention on the part of the masters of going back from the terms they had agreed upon at Westminster in regard to the management of works and the working hours of the week. There was nothing either new or novel in the rules of management which had been submitted, and the Boilermakers' Society had worked under similar rules for years and was a flourishing section of the trades unions of the country.

A rumour was in circulation in Glasgow yesterday (Thursday) to the effect that the men were going back to work, and that the Amalgamated Society of Engineers had collapsed. Needless to say, the rumour found little credit, although the statement was alleged to have been made by a prominent official.

Wallasey.—The Gas, Water and Electrical Committee have resolved to lay electric light mains in several additional streets, and to apply for power to borrow £1,500 for carrying out the work.

Waterford.—The Finance and Law Committee of the Town Commissioners have under consideration a scheme which has been submitted for the construction of a system of electric tramways in this town.

Wednesbury.—The Town Council have resolved to oppose the application of the Midland Electric Corporation for Power Distribution for a Provisional Order so far as it relates to Wednesbury. The Council threaten "at the earliest opportunity" to themselves establish municipal supply; in fact, the Mayor advocated the

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immediate erection of a station for the supply of current to the Town Hall, the Art Galleries, Post Office, School Board offices, &c., and thought the necessary generating plant could be obtained for £1,000, and that the annual upkeep would not exceed £50!

West Derby Union.—The Board of Guardians of this Union have instructed Mr. Thomas L. Miller, M.I.E.E., of Tower Buildings, Liverpool, to prepare plans and specifications, and to invite tenders for the lighting of the Mill-road Infirmary by electricity. Over £5,000 is, we learn, to be expended.

West Hartlepool.—There was no opposition at a Local Government Board inquiry held by Col. Luard on Tuesday into the application of the Town Council to borrow £30,000 for electric lighting purposes. The Town Clerk (Mr. H. Simpson), who appeared in support of the application, gave particulars of the financial condition of the borough, after which Prof. A. B. W. Kennedy submitted plans and technical details.

Workhouse Lighting.—The Ipswich Guardians have resolved to light the new workhouse electrically at an estimated cost of £1,900.

Annual Dinner.—The staff of the Western Union Telegraph Company stationed at Penzance held their annual dinner on Saturday last, Mr. G. R. Mockridge, superintendent, presiding.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

December 2, 1897.

28,453. P. C. F. HOFFMANN. London. Improvements in and relating to electrically-controlled submarine mines.

28,460. C. PAYEN. London. An improved electrical accumulator. (Date applied for under Patents, &c., Act 1883, Sec. 103, May 4, 1897, being date of application in Belgium.)

28,461. A. W. RIEBEL. London. Improvements in or relating to the globe carriers of arc lamps for retaining ash or loose particles.*

28,480. L. VOJÁČEK. London. Improvements in or relating to the application of electric propulsion on railways and tramways.*

28,492. W. ROWBOTHAM. London. Improvements in variable electrical resistances.

December 3, 1897.

28,519. A. WATSON. Birmingham. Improvements in electrical tumbler switches.

December 4, 1897.

28,689. H. MAXIM and W. H. GRAHAM. London. Methods and means for supplying electrical energy to electric furnaces or to individual pairs of electrodes.

28,716. F. J. ANSON. London. Improvements relating to controlling devices for electric circuits, or to apparatus for indicating when the current in an electric circuit exceeds a given limit.

28,721. H. HELBERGER. London. Improvements in the manufacture of electrical resistances of metal foil.

28,726 J. BOOTH. Birmingham. Improvements in lamp and shade holders for incandescent electric lamps.

28,727. J. BOOTH. Birmingham. Improvements in insulating blocks connected with holders for incandescent electric lamps.

28,728. J. BOOTH. Birmingham. Improvements in holders for incandescent electric lamps.

28,729. J. BOOTH. Birmingham. Improvements in electrical switches.

December 6, 1897.

28,746. W. DOHERTY. Liverpool. A simplified automatic generator for supplying the electric light for cycles and other vehicles.

28,751. C. TURNBULL, JUN. North Shields. Improvements in or relating to electric bells.

28,765. H. PATCHETT. Bury. Electric fire alarm.

28,784. E. P. DIX. London. An electrical apparatus for communicating between railway carriages and the guard's van or engine.

28,795. H. J. BROWN, O. R. H. SCHMIDT and A. MACKENZIE. London. A new or improved compound or material for electrical insulating purposes.

28,799. P. EIBIG. London. Improvements in electric current meters.*

28,800. A. PELOUX. London. Improved electric meter.

28,809. C. OLIVER. London. Improvements in or relating to electric arc lamps.

28,823. J. PRICE and J. JOHNSON. Birmingham. Improvements in covers, caps and lids of gas, sewer, telephone and electrical supply shafts and holes, gullies and the like.

December 7, 1897.

28,839. W. WOOD. Bristol. Improvements in trolleys used on overhead wires for electric traction.

28,853. W. G. HEYS. Manchester. Improvements in electrical magazine fuse blocks. (W. Ehrhardt, W. B. Thom, and G. O'Connor, United States).*

28,859. H. LYON. Glasgow. Improvements in resistance and contact apparatus for electric currents.

28,882. G. BARKER. Birmingham. Improvements in electric valve controlling devices. (G. J. Schoeffel, United States.)*

28,883. H. M. BAKER, JUN., and A. W. FOX. London. Improvements in mechanical movements, and in mechanism of arc lamps for automatic feeding of the carbons as required by their consumption.*

28,895. A. ANDERSON. London. Improvements in insulating supports for the third rail or electric conductor of electric railways.*

28,921. E. OXLEY. London. Improvements in transformers and apparatus connected therewith for alternating-current systems of electrical distribution.*

28,923. F. V. BEAUVOIS. London. Improvements in means for electrically controlling the opening and closing of a plurality of escape orifices for fluids.

28,926. F. A. GILBERT. London. An improved electric switch.*

28,932. P. J. M. GASNIER. London. An arrangement of electric motor for the propulsion of vehicles.

28,940. O. J. LODGE. Liverpool. Improvements in magnetic telegraphy.

28,943. E. CORRENS and the firm of C. WILH, KAYSER AND CO. Liverpool. Improvements in or connected with electric-driving gear.*

28,952. J. D. BISHOP. London. Improvements in insulated electric conductors and apparatus for making the same. (Date applied for under Patents, &c., Act, 1883, Sec. 103, June 7, 1897, being date of application in United States.)

28,956. J. H. KELMAN. London. Improvements in electric cables.*

28,960. J. H. PARSONS, A. W. STAVELEY, and J. H. PARSONS (trading as Gent and Co.). London. Improvements in pushes for electric bells and the like.

28,965. A. GROSSMAN. London. Improvements in controllers for motors and brakes of electric cars.*

December 8, 1897.

28,994. W. H. SCOTT. Norwich. Regulating electric motors for working hoists or the like.

29,009. J. BASTICK and W. A. THORNTON. Leeds. Improvements in or relating to electric furnaces for the production of calcium carbide and other substances.

29,010. J. BASTICK and W. A. THORNTON. Leeds. Improvements in or relating to means or apparatus for conveying the boxes to and from electric furnaces.

29,011. J. BASTICK and W. A. THORNTON. Leeds. Improvements in or relating to electric furnaces for the production of calcium carbide and other substances.

29,024. J. WEBSTER and W. REYNOLDS, JUN. London. Improvements in electric lighting.*

29,048. F. E. ELMORE and A. S. ELMORE. London. Improvements in effecting electrolytic deposit of iron. (J. O. S. Elmore, India.)

29,055. C. P. FELDMANN and HELIOS ELEKTRICITÄTS-AKTIENGESELLSCHAFT. London. Improvements in or relating to alternate current meters.*

29,062. W. S. SMITH and W. P. GRANVILLE. London. Improvements in apparatus for the manufacture of electric cables.

29,069. O. J. LODGE and A. MUIRHEAD. London. Improvements in syntonic telegraphy.

December 9, 1897.

29,090. A. B. OGDEN. Manchester. New process or system of sewage and foul-water purification by electrical action.

29,116. S. W. BAYNES. London. Improvements in the distribution and regulation of electric energy, and in conductors connected therewith.

29,155. E. L. JOSEPH. London. Improvements in electric lamp holders.*

29,163. E. B. MERRILL. Canada. Improvements in the construction of dynamo electric machines.

29,177. J. ATHERTON. London. Improvements in and connected with underground electric conduits.

29,180. P. BRANDT. London. An improved electrical accumulator.*

December 10, 1897.

29,222. S. E. FOSTER. Birmingham. An improved terminal for use in electric switches, cut-outs, ceiling roses, wall plugs, and the like accessories.

29,229. A. H. GIBBINGS and C. A. L. PRUSMAUN. Bradford. Improvements in inner globes for electric arc lights.

29,235. J. MOORES and H. O. FARRELL. Manchester. Improvements in electrical switches.

29,244. P. GUYENOT. London. Improvements in apparatus for freeing, lighting and extinguishing gas-burners at a distance by means of electricity.*

29,257. W. S. BOULT and C. R. BOULT. London. Improvements in or relating to electric signalling, particularly on railways.

29,273. H. H. LAKE. London. Improvements in plates or electrodes for electric accumulators. (C. Francke, Germany.)*

29,306. G. MARCONI. London. Improvements in apparatus employed in wireless telegraphy.

December 11, 1897.

29,318. E. J. WADE and THE ELECTRIC MOTIVE POWER COMPANY (LIMITED). London. Improvements in and connected with the control and regulation of electrically-propelled vehicles.

29,322. H. S. MAXIM. London. An improved method of exhausting incandescent electric lamps and apparatus to be used therefor, and for similar purposes.

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

25,644. HIGGINS. Type printing telegraphic apparatus.
25,701. MAY and KING. Secondary batteries.
26,059. CONNOR. Electrodes.
26,099. DICK. Means for electrically lighting railway carriages.
26,546. SANDOW and ADAMSON. Motor carriages and the adaptation of same to electrical advertising.
26,864. BRAB AND KNOCHE. Continuous-current electric motor generator.
26,969. HOLZAPFEL. Frames for holding finely-divided mass, such as the active material of electric accumulators.
27,209. SAYERS, MAVOR, COULSON AND MAVOR. Dynamo-electric machines.
27,227. RYAN. Method of lighting pianofortes by electricity.
27,323. THE ACETYLENE ILLUMINATING COMPANY (LIMITED) and DAY. Electric arc furnaces.
27,449. CHATEAU. Means or apparatus for igniting and extinguishing gas from a distance by means of electricity.
27,753. SMITH, ELPHINSTONE and HEAP. Electrical measuring apparatus for comparing differences of potential
27,992. CULLIGAN. Electrical cable couplings by means of an insulating and locking arrangement.
28,314. KENNEDY. Electrical storage batteries and cells.
28,442. STILL and COWAN. Regulating transformers.
28,736. BELFIELD (Lamme). Direct current dynamo electric generators.
29,473. JACKSON AND CO. (LIMITED) and LEWIS. Armatures for dynamo-electric machinery.

NEW COMPANIES, STATUTORY RETURNS, &c

CITY OF MEXICO ELECTRIC POWER SYNDICATE (LIMITED).—This Company was registered on Dec. 30, with a capital of £5,000, in 40 Preference and 60 Ordinary shares of £50 each, to acquire any rights and grants for producing electricity in the republic of Mexico or elsewhere, and in particular the use of any water power for that purpose, and to carry on the business of electrical engineers and contractors. The first subscribers are: H. K. Baynes, Frank S. Courtney, civil engineer, J. Fletcher Toomer, civil engineer, T. P. Willson, civil engineer, A. P. Friend, engineer, R. J. Price, M.P., and F. Sillem. The first directors are: Robert J. Price, M.P., Henry K. Baynes and J. Fletcher Toomer.

HESWALL ELECTRIC LIGHT COMPANY (LIMITED).—This Company was registered on Jan. 1 with a capital of £1,500 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, manufacturers of electrical apparatus, and the general business of an electric light and power supply company at Heswall, Cheshire, or elsewhere. The first subscribers are: C. MacIver, L. J. Dobie, T. Brocklebank, C. B. Royds, R. E. R. Brocklebank, R. Brancker, and Mrs. E. M. Brancker. The first directors are: Messrs. T. Brocklebank, L. Dobie, C. MacIver, and R. Brancker.

PICKUP (J. H.) AND CO. (LIMITED).—This Company was registered on Dec. 28, with a capital of £50,000, in £5 shares, to acquire the business of mechanical, electrical, ventilating, lighting and general engineers, machinists, &c., carried on at Bury by a company of the same name.

SYNCHRONOME SYNDICATE (LIMITED).—This Company was registered on Dec. 31, with a capital of £15,000, in £1 shares, to acquire the business carried on at Westminster under the style or firm of the Synchronome Syndicate, to acquire certain patented inventions relating to electric clocks, to enter into an agreement with Messrs. F. Hope Jones and George B. Bowell, and to carry on the business of manufacturers of and dealers in electric clocks, electric synchronisers, dials and other electrical apparatus. The first subscribers are: A. Morley Fletcher, J. Robertson, W. Bryson Butler, J. M. Macmorran, W. Murray, F. B. Grey, C. S. Hobson. The first directors are: Frank E. D. Acland, William Murray and J. Mackenzie Macmorran.

ELECTRIC WELDING COMPANY (LIMITED).—The annual return to Dec. 14 has been filed. The capital is £460,000, in £10 shares (of which 1,000 are Founders') 24,780 Ordinary and 953 Founders' shares have been taken up, and 8,333 of the former are considered as paid. £6 per share has been called on 16,447 Ordinary, and £10 per share on 953 Founders', resulting in the receipt of £119,092, and leaving £54,908 in arrears.

ELECTRO-CHEMICAL COMPANY (LIMITED).—The annual return to Dec. 3rd has been filed. The whole capital of £200,000, in £5 shares (of which 26 000 are Preference), has been taken up, and all the Ordinary and 5,000 Preference are considered as paid. £5 per share has been called on 12,710 Preference, and £4 per share on 8,290 Preference.

NEWTON ELECTRICAL WORKS (LIMITED).—The annual return to Sept. 1st shows that 2,100 shares have been taken up out of a capital of £30,000 in £10 shares. 1,400 shares have been issued as paid, and £7,000 has been paid on the others.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY (LIMITED).—The annual return to Dec. 2 was filed on the 4th ult. The capital is now £85,000, in 70,000 shares of £1 each, and 1,500 shares of £10 each. All the former and 360 of the latter have been taken up, and 56,506 £1 shares have been issued as paid. The full amount has been called on the others.

WIRELESS TELEGRAPHY AND SIGNAL COMPANY (LIMITED).—The statutory return to Dec. 2nd was filed on the 10th ult., when 95,015 shares were taken up out of a capital of £100,000, in £1 shares. 60,000 shares have been issued as paid, and £35,015 has been received on the others.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26½d. per oz. (Jan. 6). Consols (2¾ per cent.) 112⅞—113 for money, 112⅞—113⅛ for account; 2½ per cent. 106—106¼ (Jan. 6). Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Days, Jan. 11 and 25; Ticket Days, Jan. 12 and 26; Pay Days, Jan. 13 and 27; Mining Share Carry-over Days, Jan. 10 and 24.

BARCELONA TRAMWAYS COMPANY (LIMITED).—Applications have been invited this week for £100,000 Four and a-Half per Cent. redeemable Debenture Stock in this Company at par. The object of the issue is to provide funds for the conversion of the Company's Barcelona system of tramways into an electric line. The Company was formed in 1872, and now operates 17½ miles of line, which is to be increased to 19 miles. Its earliest concession expires in 1931.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—Warrants for interest due on this Company's £400,000 Five per Cent. Debenture Stock have been posted.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—The transfer books of the First Mortgage Debentures of this Company will be closed from the 8th to the 14th inst. inclusive.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY (LIMITED AND REDUCED).—Notice is given that the reduction of the capital of this Company from £250,000 (in 50,000 Preference and 75,000 Ordinary shares of £2 each) to £162,981 in 50,000 Preference shares of £2 each and 62,981 Ordinary shares of £1 each, has been approved by the High Court.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company in Dec., 1897, were £25,000, and the total receipts from Jan. 1 to Dec. 31 £277,800, against £285,800 and £312,400 in the corresponding months of 1896 and 1895 respectively.

SULPHIDE CORPORATION (ASHCROFT'S PROCESS), LIMITED.—Interest warrants on the Five per Cent. Debenture Stock of this Corporation to the 31st ult. have been sent out.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Dec. 31 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,384. Debentures of Series "A" of this Company to the nominal amount of £8,000, and Debentures Series "B" to the amount of £10,000, will shortly be drawn for payment at par.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half month ended Dec. 31 is £2,205, against £2,640 in the corresponding period of 1896. The August receipts (estimated at £2,998) realised £2,981.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate—to date. Amount.	Aggregate—to date. Inc. or Dec.
		£	£		£	£
Birmingham Tramways.	Jan. 1,'98	4,057	+347	...	...	...
Bristol Trams & Carriage	D'c.31'97	2,654	+260	26	68,171	+10,433
City & South London Ry.	Jan.2'98	1,050	- 27	1	...	...
Dover Tramways	„ 1	150	...	17	1,931	...
Dublin United (Southern)	D'c.24'97	410	- 15	25	15,445	- 833
	„ 31	529	- 19	26	15,974	- 852
Liverpool Overhead Rly.	Jan.2'98	1,357	- 17	1	...	...
Sheffield Tramways	„ 2	1,332	+226	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Dec. 29.		Price Wednesday, Jan. 5.		Rate per Cent. yielded.	Dividend Due.	Business done during Week ending Jan. 1. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.					£ s. d.			
£19,126	£10	3/0	Central London Ordinary ..... xd	9¾	10¼	9¾	10¼	2 13 6	June and December	..	..
143,106	10	1/0½	Do. (£6 paid)	5¼	5	5¼	6	3 0 0	„ „	5⅜	5⅛
£880,000	Stock	2¾	City and South London Railway Con. Ordy.	66	68	67	69	2 15 2	January and July	67½	67
8,419	£10	5¾	Do. 5% Perpetual Preference	15½	16	15½	16	3 2 6	„ „	..	..
£135,701	Stock	4¾	Do. 4% Perpetual Debenture	138	140	138	140	2 17 2	May and November	139	..
54,000	10	5/8½	Waterloo and City Ordinary ..... xd	12¼	13	12¼	13	2 6 1	June and December	..	..
37,500	10	3¾	Liverpool Overhead Railway Ordinary	11½	11⅝	11½	11⅝	2 11 7	February & August	..	..
10,000	10	5¾	Do. 5% Preference	16	16½	16	16½	3 0 7	„ „	..	..
125,000	Stock	4¾	Do. 4% Debenture ..... xd	110	113	108	110	3 11 5	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 29.		Price Wednesday, Jan. 5.		Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending Jan. 1.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£922,960	Stock	14/0	Anglo-American	59	61	61	63	4 7 4	Feb., May, Aug., Nov.	60	...
£3,038,020	Stock	23/0	Do. Preferred	107¼	108½	109½	110½	5 4 1	" "	110	106½
£3,038,020	Stock	5/0	Do. Deferred	13	13½	13½	14	.. ..		14⅛	13
£187,400	£100	4%	*African Direct Telegraph (Red) xd	101	105	100	104	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	5⅜	6⅛	5½	6½	.. ..		..	..
120,000	10	3/0	Brazilian Submarine	16	16½	16	16½	4 4 10	Mar., June, Oct., Dec.	16½	16⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906) xd	114	118	112	116	4 6 2	June and December	..	..
10,000,000	$100	2⅜	Commercial Cable Capital Stock xd	183	188	182	187	4 5 1	Jan., Apr., July, Oct.	..	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock xd	105	107	104	106	3 14 9	" "	..	..
16,000	10	8/0	Cuba Submarine	8½	9½	8½	9½	8 8 5	February and August	9½	9
6,000	10	10%	Do. Preference 10 per Cent.	18½	19½	18½	19½	5 2 7	" "	..	..
12,961	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	10½	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures xd	103%	106%	103%	105%	4 5 9	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10½	10⅝	10½	10⅝	4 17 8	Jan., Apr., July, Oct.	10½	..
400,000	£10	2/6	Eastern	17	17⅛	17	17⅛	3 14 4	" "	17⅜	17⅛
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18	19	18	19	3 3 8	" "	18⅜	18⅛
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	130	133	130	133	3 0 6	May and November	133	132
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	102	105	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension	18½	18⅝	18½	18⅝	3 17 9	Jan., Apr., July, Oct.	18⅜	18½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	132	135	132	135	2 19 3	February & August	..	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 xd	101	103	99	103	4 17 3	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900 xd	101	105	99	103	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103	106	103	106	3 15 8	February & August	..	..
£200,000	£5	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108%	111%	108%	111%	3 12 1	May and November	109	108½
180,227	10	1/0	Globe Telegraph and Trust	11½	12	11½	12	3 15 0	Jan., Apr., July, Oct.	12	11⅛
180,042	10	6%	Do. 6 per Cent. Preference	17½	18	17½	18	3 6 8	" "	17⅞	..
150,000	10	5/0	Great Northern of Copenhagen	25½	26½	25½	26½	3 15 6	January, April, July	..	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	102	105	102	105	4 15 3	March & September	..	..
17,000	£5	12/6	Indo-European	52	55	52	55	4 10 11	May and November	53½	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	107	110	107	110	5 9 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942 xd	107	110	105	108	3 13 5	June and December	..	..
11,389	8	4/0	Reuter's	7½	8½	7½	8½	4 14 1	April and October	..	..
3,281	£100 Cert.	6%	Submarine Cables Trust	136	141	136	141	4 5 1	" "	..	..
15,609	10	6/0	West African Telegraph	4½	5⅛	4½	5½	5 0 0	.. ..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 14 4	March & September	..	..
20,000	10	..	West Coast of America	⅜	1½	⅜	1½	.. ..		..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures xd	107	109	105	107	3 14 9	June and December	..	..
88,221	10	1/0	West India and Panama	⅜	⅝	⅜	⅝	.. ..	May and November	..	..
24,562	10	6/0	Do. 6 per Cent. 1st Preference	7⅜	8¼	7½	8	7 16 3	" "	8⅛	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6	7	6	7	8 11 5	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 xd	107	110	105	108	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	9⅜	10½	9½	10½	2 18 5	May and November	..	..
35,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	7⅝	7½	7⅝	3 17 8	" "	..	..
35,129	7½	1/6	Do. Deferred Ordinary	2½	3⅛	2⅝	3⅛	.. ..		..	..
£339,230	..	4%	Do. 4 per Cent. Debenture Stock xd	106	109	104	107	3 14 1	June and December	..	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	108	110	6 7 10	Feb., May, Aug., Nov.	..	..
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3	3⅛	3	3⅛	5 14 4	August	..	..
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1⅛	1⅜	1⅛	1⅜	.. ..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2⅛	2	2⅛	8 0 0	October	..	..
484,597	5	3/0	National	6⅛	6⅝	6⅛	6⅝	4 8 11	February & August	6⅝	6⅜
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 10 7	" "	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14	16	14	16	3 15 0	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6	6⅛	6	6⅛	3 16 11	" "	..	..
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.) xd	104	109	102	107	3 5 0	June and December	107½	105
171,504	1	0/4	Oriental	⅞	1⅛	⅞	1⅛	4 2 4	April and October	..	..
58,000	5	5/0	United River Plate	3⅝	4⅛	3⅝	4⅛	5 17 8	July	..	..
£146,796	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) xd	102	107	100	105	4 14 4	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.								
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	11					March	..	..
£50,000	5	..	Do. (New Issue) £3. 10s. paid	..		..			..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	26	27	26	27	2 11 10	February & August	25½	26⅜
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17	18	17	18	3 6 8	January and July	..	..
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	131	136	129	134	3 14 3	June and December	..	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12½	13½	12½	13½	2 8 2	February & August	..	..
20,000	5	2/3	Do. 6½ per Cent. Preference	6	6½	6	6½	3 6 8	" "	6⅜	6⅛
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—		—			January and July	..	..
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	10½	11	10½	11	3 8 2	March	10⅜	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.) xd	113	116	112	114	3 14 7	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	13½	14	13⅛	14	.. ..		13⅜	13½
20,000	£10	6/0	Do. 6% Cumulative Preference	15½	16	15⅛	16	3 15 0	March & September	15⅞	..
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9	10	9	10	.. ..		..	..
10,000	£5	7%	Do. 7 per Cent. Preference	11	11½	11	11½	3 0 11	March & September	11½	..
111,009	£5	..	London Electric Supply Ordinary	2⅜	2½	2⅜	3	—		..	..
48,050	£5	..	Do. Preference	5⅜	6⅛	6⅛	6⅜	.. ..		..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	18½	19½	18⅜	19⅜	2 16 5	April and October	18⅛	..
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	18	19	18	19	.. ..	" "	18⅛	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage xd	119	123	117	121	3 13 6	June and December	117½	..
9,452	10	8/0	Notting Hill Electric Ordinary	17½	18½	17½	18½	2 3 3	March	..	..
375,000	1	—	Rand Electric	1⅞	1⅞	1⅞	1⅞	—		—	..
£125,000	Stock	5%	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb. xd	93	98	90	95	.. ..		..	..
150,000	$100	2⅜	Royal Electric Company of Montreal Shares	145	147	145	147	.. ..		..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	.. ..		..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	17	18	17	18	4 4 1	April and October	..	..
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 11	February & August	17½	17⅜
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red. xd	103	106	101	104	3 3 6	" "	10⅜	10⅛
67,900	5	4/0	Westminster Electric Supply (fully paid)	16	17	16	17	3 16 0	June and December	..	..
								2 19 0	March & September	16⅜	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	1/6	Brush Electrical Engineering	1⅞	2⅛	1⅞	2⅛	—		—	..
90,000	£2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	.. ..		2⅛	2
£25,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109	113	109	113	4 0 9	February & August	2⅛	2⅛
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.) xd	103	105	100	103	4 7 7	June and December	—	..
10,000	£10	..	British Aluminium Ordinary	—		..		—		..	..
20,000	10	..	Do. 7% Cumulative Preference	—		..		—		..	..
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7	8	7	8	6 5 0	June and December	..	..
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	108	113	107	112	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½	1⅝	1½	1⅝	—		..	..
28,150	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	2	2½	2	2½	—		—	..
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.) xd	89	94	86	91	5 6 5	January and July	..	..
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3	5 10 0	February & August	..	..
17,139	5	2/9½	Do. (£5 paid)	4½	5½	4½	5½	5 0 0	" "	..	..
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.) xd	101	103	101	103	3 17 8	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅞	2⅝	2⅝	2⅝	4 0 0	February & August	..	..
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3⅜	3⅝	3½	3⅝	4 3 4	August	..	..
91,166	1	10/0	Elmore's Patent Copper Depositing	½	⅝	½	⅝	.. ..		..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	20	21	20	21	4 15 3	February & August	..	..
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 12 0	" "	..	..
£20,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 10	" "	..	..
80,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	23	24	23½	24½	4 1 8	" "	..	..
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	103	107	3 14 9	March & September	23⅜	23¼
37,350	12	12/0	Telegraph Construction and Maintenance	36	39	36	39	4 12 4	March and July	..	..
£150,000	100	8%	* Do. 5 per Cent. Bonds (red.) 1899 xd	103	105	101	104	4 15 3	January and July	38¼	37⅞
£32,500	£5	3/0	Williams and Robinson Ordinary	7⅜	8½	7⅜	8½	4 4 10	April and October	10⅜	..
£32,500	£5	3/0	Do. 6% Cumulative Preference	6⅞	7⅛	6⅞	7⅛	4 2 9	" "	..	..
100,000	..	..	Do. 4½% First Mort. Debs.	105	107	105	107	3 19 8	" "	..	..

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NOTES.

THE map of electric supply stations of the United Kingdom, which we publish annually as a Supplement, has been modified this year so as to indicate separately the numerous stations within the metropolitan area, an addition which we believe will prove of utility and interest to our readers. We publish the new and revised edition of this map with our issue this week. Though increase in the number of supply stations is not, when taken by itself, a true index of the spread of electric lighting and power, a comparison between the present map and those of previous years, regarded in conjunction with the data published in our Tables of Electric Supply Works in the United Kingdom from year to year, will show how steady and yet rapid has been the growth of this industry. Naturally the space distribution of the stations has departed from uniformity in a marked degree; one does not expect the same density in central Ireland, or Wales, or even Scotland, that is to be found in the vicinity of London, Liverpool or Manchester. Our readers may also find some amusement if not instruction in seeking to fathom the "law of distribution" of the red and blue, or of the squares and circles.

THE *resumé* of postal and telegraph progress during 1897, which appeared in *The Times* last Friday, is very gratifying reading from a national point of view, and very flattering to the Post Office, although the writer has included many items—notably those relating to foreign extensions and reduced cable tariffs—which do not strictly come under the heading of British "Post Office Improvements." Telegraph extensions are reported even in such remote regions as North Borneo, in the Phillipine Islands, and in the Portuguese territory on the West Coast of Africa; rates have been reduced to Queensland, New Caledonia, British Guiana, and the West India Islands; whilst the extra-European system of counting is being gradually adopted on most of our Colonial Government lines. Turning to the strictly home service, the greatest advance appears to have been made in the telephone department, the completion of the transfer of the Trunk wires to the postal telegraph service early in the year being rapidly followed by very comprehensive extensions to all the chief commercial centres of the country. A notable development has also taken place in express delivery business—the transactions for London alone in the past year numbering 340,000, an increase of 21 per cent. over 1896. Whether and to what extent this system of communication robs the local telegraph traffic, one would be curious to learn; whether, also, the telegraph revenue takes any share of the proceeds, the deliveries being effected by messengers in telegraph uniform. The experiment with steam motor cars for the conveyance of mails is, we are glad to learn, about to be extended to electric cars, running between the General Post Office and the larger West end district offices.

IN commencing his sixth and last lecture in the course on "The Principles of the Electric Telegraph," at the Royal Institution on Saturday last, Prof. LODGE heroically essayed to explain to the juvenile mind, with the aid of diagrams, the difference between the propagation of heat along a thermal conductor and the transmission of an electric impulse along a telegraph cable, not neglecting HEAVISIDE'S modification of the ordinary law. We hope the children understood it. We confess we were puzzled at first to understand why he had broached so abstruse a matter before a "juvenile auditory," but it subsequently appeared that he did so in order to suggest the superfluity and uselessness of having a conductor, except in so far as it may be necessary to guide the electric impulse through the ether. Naturally enough this consideration led to the possibilities of wireless telegraphy, the objectionable conductor being dispensed with.

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Wireless telegraphy, or "space telegraphy" as Prof. Lodge prefers to call it, was explained by a series of experiments. To begin with, there was the transmission of impulses across space by electromagnetic induction, a method greatly developed by Mr. W. H. Preece; but, the lecturer stated, this was not a genuine case of space telegraphy, since the impulse did not consist simply in electromagnetic waves, but arose from changes in a magnetic field occupying the space. Hertz's researches in the propagation of true electromagnetic impulses, and the application of the coherer to the detection of Hertzian waves, next claimed attention. Marconi, the lecturer said, had done good service in stirring up a popular and departmental interest in the subject, but he had not originated anything in the nature of a fundamental invention. Perhaps, however, Signor Marconi has done more than he cares just now to publish.

Two sets of apparatus having, to a large extent the same object in view but differing radically in construction and in the details of their operation, are described in our issue this week. The purpose of these is, in each instance, to switch transformers automatically into circuit when the load on a sub-station requires it; but, whereas the Hungarian form of apparatus, devised by M. Schlatter and used on the Budapest electric supply system, aims at the additional feature of automatically switching out the transformers when no longer needed in circuit, the inventor of the English apparatus, Mr. A. H. Walton, has been content to let this second operation be performed by hand.

Opinions will probably differ as to which of the two systems, apart from the particular forms of apparatus used, is the better. We have even heard it said that "the best of all automatic arrangements is a nigger"; but, be that as it may, we have seen, to use a workshop phrase, a "nigger" in more than one apparatus for automatically controlling transformers. Simplicity of construction, certainty and promptness of action, and the absence of conditions which tend to break down insulation at the high-pressure switches, are among the imperative requirements in transformer automatic controllers. Usually speaking, mercury contacts are not desirable for breaking high.pressure power circuits; and though such have been in use at Budapest for eighteen months, and are said to have given satisfaction, we judge they must have been a source of anxiety. A high-pressure mercury break is in itself a phenomenon more dazzling than attractive, while the after-effect of minute globules of mercury copiously spread over the "insulation" does not tend to preserve the apparatus from disastrous breakdown. There is great ingenuity displayed in the Hungarian apparatus, and great simplicity in the English; the one bears the appearance of a complicated laboratory device, the other is stamped with the hall-mark of good engineering; and, though the former aims at performing more than the latter, we should be disposed to favour the latter for the heavy, risky work of a high-pressure transformer sub-station.

When a prospective client approaches a consulting engineer with a view to obtain his expert opinion or advice "for consideration received," it is reasonable for the client to expect that the advice tendered shall be honest and not biassed by any arrangement *sub rosâ* with a third party, as, for example, with a firm of contractors. We do not say that every client gets such advice, but, at least, he is entitled to it. In a similar manner, a consulting engineer is entitled to receive open-handed and candid treatment by his client, and he has just cause for complaint when he finds that his client has withheld from his knowledge the existence of an arrangement with a third party which materially affects the mutual relation between engineer and client. In our opinion the recent action of the Urban District Council of Acton in engaging two separate firms of consulting engineers to advise them is a case in point, since they did not inform each firm of the arrangement made with the other. Indeed, but for a recent paragraph in *The Electrician*, the firm of Kincaid, Waller and Manville, one of those engaged to prepare a report for the Council, might never have been aware of the arrangement by which the Council was to obtain a second report from another source. We are authoritatively informed that, having this fact in view, Messrs. Kincaid, Waller and Manville have felt it necessary to resign the engagement.

In another column we publish a short article by Herr Fischer-Hinnen on spark prevention. The author may be considered an authority on the design of continuous-current machines. In the present article he is unconsciously humorous in that he first claims priority of invention for what is known as the Ryan winding—an auxiliary series-winding distributed over the pole-pieces themselves—and immediately afterwards proceeds to demonstrate that precisely the same result is obtained both in theory and practice in a simpler manner by the auxiliary pole-pieces on the neutral zone suggested at a still earlier date by Swinburne. His modification of Swinburne's method, consisting of merely altering the disposition of the windings on the limbs of the magnets instead of placing coils on the auxiliary poles, is most ingenious, and we hope that the excellent results obtained with his small machine will induce him and other workers to experiment further with dynamos of a larger size.

Rumour has been busy for some weeks past regarding a reorganisation of the well-known firm of Messrs. Easton, Anderson and Goolden, of Erith and London. Respecting the amalgamation of this firm with Sir W. G. Armstrong, Whitworth and Co., we have previously announced that there was no foundation whatever for the rumour. Statements have been made in the Press this week (but without the knowledge or consent of the firm) relating to a supposed arrangement with Messrs. Schuckert and Co., of Nuremberg, Germany. We can state on the highest authority that this announcement is both premature and inaccurate. The statement that Messrs. Easton, Anderson and Goolden have acquired a concession for the manufacture in this country of war material from Messrs. Schneider and Co., of Creuzot and Havre, and have entered into working agreements with the Fairfield Shipbuilding and Engineering Company, &c., is in accordance with the facts. When the negotiations now proceeding are complete, it will be found that the newly-constituted Erith Company will be one of the most important and extensive engineering concerns in the world.

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The Direct West India Cable.—The laying of this Company's cable was begun last Friday from Bermuda, and it is anticipated that Jamaica will be connected by about the 20th inst.

Personal.—Herr von Heffner-Alteneck has been awarded an honorary degree of Doctor of Philosophy by the University of Munich in recognition of his services to the study of electricity, and especially to modern electrotechnics.

Electrical Engineers Volunteers Corps.—It is stated that applications are being made daily for admission into the Corps of Electrical Engineers Volunteers, and no less than 100 men connected with an electrical works near London have volunteered.

The Dangers of Telephone Operating.—The *Electrical Review* of New York is informed from Owensboro, Kentucky, that a lady recently called at the central telephone office in that town and "cowhided" an operator for alleged disclosure of conversation over the wire.

Cable Interruptions and Repairs.—

	Date of Interruption.		Date of Repair.
Bundaberg—New Caledonia ...	Nov. 4, 1897	...	—
San Thomé—Loanda	Dec. 13, 1897	...	Jan. 10, 1898.
Ceara—Maranham	Dec. 23, 1897	...	—
Teneriffe—St. Louis (Senegal)...	Dec. 24, 1897	...	—
Para—Maranham	Jan. 3, 1898	...	—
Curaçao—La Guayra...	Jan. 5, 1898	...	—

Röntgen Society.—At a meeting of the Röntgen Society on Tuesday last, Mr. W. Webster, F.C.S., read a Paper on "Practical Work with X-Rays." The author briefly reviewed the work that had been done by Sir William Crookes and others prior to Röntgen's epoch-making discovery. In the course of his Paper he described the conditions and forms of apparatus with which the best results with X-rays could be obtained, and at the close a practical demonstration of the popular bone-revealing qualities of the rays was indulged in, together with a number of photographic lantern views of radiographs, &c.

Erratum.—We have been authoritatively informed that as no appeal lies to the Board of Trade in the case of the decision of the Light Railway Commissioners as regards the projected Taunton light railway, there is a slight inaccuracy in the statement on p. 360 of our last issue. The Light Railway Act provides that an appeal to the Board of Trade lies only when the applicants are the Council of any county, borough or district. This is an important point, and it may throw light on the account of some negotiations between the Taunton Council and the President of the Board of Trade, as reported in our issue of December 17th last, page 276.

The British Fire-Prevention Committee.—This Committee, whose aims are apparent from its title, is now commencing active work. The number of members has reached nearly 300, and among them we notice many of the leading architects and surveyors, and several names familiar to our readers —*e.g.*, Sir Alexander Binnie, Mr. S. L. Brunton, Prof. Ewing, Mr. W. P. J. Fawcus, Sir Douglas Fox, Mr. W. H. Preece, Mr. A. Siemens, Mr. Swinburne and Mr. Wordingham. Besides architects, surveyors and engineers, the dramatic profession is also represented on the Committee, Sir Henry Irving and Mr. Beerbohm Tree being among the original members. The general policy of the Committee regarding fire prevention will be decided at meetings to be held shortly. Mr. Wordingham is preparing a Paper on "The Safety of Electric Lighting and Driving Power Installations."

German Traction Statistics.—The *Elektrotechnische Zeitschrift* of January 8th contains statistical tables of the electric railways and tramways in Germany. There are at present 64 German towns provided with this luxury as compared with 44 a year ago. Besides this, 26 towns have electric tramways in course of construction, and 30 more have extensions in hand. Reckoned up to September 1, 1897, the total length of the lines was 594 miles as compared with 864 miles on August 1, 1896, these figures representing 843 and 533 miles of track respectively. The number of motor-cars running was 2,255 in 1897 as compared with 1,571 in 1896, and the capacity of the railway generators in use is estimated at 24,920 kilowatts, as compared with 18,560 of the previous year. It is interesting to compare the figure 24,920 kilowatts with the plant capacity of the German electric lighting stations, which amounted to 67,340 kilowatts (exclusive of accumulators) on March 1, 1897. The overhead trolley system is used almost exclusively, and only some short lines in Berlin and Dresden have underground conduits. Accumulators alone are used on seven lines, including that between Charlottenburg and Berlin (five miles of double track), a short section in Frankfort and one of the Hanover lines, while "mixed" systems are used only in Hanover and on a short section of line in Dresden, the latter town having thus samples of three systems—overhead, underground and the Hanover system. This latter system is, however, also to be introduced on the Great Berlin Tramway Company's lines and in Halle.

An Elaborate Tariff System.—An elaborate tariff has been fixed for the supply of electrical energy for the Munich municipal electric supply station. For the first 500 kilowatt-hours consumed during the year 7·2d. is charged if used for light, and 2·4d. if used for power. After this consumption discounts are allowed, ranging from 1 per cent. between 500 and 1,000 kilowatt-hours to 12 per cent. on any electrical energy consumed over and above 20,000 kilowatt-hours per year. Current for power purposes is measured through a separate meter, and may not be used for driving lighting machines. At the end of every year each consumer receives a bonus which is credited to his next year's account. This bonus is a percentage on the consumer's consumption during the year, calculated from the formula (consumption in kilowatt-hours)/(connected kilowatts × 200) per cent. for light, and for power the same expression with 600 substituted for 200 in the denominator. But no bonuses will be allowed lower than 2 per cent. Owners of accumulators can have their cells charged, if they undertake only to use charging current during the day time, at the rate of 2·4d. per kilowatt-hour without discount, but (for no apparent reason) the owner of the battery may not furnish current to his neighbours. This charging current is also measured by a separate meter. Meter rentals, payable in advance quarterly, vary from 8s. per annum for a 500-watt meter to £2. 4s. for a 50 or 60-kilowatt meter, as many as ten differently-sized meters being quoted for.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, January 14th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Mechanical Draught," by R. Gordon Mackay.

WEDNESDAY, January 19th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square. President will read his Annual Address.

ROYAL METEOROLOGICAL SOCIETY.

7.45 p.m. Annual General Meeting at The Institution of Civil Engineers, 25, Great George-street, Westminster. Ordinary Meeting at 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting, when the question of "Accumulator Traction" will be discussed.

SOCIETY OF ARTS.

8 p.m. Sixth Ordinary Meeting. Paper to be read: "The Projection of Luminous Objects in Space," by Eric Stuart Bruce.

THURSDAY, January 20th.

INSTITUTION OF CIVIL ENGINEERS.

2.30 p.m. Students' Visit to the Central London Railway Works. Assemble at Notting Hill Gate Station.

FRIDAY, January 21st.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House, W. Agenda: (1) "On Electric Signalling Without Conducting Wires," by Prof. O. Lodge, F.R.S. (2) A Tesla oscillator will be exhibited by Prof. S. P. Thompson, F.R.S.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Lecture on "Laboratory Testing Machines: and the Latest Example," by Prof. A. C. Elliott, of Cardiff.

SATURDAY, January 22nd.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to the Engineering Laboratory of the Central Technical College, South Kensington. Demonstration by Prof. W. C. Unwin.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Absorption of Röntgen Rays.—The property of X-rays which has appealed most strongly to the popular imagination is that of penetrating certain bodies which are opaque to light. This property indicates different laws of absorption in the two cases. Light absorption is largely a molecular phenomenon, *i.e.*, it depends to some extent upon the manner in which the absorbing atoms are combined. That the absorption of Röntgen rays is purely atomic, and independent of any combination of the atoms to form compounds, has been recently made highly probable by W. J. Humphreys. He hit upon the happy idea of taking certain solids having other solids for their chemical constituents, and exposing equivalent slabs of the compound and of the two constituents together to the same X radiation, obtaining two impressions side by side on the same plate. Some of the bodies thus tested were zinc blende, stibnite, galena, speculum metal, and brass. A slab of zinc blende was placed over one hole in a lead plate, and slabs of zinc and sulphur in equivalent proportions over the other hole. On developing, the two images came out at the same time, and always retained equal brightness. To test the rule further, and to extend it to bodies partly composed of liquid or gaseous constituents, the author carried out experiments with some 40 of such substances. He found that all compounds were transparent if their constituents were so separately, and all compounds were opaque which contained one or two elements opaque in themselves when alone. It appears, therefore, fairly certain that absorptivity of X-rays is one of those few characteristic properties which an atom of matter retains throughout all its combinations with other atoms.

[Humphreys, *Phil. Mag.*, November, 1897.]

Dielectric Constants.—Ervin S. Ferry uses a method which consists in getting two electrical systems of equal inductance in resonance with a third system in which rapid electrical oscillations are set up by means of an induction coil and spark-gap. The periods of the electrical oscillations in the two secondary circuits will therefore be equal to each other, and hence the capacities in these two circuits will be equal. The capacity in one of the two secondary circuits is produced by an adjustable air condenser, and the capacity in the other circuit consists of a condenser with plates separated by a fixed distance. By securing resonance of the two secondary circuits with the primary, first when the empty condenser with fixed plates is in one of the secondary circuits, and then again when a dielectric is inserted between its plates, the specific inductive capacity of the dielectric is determined by simply computing the capacity of the adjustable air condenser in the two cases. In order to determine when the two secondary circuits are in resonance with the primary, and hence with each other, the principle of the bolometer is employed. The method is suitable for liquids or solids of regular shape. The author also includes solids of irregular shape by immersing them in a liquid of the same dielectric constant, such as an adjustable mixture of castor oil and petroleum. But it will be remembered that this was already done by Starke early last year. The frequency used in this method was about 30 million per second. For liquids of low conductivity a frequency of 20 per second was employed, substituting four capacities for the four resistances in the Wheatstone bridge, and determining the null point with a telephone.

[Ferry, *Phil. Mag.*, November, 1897.]

Recombination of Gaseous Ions.—Air which has been exposed to Röntgen radiation preserves the power of discharging positive and negative electrifications a short time after the rays have ceased, even if blown aside or conducted through a tube. E. Rutherford has devised two distinct methods for determining the duration of this after-conductivity, which is only annulled by the complete recombination of the ionised molecules. The first of these methods consists in blowing air at a known velocity along a tube, and testing the conductivity at different distances from the point of action of the rays. Röntgenised air was blown along a brass tube containing insulated electrodes at equal intervals, from which the leakage at successive points could be determined by means of an electrometer. It was found that the conductivity of the air fell off rapidly with the time elapsed since the action of the rays, and that after 2·4 seconds only one-ninth of its original value remained. This is quite in accordance with the theoretical result which maintains that the rate of diminution of the conducting particles is proportional to the square of the uncombined particles remaining in unit volume. Another method, suitable for cases in which large quantities of gas are not available, consists in applying an E.M.F. to the gas at definite intervals after the rays have ceased, and measuring the quantity of electricity that passed through the gas. It was found that the after-conductivity is profoundly affected by fine suspended particles, which afford the ions nuclei of recombination, so to speak, and make the gas rapidly lose its conductivity.

[Rutherford, *Phil. Mag.*, November, 1897.]

High Electromotive Force.—Having at his command a much improved Planté rheostatic machine, John Trowbridge has been enabled to greatly extend his studies of high E.M.F.s, and to investigate the conditions necessary to produce sparks of great body 48in. to 50in. in length, corresponding to a voltage of 1,200,000. The rheostatic machine contained 60 condensers, and the accumulator used to charge it gave 20,000 volts. Experiments with this large apparatus show that beyond a certain distance the length of spark increases strictly as the E.M.F., as, indeed, Lord Kelvin had anticipated. With the improved form of rheostatic machine devised by the author ⅓rd H.P. will produce the effects which have hitherto required the employment of from 30 to 40 H.P. The condensers in this apparatus are very uniform in thickness, and the charging and discharging method is a complete departure from that adopted by Planté. All forms of rotating cylinders carrying contact-pieces are abandoned, and two lever-arms are used to charge the condensers in parallel, and then to discharge in series. Great uniformity of action is thus secured. The sparks produced by the apparatus have great disruptive effect, and produce reports like the discharge of a pistol. The electrostatic field in the neighbourhood of the terminals is very intense, and the wires leading to the spark-gap emit brush discharges which extend at least 12in. from the surface of the wire. Extremely exhausted vacuum tubes allow the discharge to pass readily, and the vacuum is not thereby sensibly affected, but X-rays appear in great strength.

[Trowbridge, *Phil. Mag.*, January, 1898.]

Phosphorescence and Electrification.—J. Trowbridge and J. E. Burbank have endeavoured to test, by means of the phenomena of phosphorescence, whether X-rays can communicate an electric charge to bodies. When fluorspar, in the state of a comparatively coarse powder, is heated to a low red heat for about an hour it loses completely its power of phosphorescing at that temperature. If it is then electrified by means of the brush discharge of an electrical machine and then submitted to a low red heat it suddenly phosphoresces. The same effect may be produced by exposing the powder to X-rays under a sheet of aluminium, but not by exposing it to light. The action of the X-rays is here exactly similar to that of electrification by the brush discharge, so that it is natural to conclude that these rays do communicate an electric charge to bodies they impinge upon. The effect of the gentle heat is to suddenly liberate the electric energy imparted. The bright phosphorescence disappears very quickly. Most phosphorescent substances, after having been submitted to sunlight or daylight, glow more strongly when heated. The phosphorescence, however, dies out more quickly after the process of heating, which seems to cause the energy communicated to the substance by light to become dissipated more quickly. The same thing is true of the state of phosphorescence produced by the X-rays, and it is conceivable therefore that the phosphorescence excited by sunlight or daylight is due to an electrical condition which is dissipated by heat. This supposition is not inconsistent with the electromagnetic theory of light, and phosphorescence may be evidence of the electrical stresses which produce the phenomena of ultra-violet light.

[Trowbridge and Burbank, *Phil. Mag.*, January, 1898.]

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ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.*

BY J. ELTON YOUNG.

(*Continued from page 330.)*

Effects of a Second Fault on Localisations.—Before dealing with corrections for a second fault by the derived circuit method, we shall consider how far the various tests described in the foregoing pages are respectively affected by the presence of any interfering fault of which the position and resistance may be assumed approximately known. This will illustrate the nature of the general problem of the localisation of a fault when one or more others exist simultaneously. When all the positions and resistances are unknown it is one which does not admit of solution by means of any of the tests we have described†; but a knowledge as to which methods are *least affected* by a given second fault, combined with such data or probabilities respecting the latter as are available, enables a localisation to be made having a maximum degree of approximation to the truth; such an approximation will often be fairly correct, whereas without such knowledge it will frequently be very wide of the mark indeed.

Instead of exhibiting the errors algebraically, a clearer comprehension of the matter will be gained by treating a few particular cases numerically.

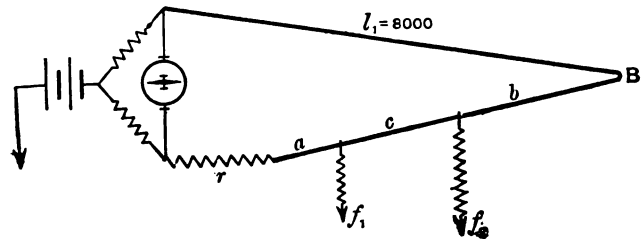

FIG. 44.

Case I.—First let the fault to be localised have a resistance $f_1 = 10{,}000$ ohms, and let $f_2 = 250{,}000$ ohms be that of a second slight fault in a long cable A B (Fig. 43). Let $a = 1{,}000$ ohms, $b = 2{,}000$ ohms, $c = 3{,}000$ ohms. Then, when B frees A observes

$$a + \frac{f_1(c+f_2)}{f_1+c+f_2} = 10{,}618,$$

and when B earths

$$a + \frac{f_1\left(c+\frac{bf_2}{b+f_2}\right)}{f_1+c+\frac{bf_2}{b+f_2}} = 4{,}317.$$

When A insulates his end, B observes

$$b + \frac{f_2(c+f_1)}{f_2+c+f_1} = 14{,}450,$$

and when A earths

$$b + \frac{f_2\left(c+\frac{af_1}{a+f_1}\right)}{f_2+c+\frac{af_1}{a+f_1}} = 5{,}875$$

Therefore, applying the formulæ of the previous chapter,

A's Blavier position = 1,061 ohms from A. Error + 61 ohms.

B's	,,	,,	1,160	,,	,,	,,	+160 ,,
Free overlap	,,	,,	1,084	,,	,,	,,	+84 ,,
Earth	,,	,,	1,136	,,	,,	,,	+136 ,,

Next, let the loop test be applied, and let the C.R. of the second cable be $l_1 = 8{,}000$ ohms, so that L = 14,000 ohms (Fig. 44). When A balances we have

$$r + a + \frac{f_1(c+f_2)}{f_1+c+f_2} = l_1 + b + \frac{f_2(c+f_1)}{f_2+c+f_1},$$

i.e., in this case,

$$r = l_1 - a + b + \frac{c(f_2-f_1)}{f_1+c+f_2} = 11{,}832 \text{ ohms},$$

whence the apparent distance of the fault from A is

$$\tfrac{1}{2}(14{,}000 - 11{,}832) = 1{,}084 \text{ ohms}.$$

This is the same result as that yielded by the free overlap. Supposing, however, that instead of the true value of L, its *apparent* value be taken, *i.e.*,

$$l_1 + a + b + \frac{c(f_1+f_2)}{c+f_1+f_2} = 13{,}985 \text{ ohms}.$$

Then the apparent distance of the fault is

$$\tfrac{1}{2}(13{,}985 - 11{,}832) = 1{,}076{\cdot}5 \text{ ohms},$$

a closer approximation than the preceding result.

When B balances the loop we have, similarly,

$$r = l_1 + a - b + \frac{c(f_2-f_1)}{f_1+c+f_2} = 4{,}168 \text{ ohms},$$

whence the apparent position, using the true value of L, will again be 1,084 from A; whilst with the apparent L, which will be the same as before, the distance will be 1,092 from A.

In the potential test (Clark's method), suppose the battery applied at A through a resistance R = 1,000, and that the full

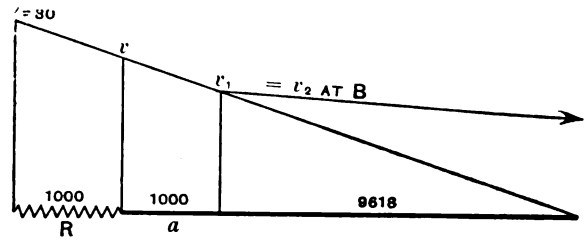

FIG. 45.

potential V = 30 volts. Then the fall of potential is through the resistances (Fig. 45).

$$R + a + \frac{f_1(c+f_2)}{f_1+c+f_2},$$

and the observed value of v will be

$$v = \frac{301 \times 10{,}618}{11{,}618} = 27{\cdot}418 \text{ volts}.$$

The actual value of potential v_1 will be

$$v_1 = \frac{301 \times 9{,}618}{11{,}618} = 24{\cdot}835 \text{ volts},$$

but as observed at B it will be diminished by the second fault, so that what B gets is

$$v_2 = \frac{v_1 \times 250{,}000}{252{,}000} = 24{\cdot}638 \text{ volts}.$$

Hence the apparent distance of the fault is,

$$R\frac{v-v_2}{V-v} = 1{,}000\,\frac{27{\cdot}418 - 24{\cdot}638}{30 - 27{\cdot}418} = 1{,}076{\cdot}5 \text{ ohms}.$$

This is precisely the same result as that of A's loop test, using the apparent value of L. Similarly it may be shown that B's position by potentials corresponds with his loop result. To sum up, therefore, we have the following six apparent positions for the fault f_1 in Case I.:—

No.	Method of localisation (Fault 1,000 ohms from A).	Apparent distance of fault from A.	Error +
1	A's Blavier	1,061·0	61
2	B's Blavier	1,160	...
3	Earth Overlap (*l true*)	1,136	136
4	Free Overlap / Loop Tests, L *true*	1,084	84
5	A's Loop, L *apparent* / A's Potential	1,076·5	76·5
6	B's Loop, L *apparent* / B's Potential	1,092	92

* *Extracted* from a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights reserved.

† Mr. Hockin has shown (*Journal* Institution of Electrical Engineers, Vol. IX., p. 208) that although, from resistance and potential observations, eleven equations may be formed connecting $f f_1 x y$, yet these equations yield but one relation between $x y z$, and so do not determine the position of the fault. In the same place he describes a solution of the problem by discharge observations, but it is not a practical one.

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In this particular case, should the mean apparent C.R. (l) of the line when f_2 existed alone—prior to the occurrence of f_1—have been used instead of the true value of l in the earth overlap formula, this method would have yielded a more correct result than any of the others. The increase of accuracy thus gained is, however, not as a general rule sufficient to render the earth overlap method equal to A's loop and potential results.

Case II.—Let the resistance of the fault to be localised be $f_1 = 500$, and that of the interfering fault $f_2 = 10{,}000$. Let $a = 200$, $b = 800$, $c = 5{,}000$ (Fig. 46), and let $l_1 = 8{,}000$ be a

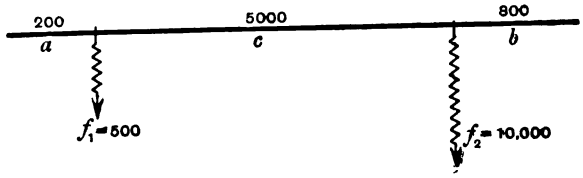

Fig. 46.

second good cable available for looping, so that L = 14,000. Then, calculating as before (neglecting decimals),

When B frees	A's reading	will be	684 ohms.
,, ,,	earths ,,	,, ,,	660 ,,
,, A	frees B's	,, ,,	4,348 ,,
,, ,,	earths ,,	,, ,,	4,186 ,,
,, B	loops A's	added res. ,,	11,664 ,,
,, ,,	,, ,,	apparent L ,,	12,387 ,,
,, A	,, B's	added res. ,,	4,336 ,,
,, ,,	,, ,,	apparent L ,,	12,387 ,,

Let potential readings be taken (by Clark's method) with a battery applied at A through R = 300 ohms say, and let V = 80 volts. Then, computing as in the previous case, we have

$$v = \frac{V \times 684}{984} = 20{\cdot}85 \text{ and } v_1 = \frac{V \times 484}{984} = 14{\cdot}75 \text{ volts,}$$

which becomes, as observed at B,

$$v_2 = \frac{v_1 \times 10{,}000}{15{,}000} = 9{\cdot}83 \text{ volts.}$$

From the above readings we find the following apparent positions for f_1:—

No.	Method of localisation (Fault 200 ohms from A).	Apparent distance of fault from A.	Error +
1	A's Blavier	302	102
2	B's Blavier	3,644	...
3	Earth Overlap (l true)	1,128	928
4	Free Overlap / Loop Tests, L true	1,168	968
5	A's Loop, L apparent / A's Potential	361	161
6	B's Loop, L apparent / B's Potential	1,975	1,775

Here all results excepting (1) and (5) are obviously useless, since the fault must lie within the limit of A's free reading, viz., 684 ohms.

Case III.—As a third case, let the same faults be separated by an extent of line $c = 1{,}000$ ohms (Fig. 47), the other conditions as before. Then it may be shown that the results of the various tests will be as below:—

No.	Method of localisation. (Fault 200 ohms from A.)	Apparent distance of fault from A.	Error +
1	A's Blavier	240	40
2	B's Blavier	394	..
3	Earth Overlap (l true)	340	140
4	Free Overlap / Loop Tests, L true	287	87
5	A's Loop, L apparent / A's Potential	244	44
6	B's Loop, L apparent / B's Potential	331	131

Case IV.—Suppose next that the interfering fault has only 1,000 ohms resistance, the first remaining unaltered; and let them occupy the same positions as in Case II. (*see* Fig. 48).

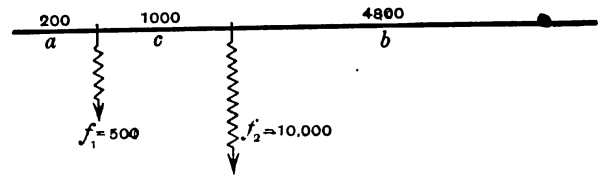

Fig. 47.

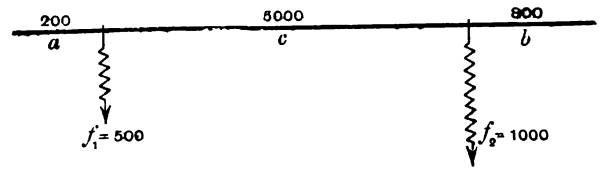

Fig. 48.

The following are the results, localising for f_1:—

No.	Method of localisation. (Fault 200 ohms from A.)	Apparent distance of fault from A.	Error +
1	A's Blavier	512	312
2	B's Blavier	4,561	...
3	Earth Overlap (l true)	2,185	1,985
4	Free Overlap / Loop Tests, L true	2,508	2,308
5	A's Loop, L apparent / A's Potential	584	384
6	B's Loop, L apparent / B's Potential	2,861	2,661

Case V.—Lastly, when f_2, having 1,000 ohms resistance, is situated as in III. (Fig. 49), the results of localisation for f_1 are as follows:—

No.	Method of localisation. (Fault 200 ohms from A.)	Apparent distance of fault from A.	Error +
1	A's Blavier	384	184
2	B's Blavier	878	...
3	Earth Overlap (l true)	628·5	428·5
4	Free Overlap / Loop Tests, L true	600	400
5	A's Loop, L apparent / A's Potential	400	200
6	B's Loop, L apparent / B's Potential	800	600

From the foregoing examples may be inferred the following general rules respecting the localisation of a fault in presence of a second leak, the latter having the greater resistance of the two:—

(1) All results give positions intermediate between the faults.

(2) The best results are those yielded by the tests made at the station *nearest* to the fault to be localised; and of these

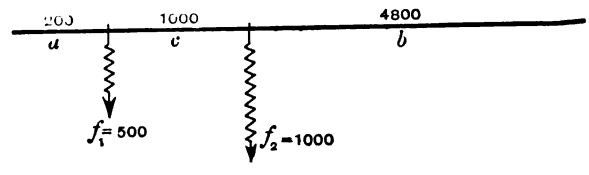

Fig. 49.

the least apparent distance is the most nearly correct, though always exceeding the true distance.

(3) This least apparent distance is given by the Blavier result, the next in order of theoretical accuracy being the Clark potential test, or the Varley loop when the apparent value of L is used, all three tests being made from the end nearest the fault. The overlap methods are quite unsuitable, and the Blavier result from the other end of the line is the least accurate of all.

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Although theory thus shows A's Blavier result to be that least affected by the interfering fault, this advantage is in practice counterbalanced by the objection that it is most deranged by variations of the fault's resistance when the test is made by the nearer station. And the general liability of the Blavier method to disturbance by such variations renders its results practically less reliable as a rule than those of A's loop or potential tests in presence of a second fault, in spite of this theoretical advantage. On the other hand the earth overlap method, though more affected by a second fault than either A's Blavier, loop, or potential results, is notwithstanding the most useful test for a high resistance fault in *other* respects.

B's tests, though to be rejected in the localisation of f_1, assign outside limits to the distance of f_2, a knowledge of which is valuable, the Blavier limit standing theoretically first as before, but the loop and potential results being in general more reliable.

Such are the general effects of any interfering fault on localisations. Conversely, it is important to notice that marked discrepancies amongst the results of localisation by various methods, otherwise sufficiently reliable, are a criterion of the existence of more than one fault.

(To be concluded).

IMPROVED OVERHEAD TROLLEY CONSTRUCTION

There are indications in more directions than one that British engineers are determined upon improving and adapting

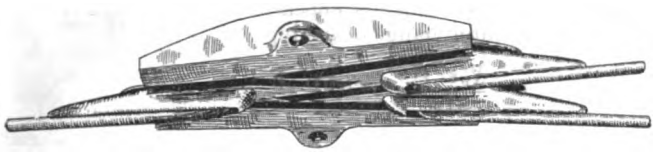

FIG. 1.—The "Wood" Frog for Overhead Trolley Construction.

to the requirements of practice in this country the electric traction plant, as supplied to them from America. The swivel-side trolley was a step in this direction, and a still later series of improvements are shown in the accompanying illustrations, which relate to frogs and other overhead equipment for turn-

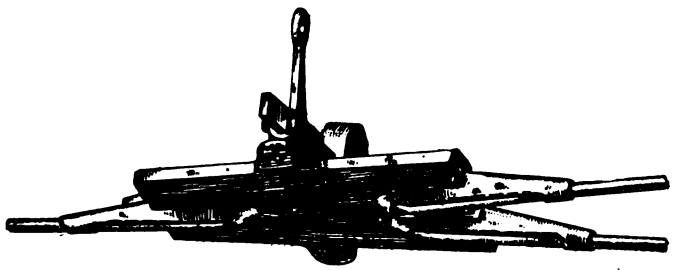

FIG. 2.—The "Wood" Movable-point Frog for Overhead Trolley-wire Turn-outs.

outs, junctions, and crossings. These latter are the inventions of Mr. W. Wood, chief engineer of the electrical department of the Bristol tramways. Fig. 1 shows a frog adapted to two overhead lines running into one, while Fig. 2 shows the frog for a divide from one line into two, the junction being pro-

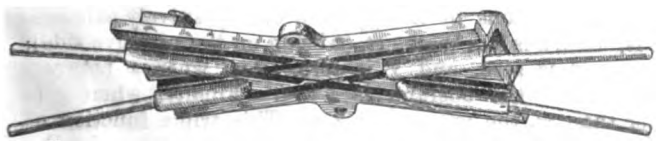

FIG. 3.—The "Wood" Crossing for Overhead Trolley Construction.

vided with a movable or oscillating point similar to that on the track rails. For a crossing the form of attachment shown in Fig. 3 is employed. We understand that these details of overhead trolley construction have been adopted for the whole of the electrical section of the Bristol tramways, the American frogs, &c., having been taken down, and the result of the change has given complete satisfaction.

NOTE ON THE MOTION OF A CHARGED BODY AT A SPEED EQUAL TO OR GREATER THAN THAT OF LIGHT.

BY OLIVER HEAVISIDE.

Mr. Searle remarks at the end of his paper* that it would seem to be impossible to make a charged body move at greater speed than that of light. Prof. J. J. Thomson† has made a similar remark in the same connection. Prof. G. F. Fitz-Gerald did so also, long ago, but in a different connection.‡

The argument implied in the cases of Thomson and Searle seems to be that since the calculated energy of a charged body is infinite when in steady rectilinear motion at the speed of light, and since this energy must be derived from an external source, an infinite amount of work must be done, that is, an infinite resistance will be experienced.

There is a fallacy here. One easy way of disproving the argument from infinity is to use not one, but two bodies, one positively and the other negatively charged to the same degree. Then the infinity disappears, and there you are, with finite energy when moving at the speed of light.

But I go much further than that, and assert that a single charged body may be moved at any speed, whether equal to or exceeding that of light, without any infiniteness of the energy or infinite resistance to motion—that, in fact, a charged body may be moved about anyhow. Remember that it is not a question of whether the mechanical construction of the ether will permit it—nothing is known about that—but merely one of electromagnetic laws. If they are valid at any speed, then there is nothing to prevent speeds of motion greater than light.

To illustrate. Start with a stationary charged body; then move it anyhow, finally bringing it to steady rectilinear motion at speed u. Wait a little while, and the special distribution of displacement round the instantaneous position of the body will be assumed. But it will not extend to infinity. For beyond the distance from the first position of the body, travelled by light in the time occupied in shifting it to a second position, there is no disturbance of the original distribution of displacement. This holds for all time, so the energy is always finite, even when the speed u is that of light or more, unless there should be infinite collections of energy at a finite distance from the body, and there is no need for that.

Where does the energy come from? The body meets with resistance as its speed is increased. Not only that, but it requires force to maintain its speed steady until the steady distribution of displacement appropriate to the speed is assumed. This force tends to vanish when $u<v$. But it does not when $u=v$. (A single charged body is in question now.) There is a pull-back on the body exerted by the deformation of the tubes of force; their pull on the body is greater behind than in front until the regular steady distribution is fully assumed. This cannot be approximated to exactly when $u=v$. But we may get over this difficulty, as before, by means of two charges.

When $u>v$, the pull-back becomes very prominent, and in any case, whether there is one body or two, the constant exertion of force is required to maintain the motion. The displacement for a point charge is a conical sheet behind the charge, together with a supplementary distribution inside the cone. The pulling back is obvious, and the energy is being wasted at a steady rate by the constant growth of the cone at its apex, which is fully accounted for by the activity of the applied moving force. This is as I suspected in 1888‖ ("El. Papers," Vol. II., p. 494), and I later corroborated it by mathematical investigation. The solution is described in my "El. Papers," Vol. II., p. 516. It is not the same formula as when $u<v$. The infinities that are concerned in it are not essential. They arise from its being a *point* charge that is

* Physical Society, 1897; *Phil. Mag.*, October, 1897.

† "Recent Researches in Electricity and Magnetism," Chap. I.

‡ Dr. Fleming has lately repeated Prof. J. J. Thomson's conclusion.

‖ But, on reference, I see that I described the electric *current* as being towards the charge inside the cone, and away from it on the outside. This should be the electric *displacement*.

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in question. Make it a surface distribution and it will all come plain, the cone (or other surface) behind the charge, and the constant pull-back exerted on the body by the displacement. (Fully worked out examples of this theory would be too lengthy here, and must be postponed.)

The tendency of the displacement to be left behind as the body moves is also the cause of the apparent increase of inertia of the body at slow speeds. We then calculate statically, as it were; in the approximate result it appears that when u varies anyhow (u/v being always very small), the resistance to motion is equivalent to an increase of inertia (J. J. Thomson). And yet there is no apparent pull-back by the electrical tension; but that is because of the erroneous assumption made, that the change of displacement is instantly assumed as the body moves. Allow for finite v, and this case is no exception.

The moral is—don't be afraid of infinity!

(The above arrived at the Physical Society too late for discussion. The matter in question is quite visionary, superficially considered; but is of considerable theoretical importance.)

ELECTROMAGNETIC THEORY.—CII.*

BY OLIVER HEAVISIDE.

(*Continued from page 266*).

§ 416. Returning to the investigation in § 414, there are some things about it worth attention in view of understanding the inner workings of the mechanism of analysis. We converted the original operational solution to a Fourier integral because we assumed that we did not see how to algebrise it directly. But then again, not seeing how to evaluate the integral simply by commonly-employed orthodox methods, we employed an operational process to avoid the complication of a full development of the functions concerned. Now, consideration will show that the Fourier integral plays an unnecessary part in the work. It may be skipped over without any loss. On the other hand, there will be a gain in simplicity by making the whole of the work operational.

Thus, given initially $V = V_0$, constant on the left side, and zero on the right side of the origin, the current that results, by (7), is

$$C = V_0\epsilon^{-\rho t}\frac{\text{shin}\, vt}{Lv}\Delta 1, \tag{54}$$

because $-\Delta V_0 = V_0\Delta 1$ here. Now use the operational expansion (41), or, which is the same,

$$\frac{\text{shin}\, vt}{v} = \epsilon^{\frac{1}{2}\sigma^2 p^{-1}t}\,\frac{\text{shin}\, vt\Delta}{v\Delta}. \tag{55}$$

Then we get

$$C = \frac{V_0\epsilon^{-\rho t}}{Lv}\epsilon^{\frac{1}{2}\sigma^2 p^{-1}t}\,\text{shin}\, vt\Delta\,.\,1. \tag{56}$$

Now $\epsilon^{vt\Delta}1$ is 1 from $x = -vt$ to ∞, and $\epsilon^{-vt\Delta}1$ is 1 from $x = +vt$ to ∞, by Taylor's theorem, § 276. So their difference represents 1 from $x = -vt$ to $+vt$. Therefore

$$C = \frac{V_0\epsilon^{-\rho t}}{2Lv}\epsilon^{\frac{1}{2}\sigma^2 p^{-1}t}[1]_{-vt}^{+vt}, \tag{57}$$

where the 1 means a function of x existent between the limits indicated. Now the limits for the time integration are 0 and t as usual, but since the operand is 0 when $x > vt$ or $< -vt$, the effective limits are x/v and t on the right side of the origin, and $-x/v$ and t on the left side. The rest of the work is as in § 414, for the right side, making

$$C = \frac{V_0\epsilon^{-\rho t}}{2Lv}I_0\{\sigma(t^2 - x^2/v^2)^{\frac{1}{2}}\}, \tag{58}$$

as before found, § 367. It is true on both sides of the origin.

It will be observed that the only troublesome part of this investigation is the initial recognition of the expansion (55). Granting that, the rest is plain enough.

The result (58) suggests a modification which did not present itself naturally previously. If two operators are strictly identical, however different in appearance, one may be substituted for the other in general, perhaps universally, if worked rightly. But the substitution may also be made when the operators are not identical, if their effects are the same under the circumstances considered. Thus, as above, $2\,\text{shin}\, vt\Delta.1$ means 1 between $x = +vt$ and $-vt$. The original operand 1 is a positively existent function of x, and the operator turns it to a function of x and t. (They are not functions at all in the limited sense of function theorists, but that does not matter. Physics is above mathematics, and the slave must be trained to work to suit the master's convenience.) Now compare it with $\epsilon^{-(x^2/v^2)D}1$, where D means the t^2 differentiator. The 1 is now a positively existent function of t^2, and the operator destroys the part between $t^2 = 0$ and x^2/v^2. The resulting function is therefore 1 provided t^2 is greater than x^2/v^2. So it is the same function of x and t as before. Instead of (56), therefore, we may write

$$C = \frac{V_0\epsilon^{-\rho t}}{2Lv}\epsilon^{\frac{1}{2}\sigma^2 p^{-1}t}\epsilon^{-(x^2/v^2)D}1. \tag{59}$$

The significance of the change will now appear. For since

$$D = \tfrac{1}{2}t^{-1}p, \qquad \text{therefore} \quad D^{-1} = 2p^{-1}t,$$

and (59) is the same as

$$C = \frac{V_0\epsilon^{-\rho t}}{2Lv}\epsilon^{\frac{1}{4}\sigma^2 D^{-1}}\epsilon^{-(x^2/v^2)D}1. \tag{60}$$

There is now only one differentiator in question, and the corresponding variable does not appear in the operators. They may therefore be interchanged, making

$$C = \frac{V_0\epsilon^{-\rho t}}{2Lv}\epsilon^{-(x^2/v^2)D}\,\epsilon^{\frac{1}{4}\sigma^2 D^{-1}}1. \tag{61}$$

Now we know that

$$\epsilon^{\frac{1}{4}\sigma^2 D^{-1}}1 = I_0(\sigma t), \tag{62}$$

as in (19), § 877. Or we may verify (62) on the spot. Then the other operator in (61) turns t^2 to $t^2 - x^2/v^2$, and brings us to the result (58) again. It is not necessary to interchange the operators as above done; but it has the result of considerably simplifying the work. We could not interchange in the form (56), because the variable t is present in the second operator, and is acted upon by the corresponding differentiator in the first.

§ 417. The corresponding treatment of the V due to initial V_0 is more difficult. We have, by (6)

$$V = V_0\epsilon^{-\rho t}(p+\sigma)\frac{\text{shin}\, vt}{v}1, \tag{63}$$

if initially $V = V_0$, constant on the + side of the origin. Now use (55). We get

$$V = \frac{V_0\epsilon^{-\rho t}}{2v}(p+\sigma)\epsilon^{\frac{1}{2}\sigma^2 p^{-1}t}(\epsilon^{vt\Delta} - \epsilon^{-vt\Delta})x, \tag{64}$$

where the x stands for $\Delta^{-1}1$. It is only positively existent.

Or,
$$V = \frac{V_0\epsilon^{-\rho t}}{2v}(p+\sigma)\epsilon^{\frac{1}{2}\rho^2 p^{-1}t}\{[x+vt] - [x-vt]\}, \tag{65}$$

where the functions in the []'s are only positively existent. That is, when x is less than $-vt$, (x being on the negative side), the operand is zero, and V is zero. And when x between $-vt$ and $+vt$, the operand is $x+vt$. Finally, when x is greater than vt, the operand is $2vt$. This triple function of x and t is fully represented either in (64) or in (65) under the limitation to positivity mentioned.

Now, when x is greater than vt, we know the result by elementary reasoning. The disturbance has not reached x, so V there is the original V_0 attenuated by the leakance. It is $V = V_0\epsilon^{-Kt/S}$. We should verify this. The operand is $2vt$, and

$$(1 + \tfrac{1}{2}\sigma^2 p^{-1}t + \ldots)t = t + \tfrac{1}{2}\sigma^2\frac{t^3}{3} + \frac{(\frac{1}{2}\sigma^2)^2}{2}\frac{t^5}{3.5} + \ldots = \sigma^{-1}\,\text{shin}\,\sigma t. \tag{66}$$

* This series of Articles is a portion of Vol. II. of Mr. Heaviside's work on "Electromagnetic Theory." All rights of reproduction are reserved.

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This makes

$$V = V_0\epsilon^{-\rho t}(p+\sigma)\frac{\text{shin}\,\sigma t}{\sigma} = V_0\epsilon^{-\rho t}\epsilon^{\sigma t}, \quad (67)$$

which is the required result.

But when x lies between $\pm vt$, and the operand is $x+vt$, the work is considerably complicated. We found before, by another method, that an infinite series of Bessel functions was needed. When x is +, or in the region of V_0, as the time goes from 0 to t, the operand is $2vt$ from $t=0$ to x/v, and is then $x+vt$ from $t=x/v$ to the full t. When x is −, the operand is 0 until the time reaches $-x/v$, and is then $x+vt$ till the full t is reached. It is not necessary to do both sides. The side away from V_0, the negative side here, is the easier to manage. We have to find U, given by

$$U = (1+\tfrac{1}{2}\sigma^2 p^{-1}t+\ldots)\,(x+vt), \quad (68)$$

the limits in the integrations being $-x/v$ and t. The beginning of the resulting series going only as far as p^{-2}, is

$$U = x+vt+\tfrac{1}{2}\sigma^2\left\{\frac{x}{2}\left(t^2-\frac{x^2}{v^2}\right)+\frac{v}{3}\left(t^3+\frac{x^3}{v^3}\right)\right\} + \frac{(\frac{1}{2}\sigma^2)^2}{2}\left\{\frac{x}{2}\left[\frac{1}{4}\left(t^4-\frac{x^4}{v^4}\right)-\frac{x^2}{2v^2}\left(t^2-\frac{x^2}{v^2}\right)\right]+\frac{v}{3}\left[\frac{1}{5}\left(t^5+\frac{x^5}{v^5}\right)+\frac{x^3}{2v^3}\left(t^2-\frac{x^2}{v^2}\right)\right]\right\} \quad (69)$$

This is horrid, and need not be pursued further, although doubtless, by extension and proper arrangement, it can be more conveniently exhibited. If the initial V_0 is on the left side, the corresponding U on the right side is obtained by changing the sign of x.

We have already found a concise and convenient way of developing the C wave when the V wave is known, and conversely, §§ 382, 386. In the present case we have (58) for the C wave, and therefore

$$V = V_0\epsilon^{-\rho t}\frac{p+\sigma}{2v\Delta}I_0(z), \quad (70)$$

for the V wave. For distinctness let V_0 be on the negative side, then we calculate V on the positive side, so as not to be troubled with the subsiding V_0. Now use the α, β differentiators, and we have

$$\frac{p+\sigma}{v\Delta} = \frac{1+\frac{1}{2}(\alpha+\beta)}{\frac{1}{2}(\alpha-\beta)} = \frac{1+\alpha}{1-\alpha}, \quad (71)$$

as explained in § 382. This makes

$$V = \tfrac{1}{2}V_0\epsilon^{-\rho t}(1+2\alpha+2\alpha^2+\ldots)P_0(z) \quad (72)$$

$$= \tfrac{1}{2}V_0\epsilon^{-\rho t}\left(P_0+2wP_1+2\frac{w^2}{2}P_2+\ldots\right)(z). \quad (73)$$

See also §381. The investigations are practically the same on the right side of the origin; but on the left side there is a distinction. If the source is an impressed force at the origin, then C at x and at $-x$ are identical, whilst V at $-x$ is the negative of V at x, assuming that x is positive. But when the source is the distribution V_0 above assumed, then we must add on $V_0\epsilon^{-Kt/S}$ to the negative of the V in (73) to obtain V at $-x$.

(To be continued.)

ERRATA IN ARTICLE CI.— Eq. (14), *for* LvC *read* LvC. Eq. (23), *insert* $(p+\sigma)$ *after* $\epsilon^{-\rho t}$. Eq. (35), *for* v^2 *read* Lv^2. Eq. (53), *for* $-n^2$ on left side *read* $+p^2$, p being the time differentiator.

THE "HATCH" SECONDARY BATTERY.

An interesting departure in secondary or storage battery construction has been made by the Hatch Storage Battery Company, of Boston, Mass. Essentially, the modification of the ordinary pasted-plate type of secondary cell consists in placing the paste on a porous grid of baked kaolin or other earthy material, this pasted porous separator being placed between electrodes of sheet lead. The cell is built up in the following manner: first, on the outer side of the bundle of plates and pasted grids there is a slab of some non-porous insulating material to serve as a mechanical support, the two slabs of this material on the opposite sides of the bundle being held together either by elastic straps or by bolts passing from one to the other. Next to the outside slab there is placed a

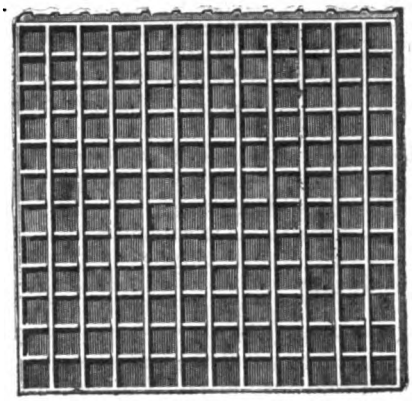

FIG. 1.

sheet of lead, with a lug on its upper edge to serve for an electrical connection; against the inner surface of this lead sheet there is placed the pasted surface of the clay partition. One side of this partition is formed into indented squares by

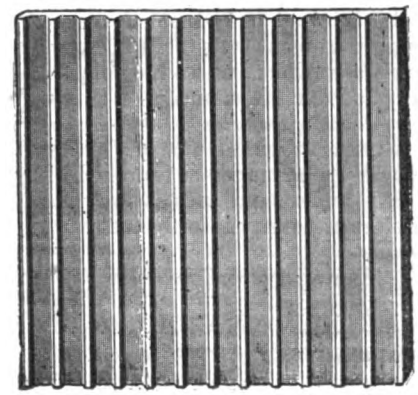

FIG. 2.

ridges running horizontally and vertically across it, as shown in Fig. 1, and into these squares the paste is compressed until the surface is smooth and flush. The other side of the partition (Fig. 2) consists of channels running only in one direc-

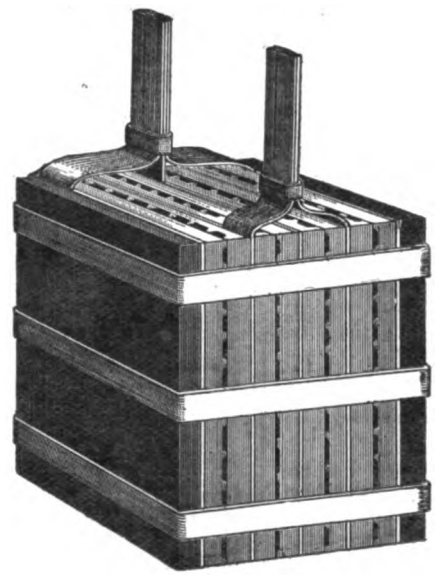

FIG. 3.

tion, and is not pasted. Next this chanelled surface is placed the similarly channelled surface of another pasted partition, but with its channels running at right angles to those of the first partition. These two sets of channels serve as passages for gases

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liberated during charging, and for circulation of the electrolyte. As already stated, the second porous partition is pasted on one side, and against this pasted side a second electrode, opposite in polarity to the first, is placed, this also consisting in a flat sheet of lead. On the other side of this second electrode the pasted side of a porous partition is placed, and the series just described is repeated until the requisite number of electrodes has been coupled up. The completed bundle of plates is shown in Fig. 3. When thus built up the cell is placed in acid of the usual strength and composition and is "formed." It is then ready for use. Another curious feature in this cell is that for large sizes of plate the porous partitions are placed over the surfaces of the electrodes in a species of tile-work, the several pasted partitions in contact with any one lead plate not being fastened together in any way, and merely being held in place by the tightness and compactness of the *tout ensemble*.

The question naturally suggests itself as to why the inventor of this battery has adopted the singular practice of placing a porous partition between the plates of active material, with the obvious risk of raising its internal resistance. The answer is, that by this plan the paste is secured in position more effectively than when it is attached to the lead plate itself, since it is practically impossible for any of this material to break away and fall to the bottom of the cell. Thus a longer life is secured for the cell, and risk of injury from excessively rapid charge or discharge is reduced very considerably. It is stated that the internal resistance of the cell is reasonably low, and a report on some tests made in America would appear to bear out this assertion; but we have not yet made any tests on the battery for ourselves, and, so far as we are aware, no tests have as yet been made by experts in this country, so we are at present unable to pronounce any opinion as to the electrical efficiency of the arrangement adopted in the construction of the cell. We understand that it is intended to introduce this form of storage battery into this country.

A NEW METHOD OF AVOIDING SPARKING IN CONTINUOUS-CURRENT MACHINES.*

BY J. FISCHER-HINNEN.

Since Mordey's recent Paper on armature reaction the so-called Ryan winding has been spoken of, in which the magnets are provided with a series winding distributed over the polar surface, the

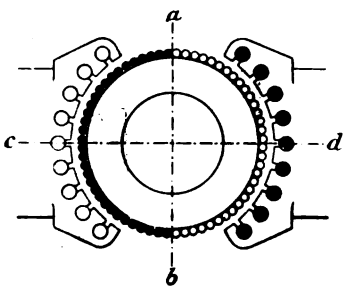

Fig. 1.

magnetic axis of this winding being in the opposite direction to that of the armature (Fig. 1). Without wishing, in this place, to dispute at length about claims to priority (I described this winding nine months before the first publication by Ryan, and had tested it more than a year previously†) I would like to make a few remarks on the method.

The action of the winding is usually wrongly imagined by assuming that, in order to completely suppress armature reaction and sparking, the number of ampere-turns of the compensating winding must be equal to that of the armature. This view is only right so far as the armature reaction is concerned; *the sparking, on the other hand, is only indirectly proportional to the armature reaction.* We know that the rise and fall of the current in the short-circuited armature coils, after commutation has taken place, is delayed by self-induction. Consequently, in order not to interrupt the short circuit while a current is flowing, an act which must invariably cause sparking, the brushes of a generator must be given so much lead that the back E.M.F. induced in that position can end the process of commutation within the time the short-circuit lasts. The action of the compensating winding above mentioned is two-fold. In the first place it prevents a distortion of the field, and secondly, it produces, in the direction of the neutral zone, poles which have the same signs as the next magnet poles in the direction of rotation. If, therefore, we neglect the first explanation of the action of the winding, we see that the method depends on giving the compensating coil so many ampere-turns that the field they produce at a and b corresponds to the induction at that point of the magnetic field at which sparkless running is obtained. In this case the brushes need not be shifted for changes of load.

It is easy to see that this requirement cannot always be made to accord with the conditions which obtain for complete suppression of the armature reaction. In practice, however, the sparking must be considered first. It may also be mentioned, by the way, that, according to experience, the drop in pressure is not much changed in spite of this winding.

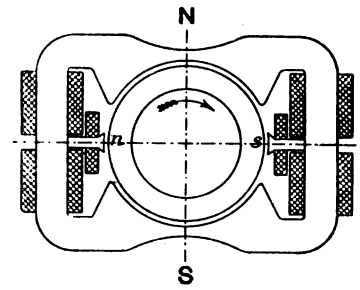

Fig. 2.

We manifestly attain the same result if we substitute for the winding distributed over the polar surface a single coil on c d, or, as proposed by Swinburne, add small auxiliary poles n and s (Fig. 2) on the neutral zone. In certain machines, as, *e.g.*, of the bi-polar Manchester or of the Thury type, a great simplification can be introduced by means of which the compensating coil is rendered unnecessary. We can, in fact, place the latter directly on the limb of the magnet above and below the auxiliary pole, and wind one coil left-handed and the other right-handed. Let $a\,w$ be the number of ampere-turns of the field-winding, and $a\,w_1$ the number of ampere-turns on the compensating coil; we have, then, referring to the magnet limb I. of Fig. 3,

$$\text{Above } n, \quad \frac{a\,w}{2} + a\,w_1 \text{ ampere-turns,}$$

$$\text{and below } n, \quad \frac{a\,w}{2} - a\,w_1 \quad ,, \quad ,,$$

Total..... $a\,w$ ampere turns,

which is the number in the original winding. It is thus sufficient to divide the original magnet winding on the two sides of th

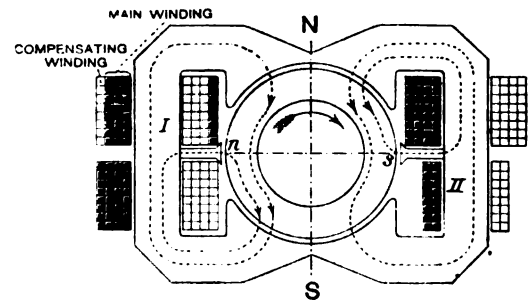

Fig. 3.

auxiliary pole in such a manner that one coil has $a w_1$ ampere-turns more than the other (*see* limb II. in Fig. 3). On the other limb the opposite arrangement must, of course, be made.

In general, less attention than they deserve is paid to such methods; for the writer had only recently an opportunity of again testing the excellent effect of his method of compensation on a small 400-ampere machine. The machine could not only be loaded without hesitation with three times its normal current (*i.e.*, 1,200 amperes), but *it was impossible with this load, in spite of careful observation at the brushes, to determine whether the machine was delivering current at all.*

The application of this method to motors has the great advantage that the speed can be regulated within the widest limits merely by altering the field, and therefore without appreciable loss of energy.

* From the *Elektrotechnische Zeitschrift* of December 30, 1897.

† See "Berechnung und Wirkungsweise Elektrischer Gleichstrommaschinen," 2nd edition, January, 1892, p. 153.

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MR. RAWORTH'S PRESIDENTIAL ADDRESS TO THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

Premising his address with the observation that "Whereas it is well sometimes to be gay, it is also well to be sometimes grave," Mr. Raworth proceeded to give the Northern Society an address decidedly more gay than grave, a light and airy discourse, largely *apropos des bottes* :—

There are many things in this world we would fain have more of :—The busy want more hours per day ; the lazy want more per night ; the municipal engineer wants more machinery ; the consumer wants more volts ; woman wants more money ; and man wants more of everything, with this exception, that I never yet heard of anyone who felt a craving for more presidential addresses.

Would Mr. Raworth thus remove the alleged general distaste for these addresses, or intensify it? A moment later he talks sensibly of a profound fact :—

The war of the future will be an industrial war, in which the resource and dogged perseverance of the English race will be as much in request as they were at Waterloo. We are up to our ankles in it already ; and yet our engineers, the advanced guard of our industrial forces, having heard so much about the might, majesty and magnificence of the British Empire, have thought it a small matter to desert the trenches for six months, vainly to discuss the breadth of the proposition contained in the declaration of the centurion of old : "I say to this man 'Go,' and he goeth, and to another 'Come,' and he cometh, and to my servant 'Do this,' and he doeth it.'

Strange that in one and the same responsible address from the chair of a leading engineering society the above should be coupled with such rubbish as—

What a pity it is that we electrical people cannot start afresh and build a new city, embodying all the latest improvements. Imagine ham and eggs for breakfast per telephone ; the subscriber would put the fork in his mouth, and having attached the wire and touched the button, the young lady at the other end would connect him to the ham and eggs battery (ham positive, egg negative), and in ten minutes he would be a new man. N.B.—Coffee thrown in.

Mr. Raworth casts in an original mould his survey of the prospects for the future. He is hopeful, and with very much the same sort of hopefulness as most of us, but he expresses it differently :—

The one thing we want is faith—it is quite as important in mechanics as in religion ; for as by faith the walls of Jericho fell down, so will the walls of prejudice and incredulity, which at present bar your path to the promised land of fame and fortune, collapse at the first brush with the dynamics of faith. It is true we have had a bad time ; we have had to fight and conquer innumerable difficulties ; our new horse has been as bad to train to harness as a zebra ; but, thanks to your indomitable pluck and perseverance under most trying conditions, our steed is now as tame as a coster's donkey, and it behoves us to consider what we can make of him. The time for hesitation and half-heartedness is past, money is plentiful, and the investor has full confidence in "Electrics." I propose, therefore, to look ahead a little, in the hope that I may at least succeed in stimulating you to apply your minds most seriously to the problem that lies before us. The problem is : How can we possibly supply the demand that is about to break upon us? When we entered upon this business we had practically only one commercial outlet—viz., lighting—and we were unable by any amount of sophistry to make the public believe that electric light was cheaper than gas ; now the conditions are changed, and Mr. Arthur Wright informs me that in Brighton the working man and the fried-fish shop are his best customers. He is actually realising Mr. Preece's oft-derided statement, that the electric light is the poor man's light. . . . I said, a moment ago, that when we entered upon this business we had practically only one commercial outlet ; even to-day that same outlet is our mainstay, but other developments are growing so rapidly that one finds it impossible to keep pace with them. Take, for instance, electro-chemistry : old in conception, new in economic application, it is now showing such vitality that the hope—I may even say the assurance—is rising within us that Widnes and St. Helens may soon cast out the "devils" which "possess" them, and, so far as it may be possible for them, atone for the sins of their youth by redigesting their waste heaps. Then, "in the habitation of dragons, where each lay, shall be grass with reeds and rushes." This great work has begun. Who can tell when it will end, or what demand it will make on our national capacity of production?

Despairing of realising his dream of an "electric city," at any rate for the present, Mr. Raworth would meanwhile seek to abolish smoke, and this brings him to discuss electric driving in factories :—

The day for tinkering with this problem is now over ; every man in this room knows that it can be carried through with absolute certainty, with satisfaction to the manufacturer, and with an enormous saving both to himself and the community. But the manufacturer does not yet know that the shaft of his machine can be fitted with a three-phase motor without commutator or brushes, and less complicated than his present double pulley and strap fork. When you have succeeded in impressing him with this fact, the remainder of your task will be an easy matter, but it must be undertaken methodically. The first step is to appoint a commission to settle uniform periodicity and voltage ; the second is to equip an electrical manufactory capable of turning out 500 cheap motors per week ; the third is for machine makers to attach the motor in place of their present pulleys, so that when a manufacturer buys a machine, he buys it all ready for attachment to his power circuit.

Having reached this point, it is obvious that the manufacturer will no longer desire to buy coal ; he will be quite satisfied with watts, which may be produced at the pit's mouth and sold retail for less than they can now be supplied mechanically to the machine axis. The whole question of external supply of power turns on this question of economics. Your manufacturer will not care two straws for your electrical development or for the annihilation of the smoke cloud which he interposes between the sun, the source of all our joys, and the dismal streets of Manchester ; but his eyes will gleam with rapture if you can prove that you can save him a thousand a year. Happily your task is an easy one so far as argument is concerned ; and if illustration be required, I am not sure that we members of this Society could spend our savings to better advantage than by taking a representative deputation of Lancashire and Yorkshire manufacturers through Switzerland and Germany, to show them how the old order is giving place to the new ; how the millwright is disappearing in favour of the electrician ; how 25,000 mechanics are struggling to keep pace with the demand for electrical machinery, of which about three-fourths is required for power purposes.

We are not concerned just now to argue details ; when the hare is caught is time enough to decide how it shall be cooked. But the prospect of being able to sell "500 cheap motors per week," provided it can be done at a profit, should redouble the energies of Mr. Raworth and all who are interested in capturing the user of old-fashioned belts and shafting.

Towards the conclusion of the address there are some interesting remarks on the steam engine :—

Our electrical brethren in Switzerland and in some parts of America can get along well enough without the steam engine, but it is not so with us ; it is fortunate, therefore, that we have plenty of coal with which to feed him. But this abundance of coal has tended to make us less careful of it than our less fortunate neighbours. The result is that, although we make good steam engines in spite of American comments to the contrary, we have not made economy our first consideration ; we have, moreover, been confirmed in this practice by the belief that economy of coal could only be obtained by increased capital expenditure and troublesome complications, But that view is totally and fundamentally erroneous. I have already proved in my Paper on the generation of electrical energy for tramways, read before the Institution of Electrical Engineers in 1897, that a high mean pressure is not uneconomical per electrical horse-power, and, consequently, that the gain by using large engines with very early cut-off is only apparent when the indicated horse-power is taken as the basis of comparison. Further, I can give you this solid fact : that the large engines at the Wandsworth electricity station are producing an electrical horse-power at practically the same steam consumption at full load as at half-load, thus showing that, taking all the losses into account, the saving effected by extreme expansion is cancelled out.

This solid fact, however, is largely a question of rating, and, if anyone wanted it, a steam engine consuming *more* steam per horse-power at full load than at half load could be designed without difficulty. But wherein would be the advantage?

The following is Mr. Raworth's explanation of the existence in this country of steam engines of American make :—

Gentlemen, you are fully aware by bitter experience that the demand for steam engines in this country altogether exceeds the supply, and that in consequence of this state of affairs engines are being introduced from America, which, although well built, will not comply with English specifications as to economy ; and consequently we are in the position that, however we may exert ourselves to fill the coming demand for electrical plant, we shall be either without the means of driving it, or dependent on American engineers for our steam engines. This is not a delightful prospect, but we must face it, even if it be to the tune of two or three millions of additional capital in engineering works.

The Utilisation of the St. Lawrence River.—We have already given particulars of the scheme for the electrical utilisation of the power of the St. Lawrence River at Massena, N.Y. (see *The Electrician*, Vol. XXXIX., pp. 109 and 629). We are now informed that the development of the scheme is making progress, orders for the turbines and dynamos having already been placed. The Westinghouse Company of Pittsburg is to manufacture the fifteen 5,000 H.P. generators, and the turbines are to be of the Victor type, made by the Stillwell-Bierce and Smith-Vaile Company, of Dayton (Ohio).

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With this issue of "THE ELECTRICIAN" is published a Coloured Sketch Map of London and Provincial Electric Supply Stations, which all purchasers of the Paper should receive gratis. Complaints of non-receipt should be promptly made to THE PUBLISHER.

ELECTRICAL FIRE RISKS.

It is not quite apparent what position the majority of fire insurance offices take up with regard to the regulations they think fit to issue for electric light and power installations. Do they intend these regulations to instruct electrical engineers and their workmen how the wiring and fitting should be done in order to minimise the fire risk when the work is completed or are the rules intended merely to insure that the risks be on a par with those incurred where other illuminants and other means of transmitting power are used? The length and elaboration of the code of rules issued by the Phœnix Fire Office suggest that the former object was held in view, while some of the other offices seem to regard electrically-lit risks on the second basis mentioned above. There is, however, no doubt that if the work of electric fitting be well executed the danger from fire will be considerably less than from gas, candle or lamp-light risks; though, on the other hand, it will hardly be denied that safety might be yet further increased by putting in a still better class of work than that recommended even by the Phœnix rules. But this does not seem to be encouraged by the fire offices, who, with but one or two exceptions we believe, take no account in their rates of premium of the manner in which the work has been done so long as there is apparently nothing in the installation contrary to their regulations, and in the case of ordinary dwelling houses, &c., charge the same premiums whatever method of illumination be employed. Let it not be understood that, in allowing that a better class of installation work could be done, we wish in any way to identify ourselves with those alarmists who point to the dangers of electric lighting—by any other than their own system. On the contrary, we hold that there can be no safer method of lighting a building than by electricity, and that for this reason the premiums payable on electrically-lit houses should be considerably reduced. If the fire offices do not consider that the risk is bettered by the adoption of electric light it should be the electrical engineer's duty to improve his work until he has convinced them, and, if necessary, let him invite them to make their regulations more stringent. The question of cost would hardly come in, as stricter regulations would take effect equally all round. The rules may still be capable of modification. At one time the use of iron-barrel systems was not allowed; later these were tolerated; now they are recom-

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ELECTRIC SUPPLY STATIONS OF THE UNITED KINGDOM.

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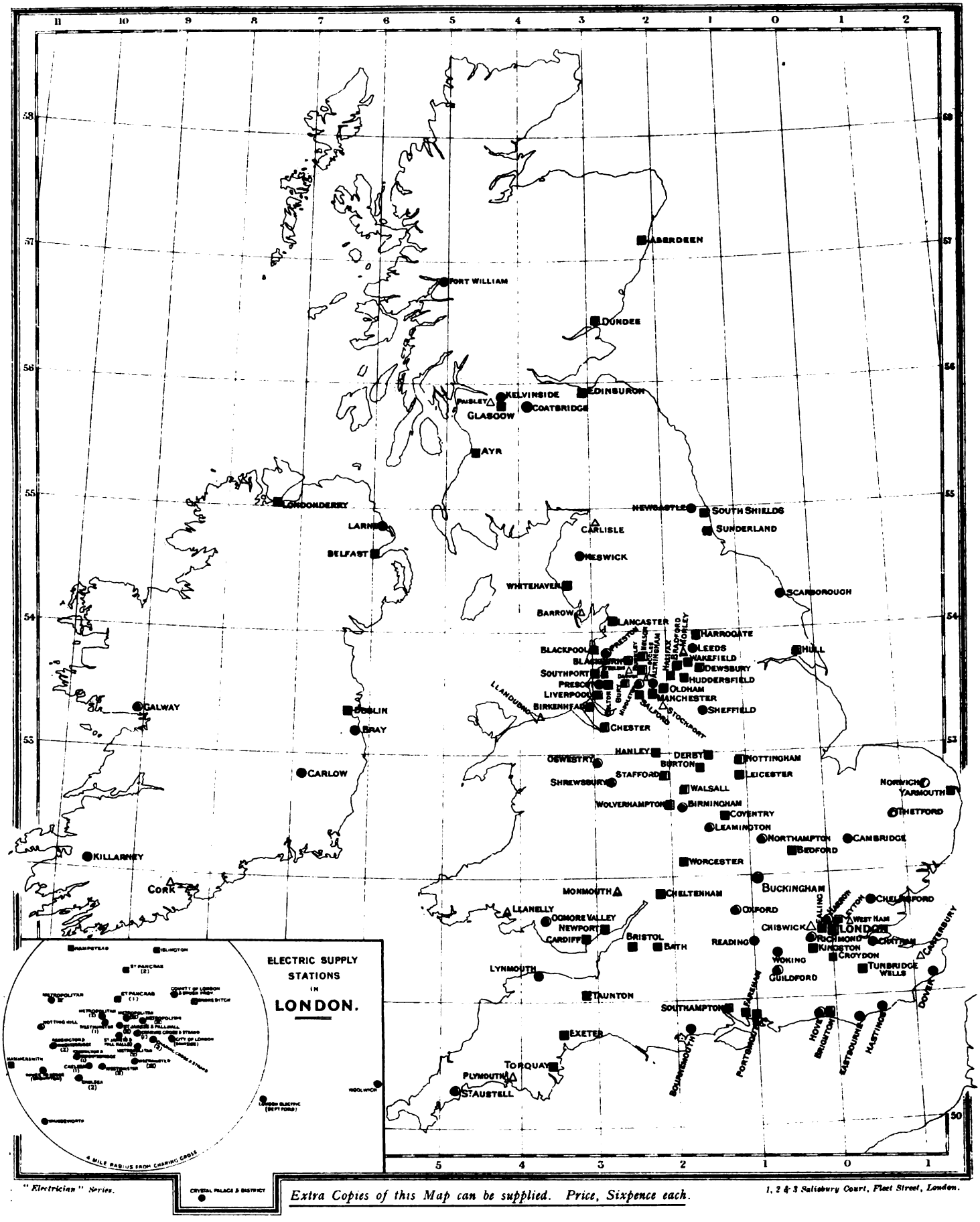

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Blue = Continuous Current.
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○ = Company.

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mended for hazardous risks. At one time all wires had to be insulated with vulcanised india-rubber; and lead-covered wire is still not approved unless protected by a casing of some sort; but yet it is stated by the contractors of a special system of wiring, involving the use of paper-insulated lead-covered wires without external protection, that the system has the approval of the fire offices.

Coming now to power plants, it is recognised that in an ordinary belt-driven factory the belts from floor to floor and from shop to shop are a first-class means of spreading fire. But electrical distribution is evidently considered capable of causing more danger, for a number of regulations have been imposed on it, one among which is that motors must be entirely enclosed by a metal cover, the pulley, ropes, belts, &c., being outside the cover—an excellent rule, especially in the case of cotton mills and similar works. In a Paper recently read by Mr. Lester Taylor, before the Manchester Insurance Institute, that gentleman set himself the task of discovering what is "the additional fire risk that may be involved in the use of electrical power." We are unable to find in the Paper any adequate solution of this problem. It is chiefly devoted to harping on the dangers of motors which are not enclosed, although it appears from the various fire office rules quoted in the Paper that to obtain a policy the motors must be enclosed. Given enclosed motors, it is evident that there is no additional fire risk—though Mr. Taylor does not say so explicitly. Finally, the Paper concludes with a list, inseparable from fire alarmist papers, of electrically-caused fires which have occurred in America. With the possible exception of some fires caused by crosses between telephone and trolley wires, all in the list would have been avoided if the installations had been constructed on English lines.

The practice of estimating English fire-risks from particulars and statistics of fires in America, or even in Germany, is obviously unfair. The jerry work which occasions such fires would not be tolerated in this country, and instances of such a class of work are now, we believe, rare. A mere comparison of the wire used for internal wiring in England and in the States will suffice to show the difference between the methods of the two countries. In a recent issue of the *Electrical Engineer* of New York some tests made on "underwriters' wire" similar to that used for house-wiring were described. Sixteen samples, bought in the open market, were immersed in water and tested at intervals. The insulation of these samples varied, on immersion, from 270 to 5,800 megohms per mile. After being left in the water for one day one sample had given way completely, and the insulation resistances of eight had dropped to below half their former values. At the end of a week the values were considerably lower, two more samples having completely broken down, and after a month's immersion the insulation of half of them had dropped to insignificant quantities. The testing was carried on for nine months, at the end of which period only six samples showed any insulation at all, and in these cases the number of megohms per mile were but a fraction of their former values, the lowest being 32, and the highest 730. But even in America, where the use of electrical energy for all purposes is very extended, the proportion of electrically-caused fires to the total number of fires is only a small figure.

Returning to electrical power transmission in workshops, so long as insurance inspectors maintain that it brings with it additional fire risk there seems little chance of a reduction in premium, although in these cases each risk is no doubt considered separately on its own merits, and the substitution of electric light for gas would no doubt be counted as improving the risk. We recently, however, heard of a case in London in which the introduction of electricity for heating purposes will result in a considerable reduction of premium. The risk in question was the works of a wholesale stationer, whose prodigality in gas-heated glue pots had resulted in his being assessed at a very high premium. Acting on the advice of a consulting electrical engineer the stationer has now determined to heat his glue pots by electrical means, with the result, not only of additional safety and a large reduction in the sum he pays annually to his insurance office, but also, it is anticipated, of considerable economy in meter bills. Although this is perhaps an exceptional case, it is the rule and not the exception that the applications of electricity, whether for light or power, will, if properly carried out, reduce the fire risk. Fire-office inspectors would be well advised, therefore, to view the question from a different standpoint than hitherto, and to use their surplus energy in adjusting their regulations and rates of premium to keep pace with the latest improvements in electrical industry.

JOSEPH WILSON SWAN.

The President of the Institution of Electrical Engineers for the year 1898 is a man whose name is a household word throughout the country, and, indeed, all over the civilised world. Others in the engineering profession have attained to a similar distinction, but there are few whose versatility has brought for them popularity and fame in so many independent ways as has that of Mr. Joseph Wilson Swan. Electrical engineers esteem him "the father of the profession"; they do honour to him, chiefly with the remembrance of his inventive labours in devising and perfecting the glow lamp. The world of art knows many other of his inventions of which the electrician and electrical engineer need know nothing. Photographic art was wonderfully accelerated when he made the chemical discovery which rendered the dry plate a practical success, and it owes to him the "autotype" or carbon process of photographic printing, while in the artistic reproduction of photographs and other pictorial work by photogravure Mr. Swan was one of the first to develop the principle of the tone process, and his name is associated with that of Mr. Woodbury in the invention of another process of mechanical printing.

Joseph Wilson Swan, the fourth son of John Swan and Isabella Cameron, was born on October 31, 1828, at Sunderland, at which town much of his early life was passed. He was educated at the private school of the Rev. John Wood, at Sunderland, and at the early age of 14 he left school for an apprenticeship at Messrs. Hudson and Osbaldiston, a firm of druggists of the same town. Here he thoroughly mastered the details of the business, and would seem to have laid the foundation of the fondness for and proficiency in chemical and allied sciences which in later years he displayed so brilliantly. In 1846, both his masters having died, Mr. Swan entered the business of Mr. John Mawson, a druggist in Newcastle-on-Tyne, whose partner and brother-in-law he ultimately became. He entered into active partnership in this concern in 1867, the firm being thereafter known by the name of "Mawson and Swan."

From the days of his childhood Mr. Swan has been a keen student of physical and chemical science. Very early in his life the problem of producing an economical and commercially practicable electric lamp attracted his attention, and called forth his energies of research and experiment. The success he ultimately achieved belongs to a story that need scarcely be repeated now—all the world knows it so well. The first lamp to be publicly exhibited that embodied the essential features of the modern carbon-filament glow lamp was made and exhibited by Mr. Swan in 1879. Nor has he rested content with the enviable reputation of being the first to hit upon the idea which transformed the glow lamp from a scientific curiosity into a practical commercial success; for he has subsequently made several important improvements, both in the actual lamp itself and in the apparatus for its manufacture,

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most notable among which, perhaps, is the invention of the squirted filament, as set forth in his patent 5,978 of 1883.

A less fertile brain than that of Mr. Swan would readily have seen that in the new source of light afforded by the glow lamp lay a practical solution of the difficult problem of affording miners a safe and serviceable illuminant. Mr. Swan soon found that in the battery lay the most troublesome part of of this problem, and he set to work to devise a satisfactory electric miner's lamp with self-contained storage apparatus. Research in this direction led to the invention of the cellular form of secondary battery plate, the utility of which has been realised in a far wider field of application than the lighting of collieries. Space does not allow of even a cursory review of all Mr. Swan's other inventions; even a list of his patents would occupy considerable space. We may, however, refer to an early form of motor-type of electric meter which he invented in 1881, also to his process for the production of gold leaf and extremely fine wire by electrolytic deposition.

The first electric lamp manufacturing company in Europe was formed at Newcastle, in 1881, as the Swan Electric Light Company. This subsequently became the Swan United Electric Light Company, which, on being incorporated with the Edison Company, developed into the present Edison and Swan United Electric Light Company, of London. On the occasion of the expiry of the master patent held by this latter Company (referred to in our issue of *The Electrician*, Vol. XXXII. of November 10, 1893), we presented our readers with a portrait of Mr. Swan, the which most people will agree is a striking likeness even at the present time; and in that issue (p. 38) we also gave a short summary of the principal electrical events in Mr. Swan's career.

Honours not a few in number have fallen to Mr. Swan in recognition of his services to mankind in his numerous inventions and discoveries. We have already announced his election to be the President of the Institution of Electrical Engineers during the present year, and last evening he delivered his presidential address. Mr. Swan is also a Vice-President of the Royal Photographic Society, a Fellow of the Royal Society, and a Fellow of the Institute of Chemistry. He is, besides, a Member of Council of University College, London, a corresponding Member of the Philosophical Society of Glasgow, a Master of Arts (*honoris causâ*) of Durham University, and a Chevalier of the Legion of Honour.

WILLIAM ASHCOMBE CHAMEN.

In connection with the recent appointment of Mr. W. A. Chamen to the important post of electrical engineer to the Glasgow Corporation, some particulars of his career may interest our readers.

William Ashcombe Chamen was born in 1863 at New Cross, London. He was educated at Forest School, Walthamstow, at the time when Dr. F. B. Gay was head-master. He left school about 1879, and went into the chemical works of Messrs. James Gibbs and Co., of Plymouth, where he remained for nearly two years and received a thorough training at bench, vice, lathe and other machine tools in the repairing shop at the works. Finding that the chemical trade did not promise the opening he desired, and being filled with the excitement of two or three readings of Jules Verne's "Twenty Thousand Leagues under the Sea," he decided to give up chemistry and to go in for electricity. He returned to London early in 1881, and was introduced to a gentleman who advised him to go to Mr. Crompton, though possessing no letter of introduction. He went, and told Mr. Crompton he wanted a start, on trial, and that he could promptly turn him out if he did not suit. Mr. Crompton, as readers can easily imagine, took kindly to this method of introduction, as it indicated "grit," and he agreed to give young Chamen a chance at Chelmsford as an "improver." Mr. Crompton had not at this time long started his electrical engineering business, so that Mr. Chamen, at this time 18 years of age, may be said to have fallen upon his feet in very promising quarters. He made rapid progress in his new work, and was put in charge of the men at Crompton's first installation of arc lighting at the Great Northern Railway, King's Cross, and was practically responsible for the running for between two and three years. His next work for the firm took him to the Munich Exhibition, and he afterwards became Crompton and Co.'s engineer in Italy, where a number of mill installations were put down in Tuscany. He was afterwards engaged upon the first large installation of incandescent lighting in the United Kingdom, that of the Royal Courts of Justice, in the Strand, London. From the Law Courts Mr. Chamen proceeded to the Forth Bridge Works, to take charge of Messrs. Crompton's men, putting down machinery in that part of the country. He now became the firm's chief outdoor engineer, and continued to hold this position until his recent appointment to the position of chief engineer to the Corporation of Glasgow's electricity supply undertaking. Among the number of installation works with which Mr. Chamen has been connected for Messrs. Crompton and Co. may be mentioned: the Tilbury Docks in 1884; the two stations of the Kensington and Knightsbridge Company (practically the first central supply station in London); the Barry Docks alternating-current installation; the two low-pressure stations at Northampton and Southampton; the Westminster Corporation's extensive station; the fine example of electric lighting work for the Great Eastern Railway at Liverpool-street; and the public and private lighting of Dewsbury and Yarmouth. This exceptional experience was interspersed with many opportunities for gaining an intimate knowledge of the requirements of modern street arc lighting, as Mr. Chamen was engaged in this work in the important towns of Edinburgh, Brighton, Southport, Hanley, Blackpool, &c. He superintended the construction and erection of the plant for the lighting of the Agricultural Hall, Islington, the South Kensington Museum, and (under Mr. J. N. Shoolbred) in the lighting of Birkenhead. He has had charge of the extensive series of contracts which have been carried out by Messrs. Crompton and Co. for the St. Pancras Vestry. This work has familiarised Mr. Chamen with the management of workmen, as he has had under his control at times as many as 300 men. Nor is he a stranger to electric railway work, as he was employed by Messrs. Crompton and Co. to superintend the erection of the electric railway on Southend pier, one of the first electric railway jobs in this country. He therefore enters upon his work at Glasgow with many advantages.

Mr. Chamen has served on the Council of the Institution of Electrical Engineers, and was one of the sub-committee which prepared the Institution's Standard Wiring Rules.

THE CLARK STANDARD CELL.

BY ARTHUR DEARLOVE.

Quite recently the champions of the various types of Clark's cell have given in your columns their views as to the difficulties experienced in satisfactorily reproducing uniform cells; in fact, in their remarks none of the defects of the Clark cell have been overlooked, its lag, short life, and high-temperature coefficient having all been duly mentioned.

The "lag" may be regarded as of small importance I consider, and the "life" of the cell it is well known varies considerably according to usage, but I may record that a hermetically-sealed cell of the amalgamated platinum wire form, made in 1880, has only within the last year broken down; this cell has done good service for more than 15 years in our laboratory. Very few, if any, other primary batteries could show such staying powers, whether continuously or only very occasionally used.

If very exceptional accuracy is required the high-temperature coefficient is certainly a defect which cannot well be avoided, as the difference of E.M.F. with rise or fall of temperature is due almost entirely to the behaviour of the zinc, which in a saturated cell becomes more or less positive as the temperature of the cell falls or rises. The mercury is affected by alterations of temperature in the same direction as the zinc, but to a much less degree (about one-eighth), this change in the E.M.F. of mercury counteracts *pro tanto* the effect of variations of temperature on the E.M.F. of the zinc.

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Table of Results of Tests of various Types of the Clark Standard Cell.

Number of cell.	Date set up.	Type of cell.	Dates of comparison with standard. No correction made for temperature variations.					Remarks.
			Nov. 2.	Nov. 8	Nov. 16.	Nov. 26.	Dec. 4.	
			14°C.	13·2°C.	12·6°C.	12·5°C.	9·6°C.	
Standard 120	1890	Old form, free Hg	1·0000	1·0000	1·0000	1·0000	1·0000	Checked by comparison with recent standards.
1	1897 Oct. 18	H form, free Hg zinc amal.	1.0002	1·0001	1·0002	1·0003	1·0003	Set up with hot paste.
2	Oct. 29	Old form, free Hg	1·0003	0·9999	0·9999	1·0003	1·0005	
3	,,	,, ,,	1·0002	0·9999	0·9998	1·0003	1·0003	Set up with cold paste.
4	,,	,, ,,	1·0004	1·0001	1·0001	1·0004	1·0002	
5	,,	,, ,,	1·0000	1·0000	1·0002	1·0004	1·0003	
6	,,	,, ,,	1·0002	0·9999	0·9999	1·0003	1·0003	
7	,,	,, ,,	1·0001	0·9998	1·0000	1·0003	1·0003	
8	Nov. 2	Pt. amal. spiral	...	0·9999	1·0000	1·0002	1·0002	Paste heated before setting up.
9	,,	,, ,,	...	1·0000	0·9998	1·0000	1·0001	
10	,,	,, ,,	...	0·9998	1·0000	1·0002	1·0001	
11	Nov. 30	Old form, free Hg	...	...	...	...	1·0000	Sulphate of mercury was made by heating excess of mercury with sulphuric acid.
12	,,	,, ,,	...	...	...	...	0·9998	
13	,,	,, ,,	...	...	...	...	0·9996	
14	,,	,, ,,	...	...	...	...	1·0000	Sulphate of mercury was made by treating mercury in excess with nitric acid, and afterwards precipitating the nitrate by addition of zinc sulphate.
15	,,	,, ,,	...	...	...	...	0·9996	
16	,,	,, ,,	...	...	..	...	0·9998	
Board of Trade Cells.								
B^1	Nov. 5	Pt. amal. spiral	...	...	0·9986	0·9990	0·9982	Prepared according to Board of Trade memorandum, using same material as for first 10 cells.
B^2	,,	,, ,,	...	...	0·9991	0·9993	0·9991	
B^3	Nov. 12	Old form, free Hg	...	...	0·9998	1·0000	0·9999	
B^4	,,	,, ,,	...	...	0·9993	0·9993	0·9992	
B^5	,,	,, ,,	...	...	1·0002	1·0002	1·0000	

The point, however, which has surprised me in the correspondence referred to is the almost general complaint that the reproduction of the cell is difficult, and can only be undertaken and satisfactorily carried out by experts. After a rather large experience with Clark's cells, and having set up scores, if not hundreds of them, both for commercial and experimental purposes, I may safely say that none of the batches of cells made have been unsuccessful, but I have never until a few weeks ago attempted to follow the slightly complicated instructions known as the Board of Trade specification, but have followed an older and simpler process, which is practically identical with that described by Mr. L. Clark in his original Paper "On a Standard Voltaic Battery," 1873.

A batch of cells more than 20 in number, of different types, has lately been made, using the same materials for all, but varying the process of preparation, particularly with regard to the sulphate solutions.

Zinc and Zinc Sulphate.—The $ZnSo_4$ and zinc rods were obtained at Townson and Mercers, and supplied as pure.

Mercurous Sulphate and Mercury.—The mercurous sulphate was rather old in bottle, as it had been in stock about 10 years, and was somewhat discoloured by the action of light; it originally came from Messrs. Hopkin and Williams, whilst the mercury was lately purchased from the same chemists and described as pure re-distilled.

Home-made Mercurous Sulphate.—"Home-made" sulphate of mercury, prepared as mentioned in the following table, gave equally good results, but the cells did not arrive at their now constant value for two or three days.

The mixing and preparation of the sulphates before setting up the cells was the same for all of the first 16 cells, but the electrodes of the cells were varied so as to include pure zinc and zinc amalgam as positive electrodes and free mercury, as well as amalgamated platinum spirals for negative electrodes. The cells B_1 B_2 B_3 B_4 B_5 were made with the same materials, but the preparation of the $ZnSo_4$ solution and the sulphate of mercury was strictly according to the memorandum of the Board of Trade on the subject. The cells newly made were "naked," and for this reason they followed the variations of temperature quicker than the standard (No. 120) which was "cased in." The following table gives the results of the comparison of these cells with the "standard."

The uniformity of the first 16 cells made leaves little to be desired, the maximum variation between each other is not higher than 4 in 10,000, or equivalent to the difference in E.M.F. produced by, say, 0·5°C.; they also compare, as is shown by the tests, with existing cells.

On the other hand, the five cells B_1, B_2, &c., made to the Board of Trade specification, were neither uniform nor constant, though for some days they have been gradually approaching to agreement amongst themselves, and to their proper value in volts.

The same cleanliness and care was taken with these latter cells as with the others, but perhaps the want of success attending the operation may be due to inexperience with the system of preparation advised by the Board of Trade.

Assuming that this is the case, and also that the precautions and instructions given in the memorandum are right and necessary, do experimenters and others succeed in producing either more uniform results or better cells than those referred to in the table of tests? In view of the recent correspondence the inference is that they do not, and, if this is so, may I suggest that those unsuccessful in reproducing the Clark cell satisfactorily on official lines should try the method mentioned in the original Paper?

I am aware that Lord Rayleigh objects to the boiling of the zinc sulphate, but I have never found ill results arising from the operation; in fact, in some cases cited here the zinc sulphate as well as the paste have been heated considerably over the limit prescribed by the Board of Trade.

In the course of these experiments the electrolytic method of amalgamating the platinum spirals (used in the portable form of cell) has been tried and found unsatisfactory; the heating of the spiral red hot and plunging into mercury is certainly efficient, but a simpler and more effective plan than either of these is to place the spirals in boiling mercury, or if the cells are already fitted with the platinum spirals, boil a little pure mercury in each cell—this secures perfect amalgamation.

The following tests of some Weston cadmium mercury cells made by the writer in 1892 may be of interest, and though they have not been treated with any particular care they are still in good order, their E.M.F. in true volts being as follows:—

B = 1·0197 T.V.	E = 1·0197 T.V.
C = 1·0197 T.V.	F = 1·0184 T.V.
D = 1·0176 T.V.	G = 1·0190 T.V.

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POWER UTILISATION AT ST. ANTHONY FALLS.

(BY OUR SPECIAL CORRESPONDENT.)

While going round the spacious and admirably equipped works of the General Electric Company at Schenectady, I saw in process of erection one of a set of ten large 1,000 H.P. generators, the construction of which for the magnificent power-house on St. Anthony Falls at Minneapolis is now nearing completion. I hope shortly to describe in closer detail the construction of these mammoth dynamos, but meanwhile it may be of interest to give some account of the utilisation of the water-power of the Mississippi river, which is now being made at St. Anthony Falls.

These falls, in their natural state, were a long series of rapid cataracts extending along nearly half a mile of the river. The upper and principal portion of the falls lies between the river banks and a small islet known as Hennepin island, and it is here that the earliest and most abundant utilisation of the water-power has been made. This part of the falls—as indeed is also the lower part, which is now about to be electrically utilised—is situated near the centre of the city of Minneapolis, and in the heart of an industrial district, thickly populated, which extends from Minneapolis to the "twin city" of St. Paul, the two cities practically forming one larger city. Minneapolis, as its hybrid name indicates, is a "city of water," and water-power has virtually created it. It is the chief grain-grinding place in the world, and the north-eastern bank of the river at St. Anthony Falls abounds with immense flour mills and gigantic grain elevators, for either of which class of works an enormous amount of power in the aggregate is required. This power has for many years past been obtained by means of turbines and water-wheels driven by the upper and chief of the falls, where there is an available fall of about 50ft. and a yield of from 50,000 to 100,000 H.P. Another important power-using industry is the sawing into planks of the immense volume of lumber floated down the Mississippi into the lumber mills principally on the south-western bank. Here the logs are raised from the booms, and are sawn into planks almost before they are quite out of the water. For working the band saws and other tools, as well as for handling the lumber and planks, a large amount of power is constantly required that doubtless might remuneratively be supplied from a central electric power station. It seems probable also that electrical power, derived from the principal fall, might advantageously be used to supplant the isolated water-power plants in the flour-mill and grain-elevator district, the very isolation and individualism of which plants would seem to proclaim their inferior efficiency. So far as I know no such complete consolidation of the various power-utilisation plants is yet in contemplation, though it cannot but forcibly commend itself to every engineer who is familiar with the nature of the problem. To how much greater advantage than at present might the Falls of St. Anthony be used were their power systematically collected and efficiently distributed! But the present scheme for the electrical utilisation of the Mississippi at this point, though actually of important magnitude, is comparatively small, since it contemplates the usage of only one of the smaller cataracts some quarter of a mile or so below the principal fall.

At this point there is an available head of about 20ft., and a flow varying from some 60,000 to a minimum of about 2,500 cubic ft. per second, the annual average flow being about 6,000 cubic ft. per second. The main part of the head of 20ft. was only to be obtained after the construction of a weir across the river, which, with the flow just mentioned, would develop an available power of 12,000 H.P. on the average, or a maximum of about 120,000 H.P. Apart altogether from the power-consuming industries already enumerated there exists in the twin cities a miscellaneous market for electrical power, one important prospective outlet being the extensive system of tramways. These lines, with the exception of six miles of cable track, are run by electricity from three steam-driven power stations, having an aggregate of 5,000 H.P. They are owned by a consolidation of several concerns, styled the Twin-City Rapid Transit Company. It is this powerful corporation which has leased from the St. Anthony Falls Power Company, for a period of 40 years, the lower cataract, and has developed it for the purpose of utilising it in place of the existing steam stations. The available power is, of course, far in excess of that required for the tramways, and it is intended to distribute the surplus for general use.

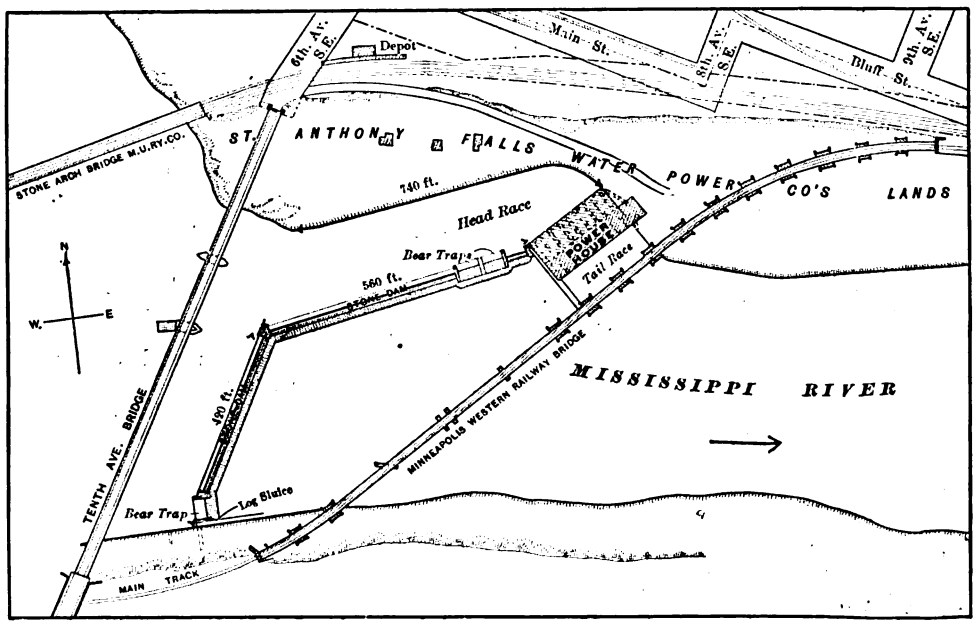

FIG. 1.—Plan of Hydraulic Works and Power House for the Utilisation of St. Anthony Falls, U.S.A.

The weir which has been constructed across the river for the purpose of developing this mill site to its fullest extent is substantially built of granite and blue lias, with stone crib work on the front face and a terraced or stepped face down-stream. Logs are passed over the weir when the river is in flood. Ordinarily, the main part of the weir is dry, but when the river is flooded it washes over the full width of the weir. To provide against excessive storm water three sluice gates have been constructed, while, in order that the lumber traffic may not be impeded when the sill of the weir is dry, two log chutes have been built, one on each side of the river. A good idea of the arrangement of the weir and, generally, of the mill site is given by the plan shown in Fig. 1. It will be seen that the weir is wedge-shaped, with the vertex set up-stream, the right wing measuring 560ft. and the left wing 420ft. in

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length. The right wing also serves as a retaining wall for the head race, which measures 600ft. long from the in-take to the forebay entrance to the wheel pits, the width of this race being 207ft. A view of the weir from the bank of the head race is given in Fig. 2, which clearly shows the position and general construction of two of the three sluice gates—the third being on the other side of the river—and of the entrance to one of the two log chutes. The gates at these passages are operated by hydraulic power, though it is not easy to understand why they are not worked by electric motors. One is reminded of another curious anomaly, viz., at the famous power station of the Niagara Falls Power Company, where

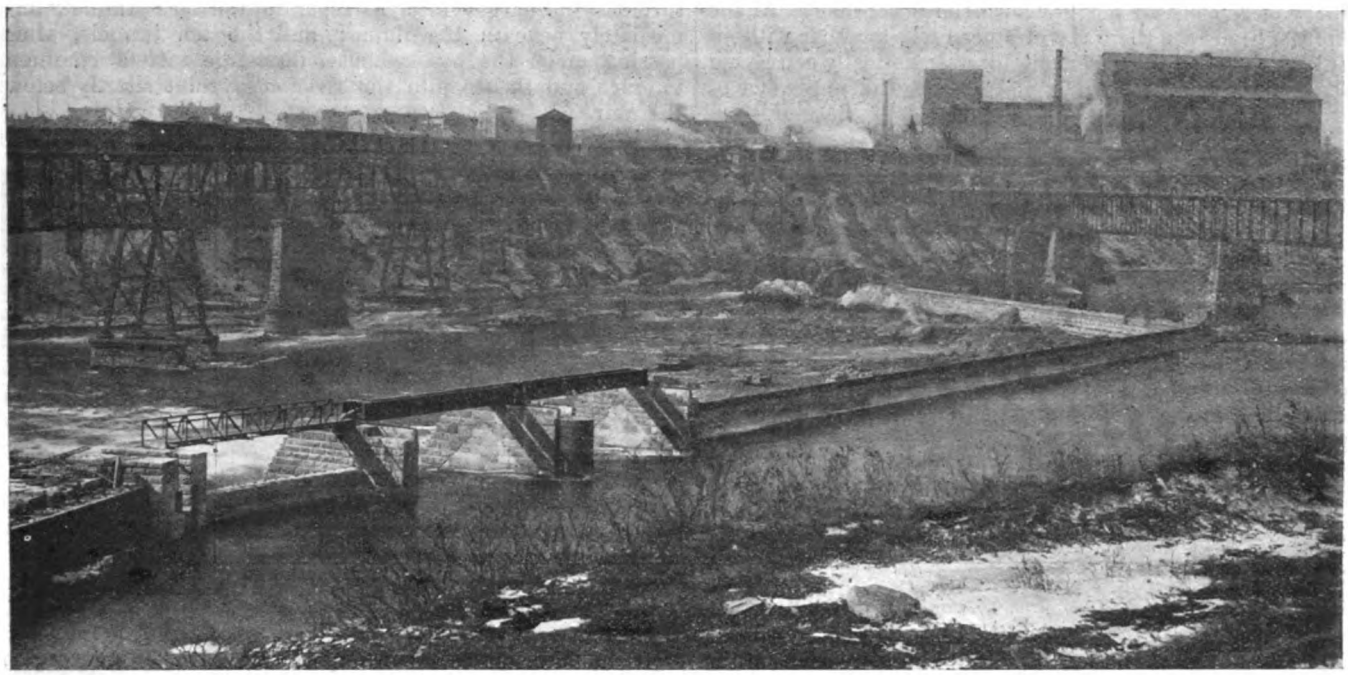

FIG. 2.—View of Falls, showing Masonry Weir and Sluice Gates, with Head Race in the Foreground.

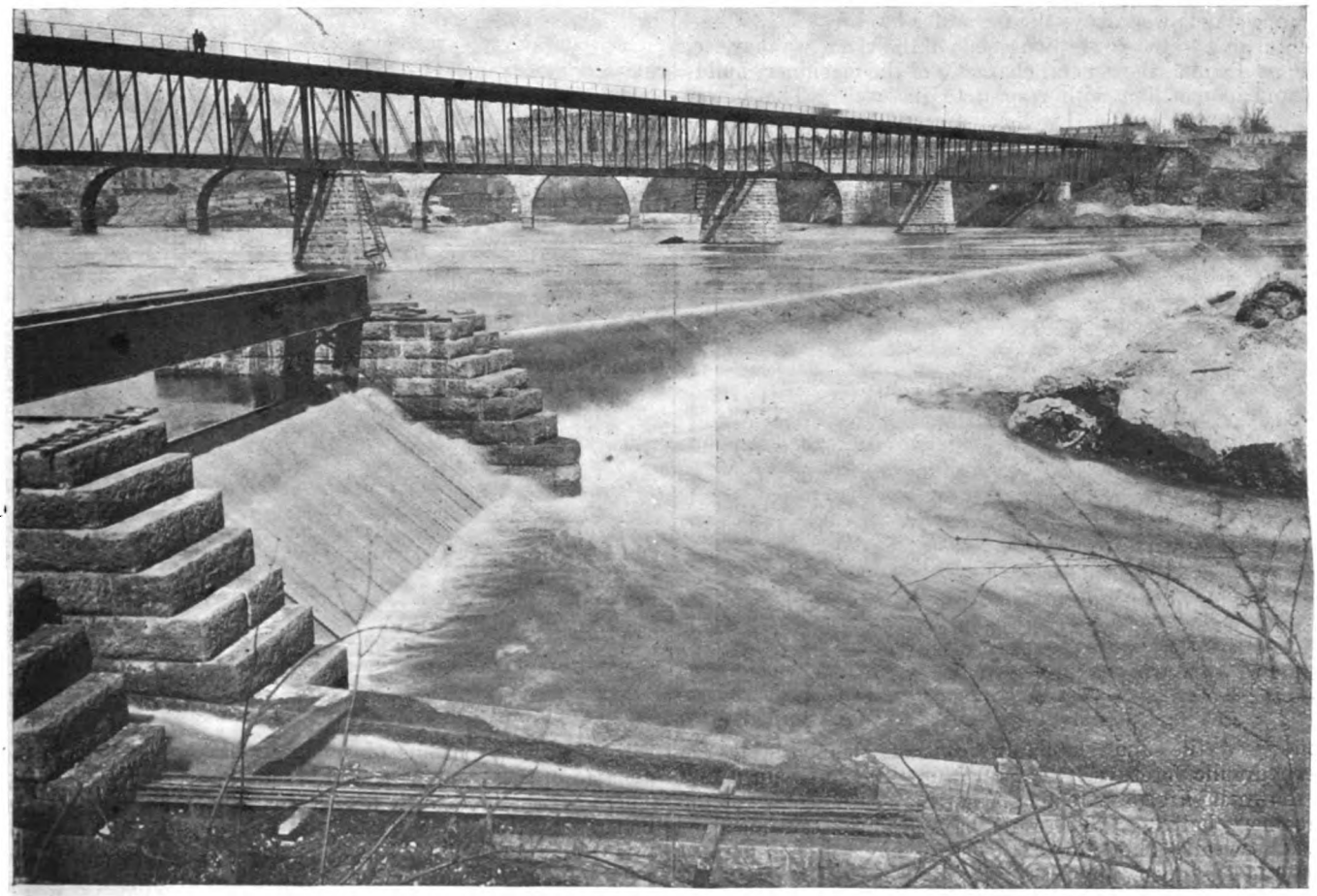

FIG. 3.—View of Falls, showing Masonry Weir and By-wash, with Log Chute in the Foreground.

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the current for operating the electric travellers in the machinery room is generated by—*steam!* The three sluice gates first mentioned are steel framed, with timber decking, and measure each 50ft. in width. They move between heavy masonry piers, 25ft. in height above the lower floor. At the end of the head race there is a strainer rack, together with an ingenious electrical arrangement for automatically conveying the accumulations of floating matter from the upper face of the rock, and discharging them over the top of the weir.

revolutions per minute. One end of this shaft passes through a bearing and stuffing box in the end partition of the flume and is direct-connected to a 1,000-H.P. alternator, built by the General Electric Company, of Schenectady. Each set of four turbines discharges into a separate tail-race tunnel, immediately beneath the flume; and the ten tunnels, after passing under the power house, discharge into a common tail-race and thence into the river at a point shortly below the weir.

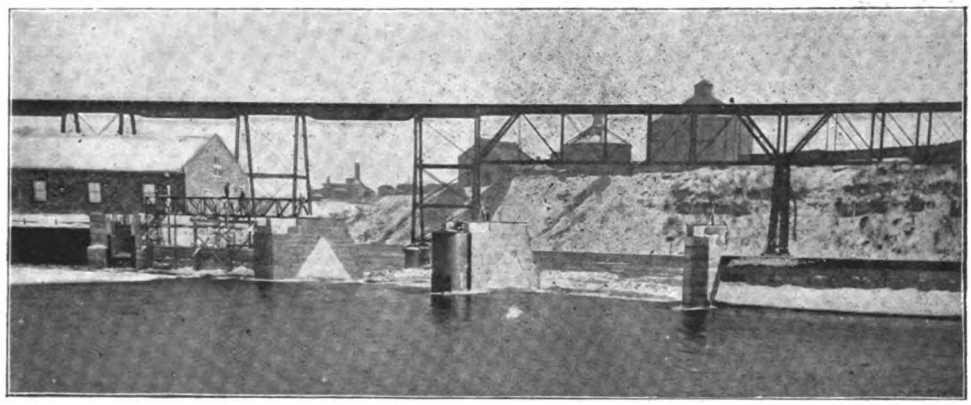

FIG. 4.—Power House and By-wash Sluice-Gates, viewed from the Head Race.

Fig. 3 is a view of the weir in flood, and is taken from the bank opposite to the power house. It shows the lower face of one of the by-washes at which the storm-water sluices are placed, as well as one of the lumber chutes. The river at the time this view was taken was not in flood, and the crown of the weir stands well above the top water-level.

Returning to the power house side of the river, we may see, in Figs. 4 and 5, the general character of the machinery building and its position with respect to the weir. The power house is a substantial and well-constructed building, 250ft. in length, 57ft. wide and 51ft. in height to the top of the roof, which is in a single span. The frame and roof girders are of steel, the main walls being of glazed brickwork and the

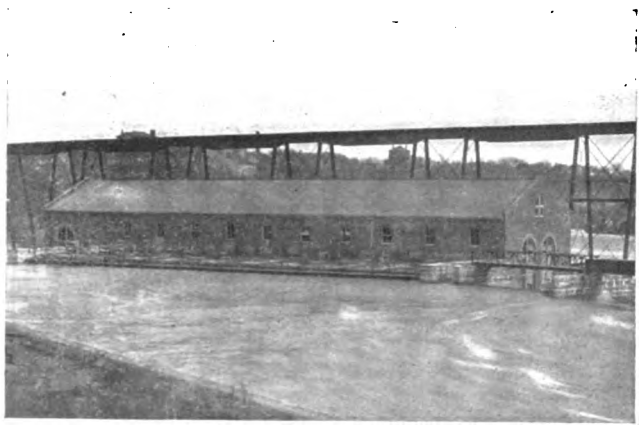

FIG. 5.—Full View of Power House from the Forebay.

roofing of tile and slate. In front of the building are the hydraulic forebays, which measure 40ft. in width, and as shown in Fig. 5, extend almost the entire length of the machinery building. These forebays lead to ten masonry flumes within the power house, which are separated from each other by masonry partitions 4ft. in thickness. At the end of each flume there is a partition measuring 7ft. 6in. in thickness, which separates the flume from the dynamo room. The water passes separately into each flume through two head gates, each 8ft. wide, which are regulated from above the roof of the flume, chamber. In each flume are four 250-H.P. "Victor" turbines, directly arranged on a horizontal shaft which runs at 180

It should be stated, as an important element in the design and construction of this station, that it is to be provided with a stand-by steam plant of equal capacity with the turbines. Thus it is intended to erect a 1,000-H.P. steam engine beside each alternator, on the side further from the turbines, and

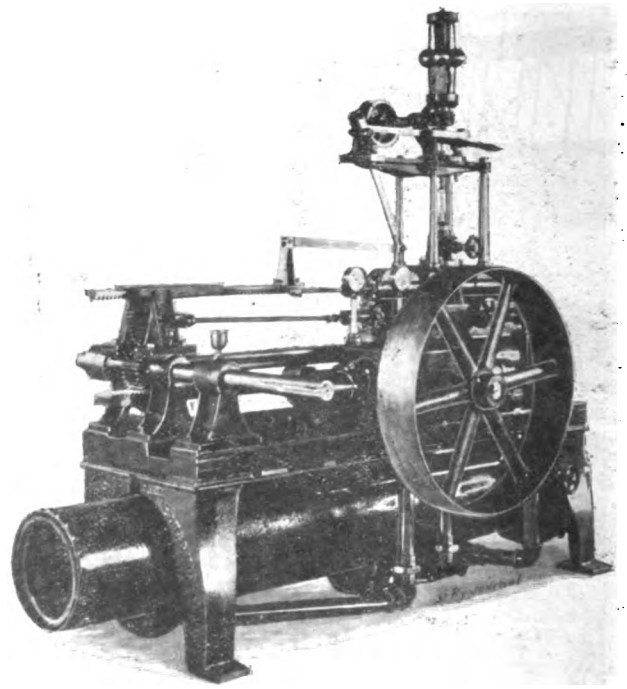

FIG. 6.—Turbine Governor at St. Anthony Falls Power House.

with a clutch by means of which it may be coupled to the dynamo in the event of water becoming scarce or freezing. There is therefore also necessitated a complete battery of boilers, and thus the capital outlay for plant is made to comprise all that would have to be expended for the equipment of any ordinary steam-driven station of the same capacity.

An important matter in an electric water-power station is the governing of the turbines. At more than one such station I have visited in America the practice of governing the turbines has been abandoned as a hopeless task, and, instead, the surplus power generated by the dynamos is absorbed in idle resistances. The engineers of the St. Anthony Falls plant, however, are more hopeful, and, following the

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example set at Niagara Falls, they have decided to equip their turbines with mechanical governors. The type of governor in use is shown in Fig. 6 It consists primarily in a centrifugal governor of the Pickering type, which directly controls a small hydraulic ram. This ram controls the distribution of water to a second ram, which in turn actuates a third ram, which acts directly upon the gate-moving gear. This governor is said to operate between full and zero load with only five per cent. variation in speed, and to act promptly when the load changes ; but it is difficult to see that such a lengthy chain of hydraulic cylinders will not cause delay and even hunting.

Speaking just now of the absorption of power by resistances reminds me to say that the power house I am describing is to be heated electrically in cold weather, and as much as 1,000 H.P. has been provided for this purpose, or, roughly, one-tenth of the capacity of the station.

To meet the varied conditions of distribution power is to be transmitted from the station at three distinct pressures, viz., at 12,000 volts for the long-distance three-phase circuits, at 3,450 volts for polyphase circuits of shorter radius, and at 600 volts for the continuous current for the tramways in the immediate neighbourhood. The continuous-current railway generators are to be operated in a manner similar to the alternators, these machines being direct-coupled to turbines on one side and to steam engines on the other side. For the highest pressure circuits step-up transformers are to be used, to transform from 3,450 volts—the standard pressure of the polyphase generators—to 12,000 volts, this latter pressure being used for the underground cable lines to St. Paul, a distance of about 10 miles. These transformers are of the air-blast type, the air being supplied by a blower driven by a small motor. There are six transformers in the present equipment, aggregating 1,400 kilowatts capacity. It is an important and praiseworthy feature of the system of transmission that all the feeder lines are to be carried underground. For this purpose covered cables in earthenware conduits will be used throughout.

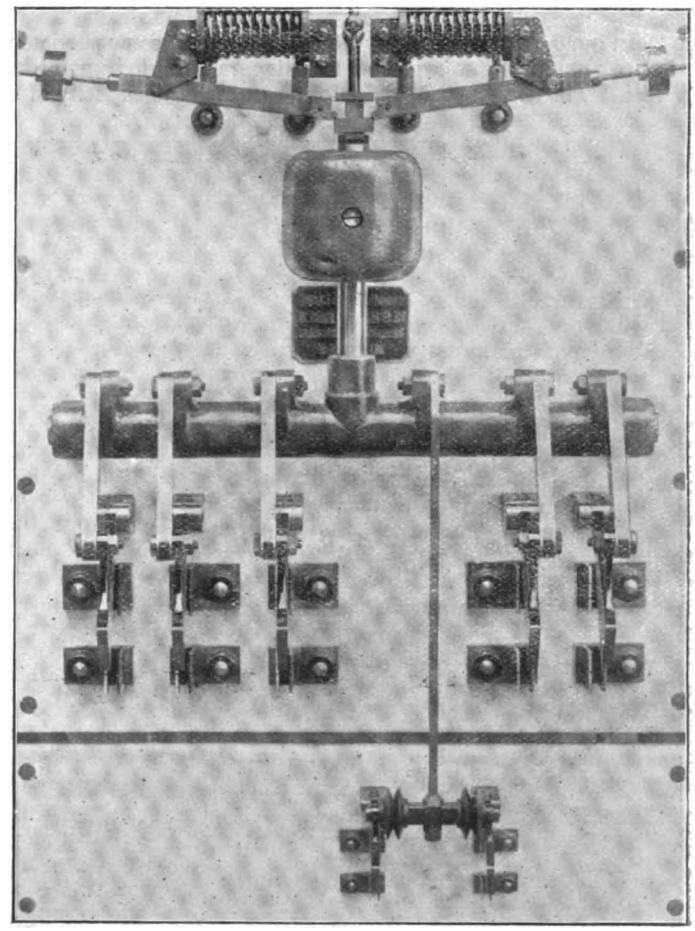
For the present only one sub-station is in course of construction at St. Paul, two sub-stations being provided for the district of Minneapolis. Each sub-station will be provided with step-down transformers and rotatory converters for the electric tramway supply.

It is stated that the entire construction and equipment of the St. Anthony Falls electric power plant will have cost, when completed, a sum of about £100,000, or approximately £10 per available horse-power—a figure which, if it really includes all the items of expenditure in the complete and full equipment of the station, is one that must be regarded as extremely moderate, considering the substantial nature of the work.

THE "WALTON" TRANSFORMER SUB-STATION CUT-IN GEAR.

The problem of controlling the number of transformers in circuit at a sub-station without the direct manual action of an attendant has been attacked in various ways, the most recent of which is that due to Mr. A. H. Walton, acting engineer to the Metropolitan Electric Supply Company. In some solutions of the problem the control of the sub-station is effected from the central station ; in others, the control is automatic, and entirely depends on the load on the sub-station. Mr. Walton's plan belongs to the latter of these two classes.

During the past week we have had an opportunity of seeing the "Walton" cut-in gear in operation at the Bayswater sub-station of the Metropolitan Electric Supply Company, where it has been working successfully for several months past. At this particular sub-station there are three banks of transformers, each bank feeding a separate distributing circuit. To each transformer in every bank that is to be automatically cut-in, *i.e.*, to all the transformers save one permanently-connected one in each bank, an automatic switch gear, shown in the accompanying illustration, is connected. From the illustration it will be seen that this apparatus has in all six switches —one double-pole switch for the primary, mounted on an independent marble base; two single-pole switches for short-circuiting the actuating solenoids after the switch is brought into action; and three for connecting the transformer on the low-pressure side of a three-wire system. The action is as follows: When the transformer permanently connected to the distributing circuit becomes overloaded beyond a certain pre-arranged amount the current in the solenoids, shown at the top of the illustration, increases, and usually it will increase in one more rapidly than in the other, owing to slight want of balance on the three-wire mains. The effect of this is to raise and tilt the detent which holds up the heavily-weighted lever, which is shown in the illustration in position ready to be released. As soon as the lever is released the weight falls forward, and throws the switches into circuit, the momentum of the weight serving to drive them well home. It will be observed that whereas the five upper switches are directly connected to a rocking shaft attached to the weighted lever, the two



The "Walton" Transformer Cut-in Gear.

lower switches are actuated by a link driven through a cam-plate from the rocking shaft. The effect of this arrangement is to delay the closing of the lower, or primary switches, the upper, or secondary switches being closed first and magnetising the transformer iron before the primary current is switched on, thus preventing an impulsive current rush into the primary coils. Three of the upper switches belong to the secondary 3-wire mains, the other two upper switches serving to short-circuit the solenoids when the transformer has been thrown into circuit, thereby silencing these solenoids and preventing any continuous waste of energy in them.

The action of each and every controlling gear in the bank of transformers is the same as described above, the gear being set so as to throw in an additional transformer when the load exceeds a certain percentage above the normal load. But although the "Walton" gear thus automatically cuts-in transformers, there is no provision for automatically cutting them out when the load falls, and at the Bayswater sub-station the cutting-out is done by hand by a man who resides on the

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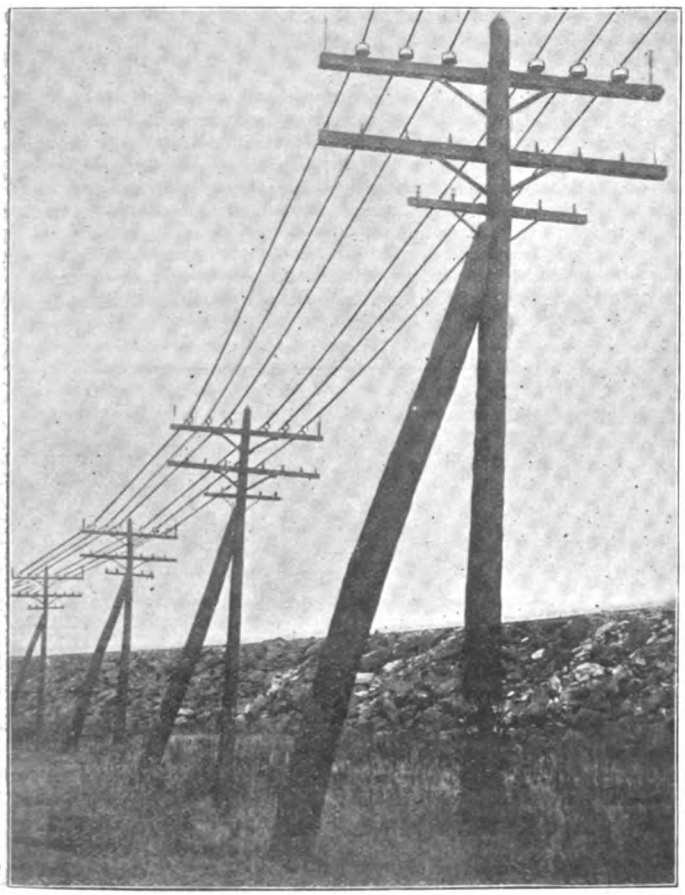
premises. Late at night, when the maximum load is past, or at any time of day after a heavy fog has lifted, the man pays a visit of inspection, and lifts the switches of as many of the transformers as may be deemed superfluous. Should he throw too many out of circuit the automatic gear will promptly remedy the error, and nothing worse than a transient overload on the transformers will occur in consequence. It is claimed that the inability of the gear to cut-out automatically is a distinct advantage, inasmuch as it secures the regular attendance and attention of the inspector.

We understand that these switch cut-in gears are about to be placed in several others of the sub-stations of the Metropolitan Electric Supply Company. The manufacturers of these gears are Messrs. Reyrolle and Co., of St.-Pancras.

THE NIAGARA-BUFFALO TRANSMISSION LINE.

In our "American Notes" on the 24th ult. some particulars were given of the enlarging of the Niagara-Buffalo transmission line. The three extra conductors, by which the capacity of the



A Portion of the Niagara-Buffalo Electric Power Transmission Pole-Line

line is doubled, were similar to those already working, being composed of 19 strands, making up a total cross-section for each cable of 350,000 circular mils, and to a weight of 6,000lb. per mile. The accompanying illustration shows the appearance of the line since the addition, which brings the total length of conductor up to about 156 miles.

BOOKS RECEIVED.

"A Trip to Venus." By John Munro. (London: Jarrold and Sons.) Price, 3s. 6d.

"The Tutorial Chemistry." Part II., Metals. By. G. H. Bailey. Edited by William Briggs. (London: W. B. Clive.) Price 3s. 6d.

A MEANS OF DIMINISHING THE ENERGY LOSSES IN ALTERNATING CURRENT TRANSFORMER DISTRIBUTION.*

An interesting article on this subject by Mr. Alfred Schlatter, manager of the large alternating-current central station at Budapest, is published in the *Polytechnikai Szemle*, of September 1, 1897, and Mr. Schlatter's position makes his practical deductions of considerable importance.

It is generally admitted that alternating-current transformers are the simplest in construction of all transformers of energy, and at the same time the most economical in their working, for the loss in such apparatus may be less than 3 per cent. It is true that such high efficiencies can only be obtained in transformers for large power and on condition of their working at full load; but even in transformers for very small power the efficiency seldom falls below 92 per cent., and there are very few mechanical constructions which give such a good result. Moreover, the general use of the transformer in long-distance energy transmission is due not alone to the high efficiency, but also to the fact that the apparatus requires absolutely no supervision.

In practice, however, transformers work very little at their maximum loads. In fact the majority of alternating-current transformer distributions have been established for lighting service, and the motors driven from the system represent but a small fraction of the power supplied. Thus the time and duration of the full load varies for different days and seasons, although the system must always be capable of supplying the maximum current. This can, in ordinary practice, only be attained by leaving the transformers continuously connected to the mains with a consequent continuous loss of energy. We will examine the influence of this permanent loss on the mean efficiency of distribution during a certain period, for instance one day. It is found in practice that the work done by a central station during a day corresponds approximately to that which would be done by running on full load for two hours. The following figures are worked out on this assumption for transformers of various sizes:—

I. *Ten-kilowatt Transformer:*—Provides daily a useful energy of $2 \times 10 = 20$ kilowatt-hours, during which time the power absorbed is

(*a*) Useful energy	20·000	kilowatt-hours.
(*b*) Iron losses	5·520	„ „
(*c*) Copper losses	0·310	„ „
(*d*) Losses in the meter	0·864	„ „
Total energy absorbed	26·694	„ „

Corresponding to an all-day efficiency of 75 per cent.

II. *Five-kilowatt Transformer:*—

(*a*) Useful energy	10·000	kilowatt-hours.
(*b*) Iron losses	3·720	„ „
(*c*) Copper losses	0·170	„ „
(*d*) Losses in the meter	0·576	„ „
Total energy absorbed	14·466	„ „

All-day efficiency, 69·2 per cent.

III. *2·5-Kilowatt Transformer:*—

(*a*) Useful energy	5·000	kilowatt-hours.
(*b*) Iron losses	2·280	„ „
(*c*) Copper losses	0·090	„ „
(*d*) Losses in the meter	0·288	„ „
Total energy absorbed	7·658	„ „

All-day efficiency, 65·2 per cent.

IV. *One-Kilowatt Transformer:*—

(*a*) Useful energy	2·000	kilowatt-hours.
(*b*) Iron losses	1·560	„ „
(*c*) Copper losses	0·040	„ „
(*d*) Losses in the meter	0·288	„ „
Total energy absorbed	3·888	„ „

All-day efficiency, 51·5 per cent.

These figures have been calculated from the results of tests communicated by Messrs. Ganz and Co., and set forth in the table below. The losses, *d*, are those in the shunt coil of the meter; a meter absorbs 12 watts. As statistics show that, on an average in transformer distribution, the number of meters is double the number of transformers, three meters have been allowed for in the case of ten kilowatt transformers, two per five-kilowatt transformer, and a single meter for each of the smaller sizes:—

Size of transformer (kw.).	Joule losses per cent.		Iron losses.		Efficiencies per cent.		
	Primary.	Secondary.	Per cent.	Watts.	Full load.	Half load.	Quarter load.
1·0	1·0	1·0	6·0	65	92·7	83·6	80·0
2·5	0·8	1·0	3·6	95	94·8	92·2	86·6
5·0	0·6	1·1	3·0	155	95·4	93·4	88·6
10·0	0·55	1·0	2·2	230	96·2	94·8	91·3

* From *L'Industrie Electrique* of October 25, 1897.

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Thus it is seen that if these four types be employed in equal numbers on a network, the all-day efficiency will be on an average 65·2 per cent. This value deduced from the preceding figures agrees well with the results of practice. Such an unfavourable efficiency (although it is not bettered in any other system of distribution) increases sensibly the coal consumption at the central station, but it does not affect the general expenses until the number of transformers exceeds a certain limit. This limit is attained when the current required by the transformers at no load exceeds the normal output of one machine at the generating station, when it would be necessary to keep an extra machine running in parallel with the others, and the net efficiency of the distributing system would be reduced as the losses in the extra unit would have to be taken account of.

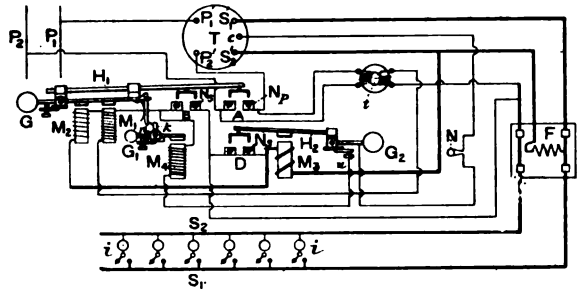

FIG. 1.—Connections of Automatic Switch for one Transformer.

Different methods have been tried to increase the all-day efficiency. First of all the proportions of the transformers were modified so as to obtain a better all-day efficiency with a lower full-load efficiency. Then the number of transformers was diminished, particularly the number of smaller transformers. In this way one was led to abandon the most natural form of this distribution system—that of isolated transformers with one primary network, and as many secondary stations as there are houses or groups of houses to supply—and to adopt the system of distribution by means of sub-stations, the district of supply being divided into a certain number of independent agglomerations, each of which is fed by a bank of transformers. This latter system is very advantageous, in that besides employing transformer units of larger size, one can vary the number of the units working so as to maintain only the number strictly necessary in circuit, and thus have them

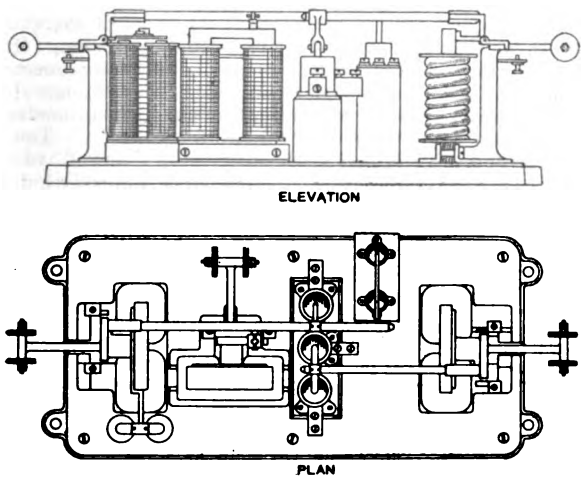

FIG. 2.—Automatic Switch for one Transformer.

working under the best conditions of efficiency. Nevertheless this system is still far from furnishing the greatest economy to be exacted from the point of view of work spent on magnetisation; besides the consideration of the critical number of transformers applies as well in this case as in the case of isolated transformers. In fact, the only way to reduce the energy lost in a transformer during the day to its least value is to disconnect from the circuit any transformer when it is not necessary for feeding the secondary network. The idea is old, and since the days of the first applications of alternating currents attempts have been made to construct automatic switches for transformers. The duty of such an automatic switch is to connect the primary of the transformer to the circuit as soon as the smallest current is required from the secondary, and to disconnect the primary so soon as the last current-consuming apparatus is disconnected. A switch of this type should allow daily and yearly efficiencies to be obtained approaching the full-load efficiencies; at the same time the critical load whose importance we have noticed would be avoided.

The apparatus devised by Mr. Alfred Schlatter have been working with very good result during the last 18 months. There are two different types of apparatus according as they are required for single or for a battery of transformers. Figs. 1 and 2 represent the single transformer switch. In Fig. 1, P_1 and P_2 are the primary conductors, and S'_1 and S'_2 the secondary conductors. T is the transformer in question, and t is a small auxiliary transformer whose primary and secondary windings are in series with the corresponding windings of the transformer T. M_1, M_2 and M_3 are electromagnets with different windings, and, in consequence, different coefficients of self-induction. The armatures of these electromagnets are fixed to the levers H_1 and H_2 to which

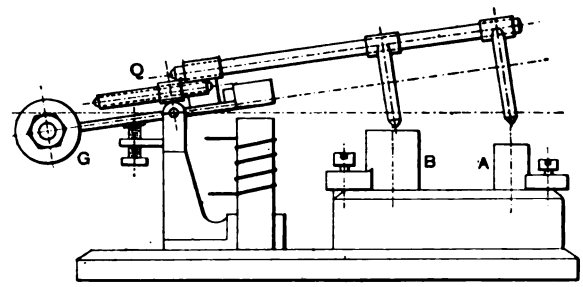

FIG. 3.—Automatic Switch for a Bank of Transformers.

bridging-pieces are attached for bridging the mercury cups A, B and D; $n\,k$ is an escapement movement whose action will be explained presently; G, G_1 and G_2 represent counter-weights; N is an incandescent lamp in the circuit of the electro-magnet M_4; c is an intermediate terminal of the transformer, say at 50 volts; and F is the shunt-winding of the meter. The lamps and other apparatus fed by the secondary are shown at $i\,i$.

At no load the transformer is not quite disconnected, but the apparatus reduces the no-load loss by about 95 per cent. by confining this loss almost entirely in the transformer t. This auxiliary trans-

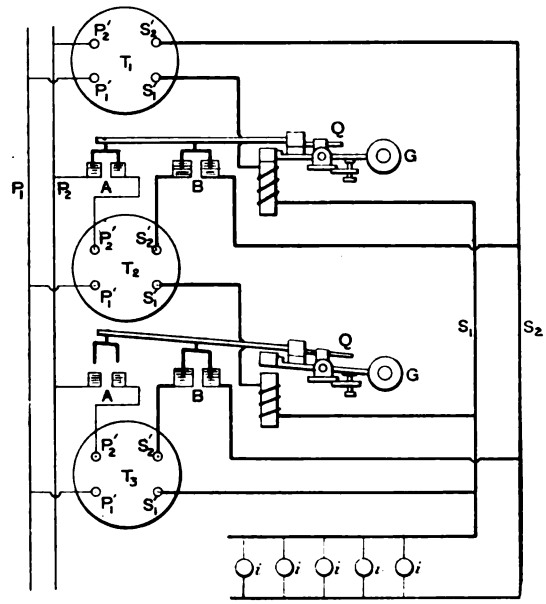

FIG. 4.—Connections of Automatic Switches for a Bank of Transformers.

former has, in fact, very little iron, and most of the power furnished at no-load is absorbed by it. If a lamp is switched on in the secondary circuit $i\,i$, the two transformers, t and T, in series supply the necessary current. On tracing out the connections it will be seen that the electromagnet M_1 is thereupon energised, the lever H_1 is pulled down, short-circuing each pair of mercury cups, A and B. A short-circuits the primary of the transformer t, and B short-circuits the secondary of this transformer through the magnet M_1. The transformer T is thus alone in action. The beam H_1 remains down by the action of the electromagnet M_2, the latter being traversed by the current feeding the lamp circuit $i\,i$, and the electromagnet is so wound that it holds down H_1 for the weakest current in the secondary circuit. The beam will thus only rise again when the secondary current is zero. The path of the secondary current at no-load is $t\,S_2\,i\,S_1\,T\,M_3\,M_1\,t$, and, when the auxiliary transformer is short-circuited, $T\,S_1\,i\,S_2\,B\,M_2\,M_3\,T$.

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In its simplest form, with two electromagnets M_1 and M_2 only, the apparatus is not suitable unless the power required in the secondary circuit is small and the section of copper on the secondary network is large enough to render the fall in volts inappreciable. In the case of larger secondary loads the pressure at the lamp terminals is kept constant by the use of a number of electromagnets M_2, M_3 . . . M_n, in series of different coefficients of self-inductions, these magnets being traversed by the secondary current. They and their counterweights are so regulated that each of the levers H_1, H_2 . . . H_n is only attracted for a fixed value of the secondary current, the lever attracted in each case short-circuiting the preceding electromagnet. It is seen that in this way a practically constant secondary pressure is obtained if account is taken of the differences in the inductances of the electromagnets.

Fig. 1 shows how this system is applied with two electromagnets. M_3 is so wound that it can only attract the lever H_2 when the load is large enough to cause, on account of the impedence of M_2, a fall of potential greater than that permitted. As soon as H_2 desceds the magnet M_2 is short-circuited, and in consequence H_1 tends to return to its normal position. This return is, however, prevented by the escapement nk. The latter consists of two parts, a detent, n, fixed to the beam H_1 and pushed outwards by a spring, and a finger K fixed rigidly to a lever controlled by the electromagnet M_4, this only engaging when the magnet M_4 is not energised. Now current passes around M_4 as soon as the transformer T is in action ; but it is seen that the circuit of M_4 is broken at u directly the lever H_2 begins to move by the attraction of M_3, that is to say, just before M_2 is short-circuited. M_4 also serves to counteract the influence of rushes of current which might take place at the moment of connecting the transformer T_1, and prevents them from releasing the lever H_1. This is accomplished by the invertion of an incandescent lamp N in the circuit of M_4 so that the current through it does not immediately attain its full value when the transformer T is put in circuit.

The apparatus just described is suitable for sub-stations in which there is only one transformer, or a group of transformers which are to be connected to the circuit *en bloc*. The switch shown in Figs. 3 and 4 is used in the case of a bank of transformers when it is desired to connect them to the circuit one after another. In the diagram of connections (Fig. 4) it is assumed that the first transformer T_1 is permanently connected to the mains, and that the others T_2 and T_3 are only to be switched on successively when the normal load on the transformers already in use is exceeded. An electromagnet is connected in series with each transformer, and when the current through it reaches the fixed maximum value it pulls down the lever shown in the diagram, and connects on the new transformer at the mercury cups A and B. This seems very simple, but there is one difficulty. As soon as the current through the first transformer reaches the maximum fixed for it, the beam is pulled down ; but immediately the second transformer is switched on the load is divided between the two, and the beam would again be released, then again attracted, and thus continue to oscillate backwards and forwards. This is, however, eliminated by the addition of a glass tube, Q (Fig. 3), closed at both ends and containing a certain quantity of mercury. In the initial position of the lever the weight of the mercury assists the counterweight, but as soon as the beam goes over the mercury runs to the other end of the glass tube, keeping the beam down in spite of the diminution of the current. The weight of the mercury is such that the first lever is only released when the current through the electromagnet is a little less than half the normal current, when again one transformer is sufficient.

THE BEHAVIOUR OF ARGON IN X-RAY TUBES.*

BY PROF. H. L. CALLENDAR, F.R.S., AND N. N. EVANS.

In continuation of some experiments made by Prof. Callendar in the early part of 1896, the authors have studied the behaviour of argon in X-ray tubes of various types. The phenomena presented by a tube filled with carefully-dried and purified argon are in many respects peculiar, as compared with those presented by other gases under similar conditions. In the early experiments above mentioned it had been our custom to keep the X-ray tube connected with the pump, which was used as a reservoir of dry air during long exposures. The gas, which was absorbed by the working of the tube at a high vacuum and a long equivalent spark-gap, was restored from time to time, as the vacuum became too high, by letting a little air in from the pump by means of a convenient tap. In this manner it was possible to operate the tube at a very high rate of efficiency for two hours or more at a time. These long exposures were required for some experiments on the velocity of the X-rays, which have been described in a communication to the Canadian Royal Society, May, 1896. It was noticed on several occasions, after one of these long exposures, that there was considerable blackening and sputtering of the electrodes, and also that the pressure of the air in the tube had increased considerably above the degree of vacuum required for the production of X-rays when the tube was first exhausted. After allowing the tube to rest for a few hours, although there was very little increase in the pressure, it was also observed that no cathode rays were produced until the discharge had been passed for some time. It appeared probable that some of these effects, which are recorded in the Paper above mentioned, were due to the accumulation of argon in the tube. The spectral lines of that gas were on some occasions faintly discernible in parts of the tube, but no systematic spectroscopic observations were taken. In making further investigations on the behaviour of argon we hoped to find that, owing to its natural inertness, the vacuum would be of a very permanent type as compared with other gases. We also hoped that its monatomic character would afford features of interest.

For the preparation and purification of the argon used in these experiments the Cavendish spark method was adopted, as described by Rayleigh and Ramsay. For this purpose a special transformer was constructed, the primary and secondary of which were wound on different parts of the core. The primary was connected to the 100-volt lighting circuit. The secondary gave 10,000 volts on open circuit, available for starting the arc, but the voltage on the arc when running was only 2,000. The secondary could be short-circuited, owing to the arrangement of the winding, without materially increasing the current, or running any risk of burning up the coil. The apparatus could thus be left running safely by itself day and night without wasting any power on resistances. After concentrating the argon to about 60 or 70 per cent. in the flask, it was further purified in a test-tube apparatus, constructed so as to contain the minimum of liquid. The excess of oxygen was sparked off with hydrogen, and the residue removed by absorption with alkaline pyrogallate. The argon thus purified was kept in a bulb containing P_2O_5.

In the first set of trials of this argon in X-ray tubes, a Fleuss mechanical pump was used which permitted very rapid exhaustion of the tubes, but had no arrangement for measuring the high vacua. The vacuum was estimated in these cases by the appearance of the tube and the width of the dark space. The first tube tried had two aluminium electrodes, and had been lying open to the air for some time previously. It was exhausted and washed out two or three times with dry argon, and then sealed off at a good X-ray vacuum. Each operation occupied only two or three minutes, and the vacuum has since that date deteriorated slightly, probably owing to insufficient removal of residual gas from the electrodes, but it still gives sufficient light to see the bones of the hand. The tube during exhaustion presented exactly the same appearances, except in colour and spectrum, as if it had been filled with air. The second tube had been worked up to a sparkless vacuum some weeks previously, and had been frequently renovated by heating. It had an aluminium cathode and a platinum anode. It was connected to the pump and exhausted as soon as possible after opening. It was then filled with dry argon up to a pressure of one-fifth millimetre, and exhausted to an X-ray vacuum five times in succession. The glow on the cathode inside the dark space showed the F line of hydrogen, and also the C line more faintly. These lines probably indicated the elimination of hydrogen from the electrodes, especially the cathode, as they became fainter with each repetition of the process of washing out.

At the sixth filling of the tube the pump was worked for ten strokes only. The cathode then began to sputter and blacken the tube, and the argon was apparently absorbed, as the discharge refused to pass in 3min. Fresh argon was again admitted, the coil was left running, but *the pump was not worked at all*. The spectroscope this time showed only blue argon without any trace of hydrogen. The concave aluminium cathode sputtered violently and partly melted down. In less than 2min. the discharge refused to pass through the tube, which was then sealed off. The coil used in these experiments was a very small one, which gave a 2in. spark with difficulty when running on a large 8-volt battery.

The next tube upon which we experimented was a double-focus tube, containing two aluminium cathodes and a platinum anti-cathode. This was washed out with argon and exhausted eight times with the 2in. spark coil running all the time. The direction of the discharge was frequently reversed, but no trace of absorption could be observed. The argon lines always disappeared, and the hydrogen lines, especially F, became faintly visible inside the cathode, as the tube approached an X-ray vacuum. The tube at each exhaustion gave fairly bright X-rays, and showed no blackening or sputtering. The hydrogen lines showed more brightly close to the cathode than in the body of the tube, where the argon lines were most conspicuous. The hydrogen appeared in fact to be coming out of the metal. The glass walls of the tube were in a very dry state, as it had been previously heated and exhausted.

Finding that we could not get rid of the residual hydrogen with the coil, we had to resort to the alternating current, which we had previously found very effective in tubes with double electrodes. It

* Paper read before Section A of the British Association, at Toronto.

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appears that the elimination of hydrogen takes place chiefly, if not entirely, at the cathode. With the first application of the alternating current the hydrogen lines showed extremely bright. The tube was then exhausted. In fifty strokes the discharge refused to pass. On refilling with argon to a pressure of one-tenth of a millimetre, the blue glow inside the dark space showed only argon and no hydrogen. The pump on this occasion was not worked at all, but the gas apparently was absorbed, and the discharge refused to pass in about 3min. There was some sputtering of the electrodes and blackening of the tube, but the aluminium, although blistered, was not melted. The experiment was repeated twice with the same results. On reconnecting the tube to the 2in. spark coil, the same absorption was observable but less rapid. The electrodes were larger, and were less heated than in the case of the first tube.

We concluded from these and similar observations, of which the above may be taken as a sample: 1. That the hydrogen occluded in the cathode played the part of carrier of the discharge from the metal to the gas. 2. That if there were sufficient occluded hydrogen, there would be little or no sputtering of the aluminium. 3. That when no hydrogen was present the discharge was conveyed from the cathode by particles of the metal itself, which were capable of exciting fluorescence of the glass, and of generating X-rays wherever they impinged, behaving in fact as cathode rays. 4. That in X-ray tubes, as usually exhausted, without excessive precautions for the drying of the gases, and the complete removal of residual hydrogen from the electrodes, the residual gas was in most cases hydrogen or water vapour.

In order to test the behaviour of other gases as compared with argon, similar experiments, in the same tubes, were made with dry air, with hydrogen, with oxygen, and with water vapour. With dry oxygen and nitrogen, the absorption of the gas was very rapid at a pressure of one-tenth of a millimetre, if the electrodes were sufficiently heated. Although hydrogen was not observable and was presumably absent, the blackening of the tubes was very slight, and a much greater power could be applied than in the case of argon, without melting the electrodes. With water vapour under the same conditions an X-ray vacuum could not be obtained (owing probably to the slowness of diffusion), unless the tube were considerably heated, either with a flame or by means of an excessive current. On allowing the tubes to cool under these circumstances, the vacuum improved very greatly, owing to absorption by the surface of the glass, and the discharge often refused to pass. Under steady conditions of running at a low temperature, there was no clear evidence of absorption of the water vapour, in spite of the drying tube on the pump. With carefully dried oxygen, under the same conditions, the process of exhausting the tubes with the mechanical pump was extremely rapid as compared with the other gases, owing to the greater velocity of diffusion of the lighter gas. With the smaller tubes ten or twenty strokes were sufficient to give brilliant X-rays, starting in each case with a pressure of half a millimetre to a millimetre. There was no marked absorption at any stage of the vacuum, and no trace of sputtering of the electrodes. We expected to find some evidence of absorption by the electrodes or the platinum anticathode, but it is possible that these became saturated with gas very rapidly at an early stage, and ceased to absorb gas at an X-ray vacuum. We concluded that hydrogen was the most suitable gas to use in X-ray tubes, but it is possible that helium, being also a very light gas, might be equally good, if its inert or monatomic character does not lead to the disintegration of the electrodes in the same manner as in the case of argon.

If the great resistance to the passage of the discharge from the cathode to the gas in the case of argon is dependent upon the monatomic nature of the gas, it might be expected that similar phenomena would be observed in the case of mercury. Some mercury vacuum tubes were therefore made in the form of inverted U tubes. The electrodes were liquid surfaces of mercury in each limb, to which connection was made by short pieces of platinum wire, which did not project above the surface of the mercury. These tubes were exhausted and boiled with an alternating discharge passing, until more than half the mercury had distilled over. They then presumably contained only mercury vapour. When cool, the 2in. spark discharge refused to pass at first, but if the tube were tilted for a moment, so as to expose the platinum wire, it appeared that sufficient gas was liberated to enable the discharge to pass without any difficulty. The tubes showed only the mercury spectrum. In the high resistance state, immediately after boiling, the cathode limb, with a larger spark coil, showed brilliant fluorescence and feeble X-rays. We concluded from these experiments that a very small trace of another gas was sufficient enormously to reduce the resistance of a mercury vapour tube, and that if the vapour could be obtained quite pure, it would possibly not conduct at all.

To verify more accurately the conditions of vacuum at which these phenomena occurred, the whole apparatus was subsequently connected to an automatic Sprengel mercury pump to which a McLeod gauge was attached. The pump and all its connections were carefully tested for leakage, and the drying tube was filled with fresh P_2O_5. We had found in previous experiments of a similar character, made two or three years previously, that sulphuric acid, however carefully prepared, gave off appreciable quantities of water vapour, which would have been quite sufficient to vitiate these results. Using a large coil and a slow mercury break, to avoid overheating the tubes, we found that fairly efficient X-rays were obtained in most of the tubes at an average vacuum of 0·006mm. if the tubes were exhausted in the ordinary way without taking special pains to remove the hydrogen. The H lines always showed faintly in the cathode light before this vacuum was reached. After using an alternating discharge to heat the electrodes, and carefully washing out the hydrogen as far as possible with argon, we found that the pressure corresponding to an X-ray vacuum gradually increased up to 0·030 mm. Before letting the argon into the tube it was allowed to remain 10 or 15 minutes in contact with the fresh P_2O_5. On omitting this precaution and admitting the argon direct from a bulb containing an old sample of P_2O_5, which was beginning to deliquesce on the surface, it was necessary to raise the vacuum to 0·015 mm. before X-rays were produced. On the other hand, the sudden addition of dry argon at this stage up to a pressure of 0·029 produced no change in the appearance of the tube. It is probable that we never succeeded *entirely* in eliminating the residual hydrogen, but we concluded from these and similar experiments that the presence of the argon by itself had little, if any, effect on the production of X-rays, since the amount present in the tube could be varied within wide limits.

We next endeavoured to ascertain at what degree of vacuum the apparent absorption of the argon previously observed could be reproduced. For this purpose we used two tubes of the double-focus pattern, and an alternating discharge. Taking the first tube slightly damp from the blowpipe, we exhausted it to one-fifth millimetre vacuum with the mechanical pump. The discharge was then turned on and adjusted to heat the tube and electrodes as much as possible with safety, *and the pump was not further worked.* Under these conditions the remaining water vapour was rapidly expelled and absorbed by the P_2O_5; the tube soon showed a brilliant hydrogen spectrum followed by green fluorescence, the anti-cathode became red hot, then cooled, and in 15 minutes the discharge (20,000 volts) refused to pass. The tube was not appreciably blackened. On connecting to the direct-current discharge, it gave brilliant X-rays. This case is interesting as showing that a very good vacuum may be obtained in these cases by simple absorption. Dry argon was then admitted into the tube up to a pressure of 0·160mm. At this pressure, in tubes 3in. in diameter, with the direct or alternating current, the tube was filled with blue light, and gave a spectrum which was verified to be that of blue argon, without any visible trace of hydrogen or nitrogen. After running the direct and alternating current through the tube for half an hour, the tube became very black, but there was no change in the pressure as measured by the gauge. It should be remarked that in measuring these high vacua, the pump was usually stopped to allow time for the equalisation of the pressure throughout the apparatus. The alternating current in the primary of the coil was only 2·5 amperes with carbon, whereas 4 amperes had been used with air. The latter current, if used with argon, would have melted up the cathodes. Finding no absorption at this pressure, the pump was started to run very slowly, and the same alternating discharge was continued. The sputtering of the electrodes rapidly increased, and at a vacuum of about one-tenth of a millimetre the upper electrode suddenly melted off. Another tube was then tried, but met with a similar fate at the same degree of vacuum. The failure was so sudden that it was difficult to control the current in time. If the argon is actually absorbed it is clear that the phenomenon depends upon very special conditions of temperature and discharge. It is possible that the absorption is only apparent, and corresponds to a very sudden increase of resistance to the discharge at a particular degree of vacuum, such as occurs in an ordinary X-ray tube when the boundary of the dark space reaches the anticathode. With greater care it may be possible to decide this point, but an unfortunate accident to our water mains prevented further investigations at the time. It is clear, however, that the behaviour of argon is peculiar, and it seems probable that most of the ordinary cathode ray phenomena are due to residual oxygen.

Electrical Distribution in Foreign Government Workshops.—The administration of the Austro-Hungarian state railways has decided, says the *Elektrotechnische Zeitschrift*, to introduce electrical distribution of power in their workshops at Laun, Lemberg, and Salzburg. The three-phase system is to be used, the plants being respectively of 60, 100, and 120 H.P. The three equipments are to be supplied by the firm of Kolben and Co., of Prague, the generators being of the inductor type, with direct-coupled exciters, and the pressure being 200 volts.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Dec. 31, 1897.*

Greater New York.—At midnight to night a score of cities, towns and villages, including New York, Brooklyn and other adjacent places, will cease their independent existences, and become a part of the Greater New York. The passing of the old to the new will be celebrated with great festivities to-night. The scene of this celebration will be City Hall Park, New York City, where great preparations have been made to render the occasion a memorable one. Coloured electric lights, search-lights, &c., will form a very conspicuous part in the celebration, and exactly at midnight the new flag of the Greater New York will be hoisted for the first time above the City Hall. This will be accomplished by the aid of electricity, and the unfurling of the colours will be done by the Mayor of San Francisco more than 3,300 miles away. It is proposed to carry out this interesting event by the closing of an electric circuit at San Francisco by the Mayor at the instant it is midnight in New York City. This current impulse will set into operation an apparatus connected with the flagstaff; the halyards will be unloosened and drawn taut, and the new flag will thus be displayed for the first time by the invisible force controlled by San Francisco's mayor. At the same moment 37 search-lights of an aggregate power of 30,000 c.p. each, placed on the high buildings around City Hall Park, will flash out and concentrate all their rays on the new flag. In this connection it will be interesting to give some statistics regarding the new municipality, particularly those relating to its electrical features. The area of the new city will be 360 square miles, and the population 3,300,000, making it the second largest city in the world both as to area and population. The surface railways in New York City represent a total track mileage of 280 miles. This service is almost entirely controlled by the Metropolitan Street Railway Company, which operates its principal lines on the cable and underground conduit systems. During the past year underground conduits have been laid along Eighth, Second and Madison-avenues, and the remainder of the long lines will be similarly equipped within the next year. In Brooklyn borough the surface system comprises 400 miles of track, and is operated entirely on the overhead trolley method. There are operated on these lines about 1,500 motor cars and 900 trailers. The power is supplied from four generating stations, one of which is famous for the size of its generating units. Two units of 1,500 kilowatts capacity each are now being installed in this station. The total rated capacity of the four stations is 16,000 kilowatts, and the coal consumed per annum is over 75,000 tons. On Staten Island, which becomes a part of the city under the name of Richmond borough, there are two electric railway systems with 58 miles of track and 148 motor cars. The length of electric railway track in the greater city, therefore, aggregates in round numbers 650 miles. The lighting interests of the new city are, of course, very large. The total number of isolated plants is 775, with an aggregate generating capacity of 46,000 kilowatts, supplying 475,000 incandescent lights, about 3,000 private arcs and 11,000 H P. for motors. The largest of these plants is that of the Astoria Hotel, recently completed, with 1,200 kilowatt generating apparatus at 110 volts, besides a large storage battery. The number of lights in this great building is 10,000. The telephone service of the new city is controlled by two companies, the New York Telephone Company alone having 13 central offices and 25,000 stations. It has over 50,000 miles of single-wire measurement underground lines, besides some 6,400 miles of overhead wires. All circuits are metallic. The annual number of calls on the Company's lines is estimated at, approximately, 41,600,000.

A Relic from the Patent Office.—Another instance of the delays that may be effected in the prosecution of a patent case in the United States Patent Office, and of the worthlessness of such a patent when issued until adjudicated by the courts, is instanced in the set of patents issued December 21, 1897, to the assignees of Rudolf M. Hunter. One of these has a record date of 1883 and the other two 1887. The first of these patents covers generically the whole field of alternating-current working, using transformers for stepping down the voltage. The other patents made various detailed claims in step-up and step-down arrangements, the multiple use of transformers, &c., but all contributory to the first-named patent. If such patents as these can be sustained by the courts and allowed a life of 17 years from December 21, 1897, it is certainly time that some radical change were made in the American patent system.

Interior Wiring.—An interior electric cable, embodying new ideas in construction, has recently been brought out in this city. The purpose of the cable is to provide fire protection as well as to be available for other purposes, such as bells, telephones and other signals. The new concentric thermostat cable, as it is called, consists of a central core of fusible wire, sometimes with a copper centre. Around the fusible wire is a wrapping of insulating material. With this insulated core may be any suitable number of bare conductors, all being enclosed in an exterior braid. The central core of fusible alloy-wire melts at a low temperature—about 370°F. Any moderate fire, therefore, in the vicinity of the cable will easily generate sufficient heat to accomplish this. When the temperature in the neighbourhood of the cable has reached the melting-point of the central core, the latter liquefies, and by its expansion is immediately forced through the fibrous insulating covering, short-circuiting any two or more of the conductors with which it is concentrically surrounded and thereby transmitting the signals. The outer wires are so wound that each is carefully insulated from the others, and they may be used for an automatic fire-alarm signal or for any other signal transmission purpose. Such cables, containing from two to six conductors in addition to the central core, are now being manufactured by the Montauk Multiphase Cable Company, of this city. The peculiar advantages resulting from the use of this combination electric cable will be appreciated in wiring a building for bells, telephones, annunciators, or any other similar purpose. The cable may be used with but slight additional expense, and not only run to and between the devices of the signal system, but also run throughout the various rooms that are to be protected from fire. The same company has developed a number of electrical circuit arrangements for this continuous fire-alarm cable, by means of which the concentric wires are used for various telephonic and telegraphic signals, and at the same time serve as fire-alarm wires to be acted upon by the melting of the central core, as above described.

CORRESPONDENCE.

DR. FLEMING'S FERROMAGNETIC HYPOTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Although I read Dr. Fleming's interesting lecture on the above subject at the time of its publication, it is only recently that I have had an opportunity of studying it carefully—hence my tardy reference to it.

In the first column on p. 83 of your issue of November 12, 1897, Dr. Fleming states that "increase of temperature, although it decreases the magnetic moment of each of the molecular magnets *per se*," &c., and lower down the same statement is repeated.

In the case of the four-atom molecule conceived by Dr. Fleming, an increase of temperature, *i.e.*, of angular velocity of rotation of the molecule, would result in an *increase* of magnetic moment—so long as the four atoms can be held together. The statement quoted would, therefore, seem to be misleading.

On the other hand, if the breaking-up of one four-atom into two two-atom molecules is referred to it seems hardly correct to say that the moment of *each* molecule is diminished.

But perhaps my interpretation of Dr. Fleming's meaning is entirely wrong!—Yours, &c., ALFRED HAY.

University College, Liverpool, Jan. 8, 1898.

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ELECTRIC LIFTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice a letter on this subject in this week's issue of your Paper in which my name appears. I designed the travelling motor and screwed spindle arrangement as a direct result of some work I did for the Brush Electrical Engineering Company (Limited) in 1893. They had taken up the manufacture of the Otis elevators, and it was my business to put through into the shops the electrical portion of the work for the various sizes, and I have still a very distinct recollection of the "box of tricks" which constituted the controlling gear. If the motor travelling with the cage has no other advantage, it at any rate will not require quite so many jim-jam arrangements to keep it in order.—Yours, &c., E. KILBURN SCOTT.

Gartmoor Gardens, Wimbledon Park, S.W., Jan. 5, 1898.

ELECTRIC TELEGRAPHY WITHOUT LINE WIRES BY MEANS OF HERTZ WAVES.*

BY G. W. SELBY, M.I.E.E.

The memorable researches of Hertz made in 1887, 1888, and 1889, most probably originated in many minds the idea of wave telegraphy without line wires, but the difficulty of observing sparks or detecting very rapid electric oscillations in tuned Hertz resonators, even at distances of 50ft., formed an apparently insuperable barrier to the use of this method over any but very moderate distances. Many able workers on the Continent and in England have since verified and extended Hertz's discoveries, and the apparatus for generating the waves (the oscillator it is called) has been constructed in innumerable forms by the various workers. Description of these oscillators will be found scattered through the *Proceedings* of the various learned societies. That telegraphy by means of waves was possible first seriously occurred to me upon reading Lodge's 1894 Lecture before the Royal Institution "On the Work of Hertz and Some of his Successors" (see *The Electrician*, June 15, 1894), but I was for a time deterred from carrying out any serious experiments by pressure of business. Dr. Lodge described a Banly coherer, and also the cohering of two metal pole-pieces under the action of electric waves when they were included in the circuit of a galvanic battery, and pointed out their great sensitiveness. Lodge's lecture was in my opinion most valuable and suggestive, for although he did not use the word telegraph nor suggest the possibility of signalling over any but very moderate distances, he nevertheless outlined the apparatus in principle, for he not only showed the sensitiveness of the coherer in its then crude form, but suggested decohering by means of an electric bell.

At any rate a partial solution of the difficulty seemed at hand, and after reading an account of Branly's experiments in the *Journal de Physique* for 1892, I set to work to see if I could not collect some of the wave energy for the purpose of converging it upon a tube of filings, or coherer as Dr. Lodge called it. With this end in view I tried various resonators, including tuned wire circles and suspended metal plates. After a lot of trouble I found that strips of copper of 2in. or 3in. in width, if held in a wooden support in a room adjoining the one in which the oscillator was at work, would freely spark to a piece of aluminium sheet or copper held in the hand, and that the sparks were most easily obtainable from the ends of the strips. The collectors, as I call them, were suspended horizontally and fairly parallel to the dumb bell oscillator used, which had solid brass spheres 2in. in diameter. Large copper globes of 12in. diameter and brass plates of 60 cm. square were also used to generate waves as well as many other forms. The action of the large spheres seemed to me especially powerful. The spark gap employed was about $\frac{3}{4}$ cm. in air, in oil less. Eventually I kept to the dumb bell type for experimenting, as being handier and taking up much less room than the larger patterns. I decided to employ copper strips as collectors, silver being expensive and hard to obtain of the size I wanted for experiments. Ultimately I succeeded in getting sparks with the copper strips up to 45ft. and even 50ft. through three 9in. brick walls. The coil used was a large 16in. by Carpentier of Paris, which I have had for many years.

A report that Tesla was at work on the problem, and that Preece was trying to telegraph by means of induction between parallel wires, induced me to persevere, and with the assistance of my friend, Mr. Stormont, I set about confirming and extending my experiments. As a preliminary I thought I would try whether I could detect any electrical oscillations by connecting a telephone to the copper strips, using an intermittent contact, and fancied I was obtaining results right out of the house and down an adjoining road, but the clearness of the sounds with increasing distance led me to doubt their cause, and I discovered they were due in some way to the contact of the telephone terminals with my hands. I have not had time to track this source of disturbance to its cause, but it did not appear to be due to thermoelectric currents, as it made no perceptible difference to the sound if the body was included in the circuit. This proving a "mare's nest" the coherer was again tried.

Tubes 8in. to 10in. long by about $\frac{1}{8}$in. diameter were filled with iron borings. Branly had tried filings of many metals in 1890, sometimes imbedding them in resin or Canada balsam, and found a thickness of even 3mm. sensitive. The Branly-Lodge coherer proved unworkable with a relay, for although I could easily get it to work sufficiently well to send the spot of light from the mirror of Deprez D'Arsonval galvanometer flying off the scale, it took no end of time to get it into the sensitive state, and decohering generally necessitated the whole process being repeated. I found it most sensitive, as Lodge observed, when just a shade of current passed. Tubes of various sizes were now made having one of the metal pole-pieces, between which the filings were placed, movable, so as to allow of adjustment of pressure by a screw; these were all unsatisfactory, whatever filings were used, but the smaller tubes proved the most manageable. Capillary tubes were tried and silver pole-pieces turned to fit, and filings of all degrees of coarseness, and of steel, nickel, brass, german-silver, platinum, gold, silver, and copper, with and without mercury; sensitive cells were obtained, but all sorts of troubles arose in working, and the filings would joggle under the action of decohering between the glass and pole-pieces. There were so many disturbing factors that I had a tube made of small bore about $\frac{1}{8}$in., and having a movable pole-piece as usual so that I could try all thicknesses of filings. Trouble with the movable pole-piece proved an insuperable objection, but this tube satisfied me that an extremely small gap gave the best results. I then tried making coherers out of microscope cells of $\frac{1}{8}$in. to $\frac{1}{16}$in. depth with threepenny and sixpenny pieces for pole-pieces, and ultimately, by fitting one of the pole-pieces inside the cell with cement, a gap of as little as $\frac{1}{32}$in. was tried.

A somewhat larger gap gave the best result. The pole-pieces were at first held together by spring clothes pegs, afterwards by an ebonite clip, and decohering was effected by tapping with the blade of a small screwdriver on one of the wires leading from the pole-pieces. In one case the coherer rapidly increased in sensitiveness as it was knocked for decohering, until it worked an ordinary unpolarised relay at 20ft. with a Clark gas-lighter. On looking for the cause of this result I found one of the pole-pieces did not fit well and nearly all the filings had joggled out. So very few filings were to be used instead of many, and a very small gap instead of a big one. Not succeeding in making lasting glass cell coherers owing to difficulties with cements, want of roundness of tubes, and creeping of filings, ebonite cells were tried with much better results, but, as I expected, the filings rapidly deteriorated, I presume by combination with the sulphur. Having devised a sensitive and fairly reliable coherer, I fitted up the apparatus before you to-night on the top of a glass insulating stem, and having an electric bell to decohere with as suggested by Dr. Lodge.

Then commenced fresh troubles, for cells which decohered perfectly when tapped with anything held in the hand absolutely refused to be decohered by the bell. This trouble was tracked to the spark at the contact breaker of the bell, and was successfully obviated by so adjusting the contact screw that the spark occurred before the clapper struck the coherer. Shunts were then made of suitable resistance to annul the spark both of the bell and relay. The announcement now reaching the Colony that Preece and Marconi had succeeded on this very method compelled my publishing my results, which, though later in date, were obtained independently. The experiments of V. V. Lang, E. Aschkinas and Carl Fromme, described in *Wiedemann's Annalen* for 1896, Vols. XLVII. and XLVIII., should also be mentioned. These men confirmed Branly's results, and E. Aschkinas showed that if a piece of tinfoil is pasted on glass and slit with a knife into two portions, one portion being then connected to one pole of a battery and the other through a galvanometer to the other pole, cohering followed the action of electric waves. Carl Fromme failed to notice any movement of the filings under the microscope while cohering, and concluded that the movement, if any, took place too rapidly for observation.

The filings in loose order have practically an infinite resistance, and upon cohering this falls to a few ohms. All observers have noticed this. Embedding filings in wax and paraffin has been tried, and they are found highly sensitive to changes of temperature, if metal pole-pieces are inserted in the solid mass, the approach of the finger causing a strong deflection of the galvanometer needle. The German experimenters justly voted the coherer, in the Branly and hitherto tried forms, an extremely capricious instrument. I advise no one to waste time over it in the form exhibited and described by Dr. Lodge in his 1894 lecture—at least,

* Paper read before the Royal Society of Victoria, at Melbourne, Sept. 9, 1897.

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to telegraph with. The instrument finally devised by me before the arrival of the description of the Preece-Marconi apparatus is extremely simple; it consists of a piece of hard fibre with a small hole bored right through it, in which are fitted metal pole-pieces from an eighth of an inch down to about a tenth or twelfth of an inch in diameter, made of silver wire, or brass or copper wire, with or without silver pole-pieces soldered on. The filings I prefer are nickel and silver, or nickel and gold, or steel and silver, or steel and gold. The best results have been obtained by me with nickel and steel filings, both of high-resistance metals and magnetic, and a trace of silver or mercury. The employment of mercury naturally suggested itself, previous experimenters having already recorded the cohering of mercury globules under the action of electric waves. In employing mercury to increase sensitiveness one is apt to use too much rather than too little; the merest trace suffices.

Coherers were also constructed and enclosed in glass tubes, afterwards exhausted with a Geissler pump, but though rendered more durable, the improved result did not appear to me to warrant the extra labour involved, for ordinary use. Some of the many forms of coherer devised are exhibited here to-night. A magnet coheres the magnetic metals. Very fine filings, though extremely sensitive, are unreliable for many reasons, one of which is the adhering in a layer to the glass or other tube employed. I have not noticed any action of lightning upon my coherers during a distant thunderstorm. Perhaps it was not near enough. Some of the coherers are sensitive to the oscillations generated by an electric-bell circuit at six yards, and I have repeatedly worked my instrument at a distance of 50ft. with a Clark gas-lighter, and at a distance of 25ft. through a brick wall or wooden door. Employment of spark gaps in oil instead of air increases the energy of radiation from three to four times, according as vaseline or petroleum oil is used.

I also tried carbon granules; they act, but appear electrically too sensitive to sound or other mechanical disturbances. In my opinion all obstacles, including wood, brick walls, and trees, absorb some of the energy. Metal screens stop the waves if they are absolutely prevented from creeping in through any air chink. In my opinion this system, or that of Preece and Marconi which is practically the same, will not be of wide practical application in its present form. The energy must, if possible, be directed by reflectors or other means yet to be discovered. For military and naval purposes for communicating in a building, or to a ship in distress, the system should prove valuable.

With regard to the copper wings or collectors I have only tuned roughly. I find signals come through even if great changes are made in the size of the wings, but wings there must be. It was Branly who, so far as I know, first noticed that a prolongation of the pole pieces increased the range of sensitiveness of the instrument.

I now show with a Clark gas-lighter that there is some sort of earth return which enables the signals to be transmitted to much greater distances. Any Hertz oscillator will work. I have tried most of them, if not all.

Those who have worked at this subject will, I think, admit after seeing it work that the coherer as devised by me is a vast improvement upon the Branly form. Credit is due to Marconi for attaining a good form of this instrument; he has employed it over much greater distances than I have yet had the time to do. Judged by the account of the Marconi instrument in the *Electrical Review* of July 16, 1897, my receiver appears four times as sensitive. I trust this brief account of my experiments may not have been uninteresting to electrical men, and that it will save fellow-workers much waste of time. Once found out, these things appear so simple that it is hard to realise the immense labour involved in working out problems like this, where there are so many unknown and disturbing factors. What can be a more simple apparatus than this piece of hard fibre, with its few filings and two metal wires for pole-pieces? But it represents months of night work. By means of some such method as this of mine I am firmly convinced we shall be able to communicate with our friends at sea on board ship, while to ring up a friend within a radius of two or three miles who carries a receiver on his back or may be in his pocket will be an easy matter, unless he solders himself inside a metal box.

Summed up, a complete sender comprises an induction coil and Hertz oscillator, with spark gap either in air or oil, according to distance to which signals have to be sent, a telegraph key, and the usual interrupter. The receiver comprises a coherer of one of the forms shown, together with the lateral appendages or wings described; this is inserted with a single Leclanché or balloon Daniel, and a polarised or ordinary relay. The relay, by means of a few Leclanché cells, operates the decoherer; a small electric bell answers; but it would be better to do as Messrs. Preece and Marconi have—namely, make a specially small clapper worked like a bell clapper; I intended doing so, but had not time. In series or derivation with the bell can be placed an ink writer or sounder. The ink writer is the best. The series of knocks can be split up by the sender into Morse signals, or single knocks can be sent and a code of numbers used. By all means put the filings in a vacuum or in some inert gas, if the coherers are for permanent use; mine are all right after a considerable lapse of time, but they decrease somewhat in sensitiveness at first, owing probably to oxidation. One batch of filings made proved quite unworkable; they were made with a greasy file. After that experience I washed the files in warm soda and water, well washed them in hot water, and dried rapidly. Coherers of silver alone or other good conducting metal cohere too readily to work with such an electromotive force. Platinum and gold mixed did not give me results at all comparable to the mixtures preferred. If I have omitted reference to other workers it is through not recollecting them. As most of the apparatus exhibited was made by myself it is somewhat rough in appearance but nevertheless works fairly well. A telephone in circuit with the coherer and battery will, of course, detect partial cohering before the relay works, as also will a sensitive galvanometer.

I should like to try Minchin's photo electric cells.

In case it has not been already recorded I mention here that two copper strips or any metal strips, *held in the hands*, near a Hertz oscillator will spark vigorously if the edges are brought near together. This in itself proves the enormous frequency of the oscillations. If one end of a coil of wire of a hundred or so ohms resistance wound so as to avoid self-induction is brought almost in contact with one side of the coil break a spark will pass to it, the other end being insulated. I noticed this in trying to get rid of the break spark by shunts. If too much battery is employed, cohering will frequently take place of itself. This takes place with only two Daniel cells. I generally have from 1,000 to 1,500 ohms in circuit with the coherer, including the relay resistance. In making coherers keep the filings and the walls of the tube they are to touch as clean and dry as possible, and avoid contact between filings or pole piece and the fingers.

The sounds heard on the telephone I have since traced to the inclusion of the body in circuit with a telephone. The experiment is performed as follows: join one terminal of the telephone to a copper wire, hold the other metal terminal in the hand, the telephone being held to the ear, now bring a piece of aluminium held in the other hand and make a light dragging contact with any part of the copper wire to which one terminal of the telephone is fastened, a creeping noise is heard due to a current of sufficient E.M.F. to work the telephone diaphragm through the body. It is generated apparently by the contact of the aluminium or other metal with the skin. The telephone terminal was nickel-plated.

The coherer in its present or a somewhat similar form should prove a powerful aid to research. Bringing an electrified ebonite rod near the wings of the coherer or waving it about does not cause cohering unless a small spark passes, when cohering instantly follows. An ordinary Voss machine works the coherer well through walls. It is chiefly the small sparks inside the gas lighter that are operative, the same applies to the electrical machine; it is the sparks at the brushes and collectors to which the coherer is most sensitive.

In conclusion, may I remark that this latest step forward will prove another instance of the benefit mankind ultimately derives rom pure research carried out by the world's scientific devotees?

LEGAL INTELLIGENCE.

Kaye v. The Croydon Tramways Company.

An action was heard by Mr. Justice Kekewich in the Chancery Division on Tuesday, in which a shareholder in the Tramways Company sought on his and other shareholders' behalf for an injunction to restrain the Company and its Directors from carrying out an agreement for the sale of the tramways undertaking to the British Electric Traction Company (Limited) on the ground that the agreement provided for the payment of certain sums of money to the Directors and officers of the Tramways Company. Counsel for the plaintiff stated that, in addition to the purchase-money of £30,543, the British Electric Traction Company undertook by its agreement to pay £3,250 to the Directors and officers of the Company, of which £1,250 went to the chairman, £500 to the secretary, and £500 to each of the Directors, as compensation for the loss of five years' remuneration. The purchase money was calculated so as to pay off the Preference shareholders in full, and to repay 60 per cent. of the capital to the Ordinary shareholders, the Traction Company taking over the Debenture debt and the contracts, engagements, and liabilities of the Tramways Company. It was contended that the purchase money was inadequate, but the main ground of complaint was the provision for the payment of a lump sum to the officers of the Tramways Company. On behalf of the defendants it was urged that the time was approaching when, under the provisions of the Tramways Act, 1870, the Corporation of Croydon, as the local authority, would be entitled to purchase the undertaking of the Tramways Company, and that the Corporation would exercise their power of purchase and refuse to grant a lease unless the line were relaid and electric traction substituted, and that the price which the Tramways Company would receive on the basis of the decision of the House of Lords in the "Edinburgh Street Tramways Company's case," was very considerably less than the sum which the Traction Company was prepared to pay, and would probably leave no return whatever to the ordinary

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shareholders. A resolution confirming the agreement was, notwithstanding the opposition of the plaintiff, passed at an extraordinary general meeting of the Company duly convened. It was, however, alleged that the notice convening the meeting did not sufficiently call attention to the terms of the purchase, and to the fact that under the agreement the shareholders in the Tramway Company would be liable to defray the costs of their liquidation.

His LORDSHIP, in giving judgment, said that if the agreement were binding on the dissentient shareholder it must be on the ground that the extraordinary general meeting of the Company had adopted it so as to be binding on him, and for that purpose it was necessary that the Court should be satisfied, not only that the matter was one which could properly be brought before the meeting, but that it was, by advertisement or otherwise, duly brought to the attention of the shareholders. In the present case the notice appeared to be erroneous and wanting in precision. The notice stated that the price to be paid would pay off the Preference shareholders and return 60 per cent. to the Ordinary shareholders. But from the sum, which was calculated at the rate of 60 per cent., there would have to be deducted certain costs and expenses, and there was no guarantee in the agreement that the 60 per cent. should be returned intact. Again, the time of the notice as to the taking over of liabilities by the purchasing company did not show whether the selling company would or would not remain in any way liable, or whether there would be a complete novation. The notice also stated that as the Directors of the purchasing Company were desirous of having the management in their own hands, the Directors and secretary had agreed to retire on being paid a lump sum for their loss of office. As a matter of fact they were to receive a very large sum, which was a considerable percentage on the sum which was to be paid to the Ordinary shareholders, but the notice did not give any information as to the amount. He (his lordship) was not satisfied that the agreement was read and explained at the meeting, and he thought there was sufficient reason for holding that the resolution was not binding on the dissentient shareholder. He therefore came to the conclusion that under circumstances such as existed in the present case it would have been beyond the powers of the Company, as against a dissentient shareholder, to pass a valid resolution voting to their officers remuneration which was not required for the benefit of the Company, and that it was impossible for the Directors and secretary to make such provision for their own benefit. In those circumstances he should grant an injunction.

E.P.S. Company v. Tomkins.

At the City of London Court on Monday the Electrical Power Storage Company sought to recover from the defendant, Mr. Tomkins, County Hotel, Canterbury, £2. 4s. 6d., being the railway fare and expenses of a journey of one of their engineers to Canterbury to examine a battery belonging to defendant. In July the defendant wrote and requested plaintiffs to send an engineer to examine a battery, and as the contemplated work was not given to them they were now claiming for an allowance for their workman's time and expenses. The defence was that there was but one contract: the plaintiffs were to send down an engineer to see the battery, and then to give an estimate to put it into repair. Mr. Registrar Wild held that the defendant was bound to pay plaintiff's charges, which, in his opinion, were reasonable.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Offic not later than first post Thursday morning. New Catalogues Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published at the end of this month.

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System o Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net, 2s. 9d. post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will, as usual, be published at the end of this month. Many new features of interest to the profession will be introduced, and all the usual important articles, &c., which have made the book indispensable to the industry, will be brought up to date and amplified where necessary. Subscription and advertisement orders, new names and addresses, and alterations to existing entries should be sent in promptly.

Tenders Invited.—The Stockport Corporation invite tenders for the supply, delivery and erection of the following plant at their electricity generating station in Millgate :—

(*b*) Two mild-steel Lancashire double-flued boilers, with brick settings, smoke flues, dampers, &c.

(*c*) Three sets of steam dynamos, with their foundations, beds, trenches, &c.; also a feed-water heater of 150 H.P. nominal, a 6-ton overhead traveller, two feed pumps, steam, exhaust, water pipes, &c.

(*d*) A storage battery of 136 cells, of 750 ampere-hours' capacity, with stands, switchboard, &c.

(*e*) Electrical instruments and other apparatus upon the general switchboard and elsewhere, electrical connections between machines, &c.

(*f*) Underground armoured cables, street boxes, &c.

Our advertisement columns contain further particulars, and plans and specifications may be seen after Monday next at the office of the consulting engineer (Mr. James N. Shoolbred, C.E.), 47, Victoria-street, Westminster, S.W., or at the Millgate Gasworks, Stockport. Tenders must be sent, addressed "Chairman of the Electric Lighting Committee, Gas Offices, Millgate," by noon of Thursday, the 27th inst. Mr. Walter Hyde is town clerk.

——— The Wimbledon Urban District Council invite tenders for the supply and erection of (*a*) water tube boilers, pumps, &c.; (*b*) condensing plant, steam pipes, &c.; (*c*) overhead crane; (*d*) high-speed steam engines and alternators; (*e*) switchboard; (*f*) underground mains, conduits, &c. Further particulars appear in our advertisement columns, and copies of specification, forms of tender, &c., may be obtained at the office of the consulting engineer, Mr. A. H. Preece, A.M.I.C.E., 39, Victoria-street, Westminster, S.W. Tenders must be sent to the clerk to the Council (Mr. W. H. Whitfield), Council's offices, Wimbledon, not later than 5 p.m. on Feb. 2.

——— It will be seen from our advertisement columns that the Corporation of Blackburn require tenders for a 500 kilowatt continuous-current steam dynamo and a 120 kilowatt steam alternator. Specifications, &c., may be obtained at the offices of the engineers, Messrs. Lacey, Clirehugh and Sillar, 10, Delahay-street, Westminster, London, S.W. Tenders must be lodged at the offices of the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by Saturday, the 22nd inst.

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Tenders Invited.—The Corporation of West Hartlepool invite tenders for work in connection with their electric lighting station, including:—(1) boilers and mechanical stokers, (2) engines, dynamos, &c., (3) storage battery, (4) switchboard, (5) arc lamps. Some further particulars are given in an advertisement on another page, and copies of the specifications, &c., can be obtained from Mr. Higson Simpson, town clerk, Town Clerk's Office, West Hartlepool, to whom tenders must be sent in not later than Monday, Jan. 24 The specifications and drawings can also be seen at (but not obtained from) the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London.

——— The Corporation of Rochdale require tenders for steam dynamos, balancer and boosters, &c. Specifications, conditions of contract, &c., can be obtained after Tuesday next at the offices of the engineers, Messrs. Lacey, Clirehugh and Sillar, 10, Delahay-street, Westminster, London, S.W., and tenders must be sent to Mr. James Leach, Town Clerk, Town Hall, Rochdale, not later than Saturday, Feb. 19. Some further particulars will be found in an advertisement elsewhere.

——— From our advertisement columns it will be seen that the Wallasey Urban District Council invite tenders for the supply and erection of a 5-ton hand-power overhead travelling crane at their electricity supply works. Copies of the specification may be obtained from the engineer (Mr. J. H. Crowther), at his office at the Great Float, near Birkenhead. Tenders, addressed to the Chairman of the Gas, Water and Electricity Committee, must be delivered at the office of the clerk to the Council (Mr. H. W. Cook), Public Offices, Church-street, Egremont, Cheshire, by 4 p.m. on Thursday, the 20th inst.

——— The Baths Committee of the Borough of Ashton-under-Lyne require tenders for wiring the Corporation Baths. Some particulars are given in an advertisement elsewhere, and further information may be obtained from the consulting engineers, Messrs. Lacey, Clirehugh and Sillar, 78, King-street, Manchester. Tenders to the borough comptroller (Mr. J. Neal), Town Hall, Ashton-under-Lyne, by noon of Wednesday, Feb. 2.

——— The Country Borough of Brighton invite tenders for the supply and delivery of dynamos, motors, switchboards, and the necessary wiring at the municipal school of science and technology. Some further particulars will be found in an advertisement elsewhere, and tenders have to be sent in to Mr. Francis J. Tillstone, town clerk, the Town Hall, Brighton, by 10 o'clock of Monday, the 31st inst.

——— *Daily Tenders and Contracts* announces that tenders are invited for the concession for the construction and working of tramways by steam or other motive power on the district road connecting Bakhtiarpore with Behar, India, a distance of 19 miles. The gauge of the line will be 2ft. 6in. The Patna District Board is prepared to guarantee a dividend not exceeding 4 per cent. per annum on the capital outlay as soon as the tramway is opened throughout its entire length. Further particulars may be obtained from Mr. T. Inglis, Chairman of the District Board, Patna, India.

——— Tenders are invited for the supply and delivery to the Bedford railway station, Bedford, of vulcanised rubber cables. Specifications, &c., can be obtained at the offices of Mr. T. S. Porter, Town Clerk, Town Hall, Bedford, to whom tenders must be sent in by 24th inst.

——— The Electricity Committee of the Council of the County Borough of Newport (Mon.) invite tenders for the supply and erection of the following plant for the extension of their electricity works. Mains: Trenching, troughing and cables; transformers and switch gear; and cast-iron posts for arc lamps. Tenders to the town clerk (Mr. Albert A. Newman), Town Hall, Newport (Mon.), by the 24th inst.

——— The Corporation of Walsall invite tenders for the construction and erection of one 250 B.H.P. high-speed vertical compound engine, and one high-tension continuous-current dynamo (2,000 volts), with spare armature. Tenders to the town clerk (Mr. John R. Cooper), Town Hall, Walsall, by the 22nd inst.

——— The tenders required by the Electricity Supply Committee of the City of Gloucester for the supply and erection of plant, machinery and apparatus (recently advertised in our columns) have to be in to the town clerk, Guildhall, Gloucester, by Jan. 18.

——— The Marylebone (London) Guardians invite tenders for wiring and fitting the new administrative buildings of the workhouse in Northumberland-street, W. Tenders to the clerk by 17th inst.

——— The County Borough of Burnley invite tenders for the supply and erection of steam engines and dynamos. Tenders to Town Clerk's Office, Burnley, by 26th inst.

——— The Municipal Authorities of Tarifa invite tenders until Feb. 1 for concession for the lighting of the streets of the town for 20 years by electricity or other illuminant. Particulars from and tenders to El Secretario del Ayuntamiento Tarifa, Spain.

Tenders Invited.—Tenders are invited by the Corporation of Wolverhampton for motor vans. Those firms sending in tenders for electrical vehicles must submit details of a van which carries electrical energy for 12 hours continuous work. Full particulars can be obtained of Mr. J. W. Bradley, C.E., borough engineer and surveyor, to whom tenders have to be sent by the 7th Feb.

——— Tenders are invited until the 29th inst. by the Hanover Direction of the Prussian State Railways for the supply of about 2½ tons of insulated wire, 39,000 porcelain insulators, 1,000 screw supports, and 300 tons of galvanised wire. Tenders to the Königliche Eisenbahn Direction, Hanover, from whom particulars may be obtained.

Tenders Accepted.—The Hammersmith (London) Vestry have accepted the tender of the Electric Construction Company for the supply of two 300 kilowatt flywheel alternators, at £3,600, and that of Messrs. Robey and Co. for supplying two 375 H.P. slow-speed vertical engines at £4,610.

——— The Blackburn Corporation have accepted the tender of Messrs. Siemens Bros. and Co. for the supply of eight tramcars for the electric tramways at £5,444. Seven tenders were submitted, the highest being £6,620 and the lowest £5,296.

——— The Barrow-in-Furness Town Council have accepted the following tenders for the supply of plant for their electricity supply works, subject, however, to the consent of the Local Government Board being obtained for the borrowing of the necessary moneys:—

Section A.—Boilers, pumps, steam and water pipes, tank, crane, economiser and iron work—Babcock and Wilcox (Limited), £5,050.

Section B.—Engines, generators, switchboards, instruments, accumulators, motor transformers, sub-station equipments—Brush Company, £9,332.

Section C.—High and low-tension feeder and distributor cables, house connection boxes; and *Section D.*—Conduits, drawing-in boxes—British Insulated Wire Company, at schedule prices.

——— The Town Council have also accepted the tender of Mr. W. W. Fairbairn for the erection of the electricity supply station building at £3,386. 10s.

——— The Leith Town Council have accepted the tender of the India Rubber Company for the supply and erection of steam dynamos, switchboard, accumulators, &c., for their electric lighting scheme for £8,844. The Electric Lighting Committee recommended the acceptance of Messrs. Crompton and Co.'s tender at £9,081, but as the India Rubber Company's offer was the lowest the Council decided by eight votes to five to override the Committee's recommendation.

Tenders Received.—A special meeting of the Canterbury City Council is being held this (Friday) afternoon for the purpose of considering a report of the Electric Lighting Committee embodying the report of the consulting engineer (Mr. Robert Hammond) upon the tenders recently submitted for the supply and erection of plant and mains for the municipal electricity supply undertaking. The Committee (acting upon the advice of Mr. Hammond) recommend that the following tenders be accepted:—

Boiler-House Plant—(R. Taylor and Sons)	£1,512	0	0
Engine-House Plant—(India Rubber Company)	3,773	13	0
Overhead Crane—(James Spencer and Co.)	235	0	0
Switchboard and Instruments—(Crompton and Co.).....	999	0	0
Accumulators—(Chloride Electrical Storage Syndicate) '...	1,165	0	0
Mains—(Fowler-Waring Cables Company, Limited)	5,336	0	0
Public Lamps—Arcs and incandescents (Crompton and Co.)	1,400	0	0
Meters—(S. Z. de Ferranti, Limited)	262	10	0
Total.....	£14,683	3	0

In addition to this plant the estimate laid before the Local Government Board Inspector included £1,000 for connecting consumers to mains, and £500 for the re-instatement of roads. The estimated expenditure in respect of the above items was £15,850, against the total of the recommended tenders, &c., of £16,183. 3s., the difference of £333. 3s. being more than covered by the amount included in the estimate for contingencies.

Sales by Auction.—Elsewhere in an advertisement will be found some particulars relating to the sale by auction, in one lot, by Mr. Henry Sherley-Price (of the firm of Wheatley Kirk, Price and Goulty) at the Mart, Tokenhouse-yard, London, E.C., on *Thursday, Jan. 27, 1898, at 2 o'clock prompt*, of the well-known and old-established concern known as the Projectile Company (Limited), with extensive works at New-road, Battersea, London, together with the goodwill, fixed and loose plant and machinery, stock-in-trade, stores, &c. The firms from whom particulars and conditions of sale may now be obtained (gratis) will be found in the advertisement. The works buildings are very substantially built, and are admirably situated for railway connection.

Vacancy.—A jointer (with experienced with high-tension rubber mains preferred) is required at the Coventry Corporation Electricity Works. Applications to the manager, Mr. Gilbert S. Ram

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Appointment Vacant.—The Council of the County Borough of West Ham invite applications for the appointment of chief assistant in the Borough electrical engineer's department. Salary £130, rising by two annual increments of £10 to £150 per annum. Some further information is given in an advertisement elsewhere, and applications are to be sent in to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, London, E., by 4 p.m. on Wednesday, the 26th inst.

Business Notices.—Mr. W. Arnot, M.I.C.E., M.I.E.E., who recently resigned his position as chief electrical engineer to the Glasgow Corporation, has taken offices at 79, West Regent-street, Glasgow, where he is now practising as a consulting engineer.

——— The National Electric Free Wiring Company (Limited) have decided to move into larger premises, and in future the registered offices and London stores will be at 8 and 10, Charing Cross-road, W.C.

——— Messrs. J. Foxcroft and W. J. V. Duncan (late of Paterson and Cooper) have started in business as electrical and mechanical engineers, at 24, Queen's-road, Dalston. Mr. Foxcroft was foreman and manufacturing contractor with the firm for 20 years.

——— We are asked to state that Messrs. Hill, Gifkins and Co. have joined interests with Messrs. Beanland, Perkin and Co., as sole selling agents of the "Ajax" enclosed arc lamp.

Partnership Notices.—Messrs. Clark, Forde and Taylor (Mr. Latimer Clark and Mr. Herbert A. Taylor) inform us that they have admitted into partnership Mr. R. E. Peake and Mr. Arthur L. Dearlove, who have for the past 20 years assisted them in their business of consulting, civil, electrical and cable engineers. The style and address of the firm will be as heretofore, Clark, Forde and Taylor, 4, Great Winchester-street, London, E.C.

——— Mr. T. Scott Anderson, electrical and mechanical engineer, Royal Insurance-buildings, Sheffield, notifies that he has taken into partnership Mr. Henry Harold Beit, A.I.E.E., and that in future the style of the firm will be Scott Anderson and Beit. During the past year the firm erected, amongst other installations, nine electric welding plants, and installed complete electric lighting plants in a large county asylum and in one of the metropolitan hospitals.

Bankruptcies.—The application for the discharge in bankruptcy of W. A. Fraser, electrical engineer, 28, Burleigh-mansions, Charing Cross-road, and 18, Cecil-street, Charing Cross, London, W.C., will be heard on 20th inst. at Bankruptcy-buildings, London.

——— A first and final dividend of 3d. will be payable on the 19th inst. at 79, Mosley-street, Manchester, in the bankruptcy of Edgar Haworth Berry, electrical engineer and contractor (lately trading as E. H. Berry and Pope), 22, St. Matthews-street, and St. James's Hall, Burnley.

——— At the London Bankruptcy Court on Tuesday, C. N. Stewart, civil engineer, of Victoria-street, was publicly examined. Debtor applied to pass upon accounts showing gross liabilities £13,566. 9s. 11s., of which £1,240. 10s. 11d. is unsecured, against assets £1,700. 10s. Debtor was for some time chairman and manager of two autocar companies. He had been connected with various other undertakings, but he had kept no books of account. The examination was concluded. Mr. P. A. Boulton, 110, Cannon-street, E.C., has been appointed trustee.

Liquidations.—It has been decided to voluntarily wind up the Coventry Electric Tramways (Limited), and to appoint Mr. E. T. Peirson, 17, Hertford-street, Coventry, liquidator. Claims against the Company are to be sent to Mr. Peirson by Feb. 21. The undertaking of the Company will be acquired by the company incorporated by last year's Coventry Tramways Bill.

——— Mr. Justice Wright, in the Chancery Division on Wednesday, heard a petition of New and Mayne (Limited), through the liquidator of the Company, asking sanction for a scheme of arrangement between the creditors of the Company and the Company. In support of the petition counsel stated that the liabilities and assets of the old Company would be tranferred to the new Company, and that one of the debenture-holders who held for £52,000 agreed to accept in satisfaction £25,000 in debentures of the new Company and £27,000 in deferred stock of the new Company. The creditors of the old Company agreed to accept in satisfaction of their debts an equivalent amount of Deferred Debenture Stock of the new Company. Arrangements had been made for securing the working capital by giving power to the new company to raise £10,000 on the security of the "A" Debentures, which would take priority over the "B" Debentures and Deferred Debenture Stock. There were creditors to the amount of £5,020 who voted for the scheme, one creditor for £900, whose debt was not allowed by the liquidator, voting against it, and creditors to the amount of £117 did not vote. There was therefore practically no opposition to the scheme. His Lordship granted the application subject to the filing of proper evidence that the meeting to approve the scheme was duly convened.

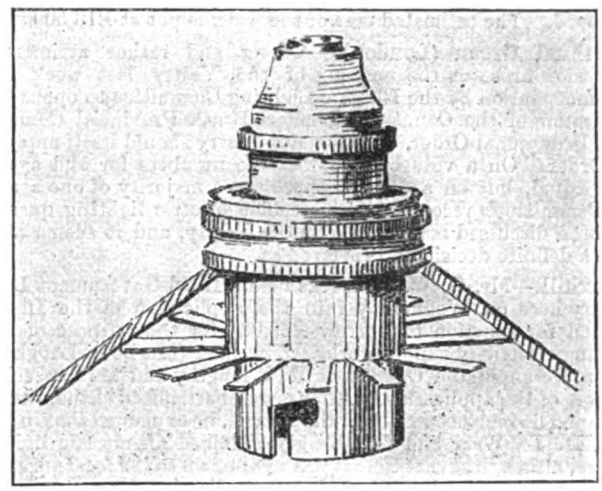
Edison and Swan Patents.—An important announcement appears in our advertisement columns relating to the expiration of licences under Edison and Swan lamp-holder patents on the 27th inst. The trade is notified that the Ediswan "S" holder is covered by two patents, and that after Jan. 27 these holders can only be made by the Company, and must bear the Ediswan trade mark. A reduction in the price of the leading types of holders is announced to take effect from the 28th inst. It is also notified that a new patent lamp-holder is to be issued, called the "Anti-shock" holder.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 5 to Jan. 11, with the ports of destination :—

Australasia—Fremantle, £1,640; Melbourne, £323; Perth, £49; Sydney, £336. *Belgium*—Brussels, £820 (fuses); Ostend, £35. *Burma*—Rangoon, £650. *Canary Islands*—Teneriffe, £3,625 (telegraph cable). *China*—Shanghai, £13. *France*—Marseilles, £85; Paris, £162; Rouen, £82. *Germany*—Hamburg, £50. *Holland*—Amsterdam, £125. *Hong Kong*, £9. *India*—Bombay, £422; Madras, £843 (telegraph cable). *Japan*—Yokohama, £737. *Malta*, £68. *North Atlantic*, £6,600 (telegraph cable). *Portugal*—Beira, £50; Lisbon, £480. *South Africa*—Cape Town, £166; Durban, £112; Port Elizabeth, £450. *Spain*—Barcelona, £25; Malaga, £50; Santander, £29. *Sweden*—Stockholm, £570 (including £100 telegraph wire). *United States*—New York, £25. *Uruguay*—Monte Video, £30. *West Indies*—Trinidad, £22. Total, £18,683, against £7,461 in the corresponding week last year (Jan. 6 to Jan. 12).

Motor Vans.—The Lambeth Vestry have authorised the Wharf Committee to purchase three motor convertible dust and water vans.

New Shade Carrier.—Messrs. Drake and Gorham forward particulars of the "Nelson" shade carrier, which is shown in the accompanying illustration. This carrier is designed to support conical and other shades, and to obviate the trouble which often



occurs with the ordinary ring carrier of the bayonet socket lampholders, owing to the difficulty in removing for cleaning the shades, and from the cracking of the shades owing to expansion when hot. The "Nelson" carrier consists of a short brass tube, which screws on to the standard bayonet socket lampholder, one end of the carrier being splayed out into a number of projections or teeth. As the tube is screwed up under the shade the extremities of the splayed end come in contact with the shade, forming a yielding but firm support. The carrier is suitable for glass shades of all shapes and sizes.

Battersea Polytechnic.—A new technical day school in connection with this Polytechnic was opened this week. The new school is destined to give special instruction to young apprentices and lads leaving the elementary schools who are desirous of entering the building, mechanical, or electrical engineering trades.

Reduction in Rates for Telegrams to British Guiana and the West Indies.—The Antlantic cable companies (including the Anglo-American, Direct United States, Compagnie Française, Western Union, and Commercial Companies) announce that the rates for telegrams to British Guiana and Islands of the West Indies have been reduced to the charges shown below:—British Guiana, 7s. 2d. West Indies: Antigua, 4s. 7d.; Barbados, 5s.; Dominica, 4s. 5d.; Grenada, 4s. 11d.; Jamaica, 3s.; Porto Rico, 5s. 10d.; St. Croix, 5s. 5d.; St. Kitts, 4s. 11d.; St. Lucia, 4s. 9d.; St. Thomas, 5s. 2d.; St. Vincent, 4s. 9d.; Trinidad, 5s. 3d.

The "Engineering Magazine."—The January number of this magazine contains articles on "The Possibilities and Limitations of Electric Traction," by F. J. Sprague; "Automatic Machinery, the Secret of Cheap Production," by Hiram S. Maxim; "The Economy and Efficiency of the Large Gas Engine," by Dugald Clerk; "The

Transmission of Power by Belts and Pulleys," by C. L. Redfield; "Ship-building as a Productive Industry in Great Britain," by James McKechnie; "Future Supremacy in the Iron Markets of the World," by J. S. Jeans; "Cost-keeping Methods in Machine-Shop and Foundry"; "European Systems of House Heating"; and "The Cyanide Process for Gold Ores in Western America." The usual review of the World's Technical Press is also given. Copies may be had, price 1s., post free 1s. 3d., at *The Electrician* Office, Salisbury-court, Fleet-street, London, E.C.

"Automotor and Horseless Vehicle Journal."—No. 4, Vol. II. of this Journal is now ready, and contains articles on Root's and Venable's latest Motor, The British Motor Syndicate, and The Great Horseless Carriage Company, as well as the usual supply of notes and interesting information relating to the motor car industry.

Catalogue of Electrical Books and Publications.—We have received from Signor Carlo Clausen, of Turin, a complete and useful catalogue of electrical works and publications published in Italy and foreign countries between 1885 and 1897. So far as we have tested the catalogue it is complete and up to date, especially in regard to the British books and periodicals. The price is 1s.

"Security" Concentric Wiring.—Messrs. J. D. F. Andrews and Co. (Limited) forward a well-printed illustrated catalogue of "Security" concentric wiring apparatus and accessories. The catalogue is the most complete of the kind relating to concentric work yet issued.

Price List.—Messrs. Newsome, Pinching and Co. forward a sheet containing illustrated particulars and prices of watertight conduit fittings for electric light wires, &c., including joint boxes, bends, switch-cases, &c.

Asylum Lighting.—At the meeting of the West Riding of Yorks County Council on Wednesday, the electric lighting and heating scheme for the West Riding Asylum, at Wakefield, was approved. The estimated cost of the work is put at £16,500.

Bethnal Green (London).—A long and rather acrimonious discussion arose at the meeting of the Vestry last week on a recommendation by the Electric Lighting Committee to oppose the application of the County of London Brush Provincial Company for a Provisional Order, and that the Vestry should itself apply for an Order. On a vote being taken the numbers for and against were equal, but on a division there was a majority of one against the Committee's recommendation. The electric lighting question has been discussed many times by the Vestry, and it seems about time a definite decision was arrived at.

Bexhill.—Mr. G. W. Willcocks held a Local Government Board inquiry here on Wednesday into the application of the District Council for sanction to borrow £20,000 for the purpose of establishing electricity supply works. The clerk (Mr. F. A. Langham), who represented the Council, made a lengthy and able speech in support of the application. After giving particulars of the rateable value and financial condition of the district, he explained that in 1895 Lord De La Warr and Mr. Kersey obtained an electric lighting licence, although at that time it was not known to the local authority that it was to be followed up by an application for a Provisional Order. When it became known that it was intended to apply for the latter the Council decided to themselves make an application for an Order, which they obtained in August, 1897. Their application was opposed by Earl De La Warr, but the Board of Trade decided that the lighting arrangements ought to be in the hands of the town authorities. Had it not been for those circumstances he thought the Council would have preferred to wait a few years longer before undertaking the supply of electric current. The Council were now paying the Bexhill Gas Company over £700 per year for public lighting. Mr. A. H. Preece, the consulting electrical engineer, then submitted technical details. The scheme included 21 arc lamps, of 1,000 c.p. each, to be placed along the Marina, independent of the present gas lamps, and 50 32 c.p. incandescents to replace the present gas lamps. His estimate of £20,000 would be ample to cover the cost. There was some slight opposition by ratepayers. In terminating the inquiry, the inspector remarked that he was at the Brighton Electric Lighting Works recently, when he was informed by the engineer (Mr. Arthur Wright) that the electric light in Brighton was taken more by the poor than by the rich, and this seemed to confirm the claim made by the Bexhill Council that the electric light was the poor man's light.

Boston.—The Town Council have passed a resolution in favour of establishing electricity supply works, and a Provisional Order is to be applied for as soon as possible. It was stated in the course of the debate that an electric lighting scheme would entail a capital expenditure of £20,000, and the annual cost, including sinking fund, would be of £800. The Council at present pay £956 per annum for gas.

Brighton.—A Local Government Board inquiry was held here on Tuesday into the application of the Town Council to borrow £2,130 for electric lighting purposes. The Council's case was presented by the borough electrical engineer (Mr. Arthur Wright).

Chatham.—Messrs. Geipel and Lange have been appointed consulting engineers to the Chatham, Rochester and District Electric Lighting Company.

Crieff (N.B.).—Mr. R. F. Yorke, of Glasgow, has submitted an alternative proposal for the electric lighting of this town. The scheme, which will be carried out by a private company, provides for the utilisation of the water-power recently offered by Sir P. Keith Murray to the Town Council. Mr. Yorke offers to supply current for public lighting at £160 per annum, provided the Council enter into a 21 years' contract. Current for private lighting will be supplied at 6d. per unit.

Dundee.—The receipts of the Electricity Department for the eight months ended December amounted to £1,985 16s. 8d., an increase of £277 4s. 4d. compared with the corresponding period of last year.

Electric Traction in the Isle of Man.—The Isle of Man Electric Tramways Company have entered into possession of all the land required for the construction of their tramway from Laxey to Ramsey. The line is to be ready for traffic by July next.

Great Yarmouth.—The receipts of the electricity department for the month of December amounted to £605. 15s., and the expenditure to £255. 8s. 11d., leaving a balance of £370. 6s. 1d. to meet the capital and other charges of £190 per month. At present there are 255 customers, representing an equivalent of 11,938 8-c.p. lamps connected.

Hyde.—The Chairman of the Highways Committee announced at the meeting of the Town Council this week that the Electric Tramways Company had decided to commence operations forthwith in connection with the construction of electric tramways in the district.

Leyton.—Col. W. R. Slacke, R.E., has held a Local Government Board inquiry into the application of the District Council for sanction to borrow £1,530 for electric lighting purposes. The clerk (Mr. R. Vincent) and the electrical engineer (Mr. H. Collings Bishop) appeared in support of the application. It was explained that the loan was required for the extension of the mains and for the purchase of fittings to let on hire to customers.

At the last meeting of the Council the Electric Lighting Committee reported the receipt of 19 further applications for current during the past month, the equivalent number of 8-c.p. lamps connected to date being 4,529. Some minor extensions of mains were approved, and the Highways and Lighting Committee were instructed to provide in future all manual labour necessary for laying mains and for street work in connection with the electricity department.

Light Railways in Hampshire.—A scheme for the construction of a light railway from Hillsea to Porchester, through Purbrook and Waterloo and on to Horndean, has been brought forward. The promoters are the Hampshire Light Railway Company, and Mr. A. W. White, the manager of the Provincial Tramways Company, who is responsible for the preparation of the scheme, is engaged in submitting details to the local authorities through whose districts the proposed line will run. Last week the Waterlooville District Council unanimously passed a resolution in support, and we understand that the other local authorities are disposed to favourably consider the scheme. The overhead trolley system will be adopted, and it is proposed to convey goods as well as passengers.

Liverpool.—At the meeting of the Electric Lighting Committee on Friday last it was resolved to obtain additional plant for the Oldham-place and Paradise-street stations. The mains are to be extended down Scotland-road at an estimated cost of £741.

Llandudno.—An unexpected obstacle has been placed in the way of the District Council in connection with the scheme for the construction of electric tramways in this district, as Lord Mostyn refuses to allow the tramways to run over any portion of his land. Under the Tramways Act the Council cannot compulsorily acquire land without a special Act of Parliament, although the promoters under the Light Railways Act can do so. A Committee of the Council has, therefore, been appointed to wait upon the Board of Trade to discuss the matter. The Council have already given notice of their intention to apply for a Provisional Order.

Llanrwst (Denbigh).—The District Council have received proposals from Mr. G. R. Peers for the erection of an electricity supply station in this district. Before coming to a decision the Council have decided to ascertain the views of the ratepayers.

Lynn.—The Town Council have authorised the Electric Light Committee to engage the services of an expert to advise and report upon the best means of lighting the district electrically.

Newport (Mon.).—The Electric Lighting Committee recommend the Town Council to increase the salary of the Borough electrical engineer (Mr. C. D. Copland) from £200 to £250, and that of the assistant engineer (Mr. Taylor) from £150 to £200.

New York.—It is rumoured that the Manhattan Elevated Railroad Company have given out the contract for the electrical equipment of its lines to the Westinghouse Electric and Manufacturing Company.

Oldham—The Electric Light Committee have been asked for their terms for supplying electric current for motor purposes at the Mumps, Central and Werneth stations of the Lancashire and Yorkshire Railway Company. The estimated net profit of the Electricity Department for the year ending March 31, 1897, is put at £1,600. The following reduced scale of charges for current is to come into force after March 25 next:—The maximum price is to be 4d. per unit, and for all current consumed in excess of two hours' maximum daily demand 2d. per unit. This is a reduction of ½d. and 1½d. per unit respectively upon existing charges. The present special rate of 2d. per unit for current for motor purposes has been abolished, while the charge for street lighting has been reduced from 3d. to 2½d. per unit.

Portsmouth.—The Electric Lighting Committee have received particulars from a company who are prepared to undertake the "free wiring" of premises in the Portsmouth district, and, as some opposition was offered to the proposal on account of its being an interference with local tradesmen, the matter has been referred to a special sub-committee for consideration and report.

Private Bill Legislation.—According to the Bill which has been lodged for the incorporation of a company for the purpose of constructing an underground electric railway from Charing Cross te Paddington, the proposed railway will commence to the north of the Avenue Theatre in Northumberland Avenue, and will terminate at James-street, near Paddington Station. It is proposed to construct subways to the Paddington Station of the G.W.R. Company, and to Albert-terrace, Knightsbridge. The capital required is £1,500,000, which is to be divided into 150,000 shares of £10 each, with the power to subsequently divide them into "preferred and deferred half-shares." Borrowing powers to the extent of £500,000 are also required. The time sought for the completion of the line is five years, during which period it is proposed to pay interest out of capital to an amount not exceeding £70,000. The Bill proposes to authorise the company to enter into agreements with the Great Western and South-Eastern Railway Companies. The promotors are Sir George Russell, Bart., Mr. Henry Cosmo Orme Bonsor, and the Hon. A. E. Gathorne-Hardy.

Reading.—The contract for supplying electroliers and other fittings, including the large Town Hall, small hall, art gallery, museum, public library, and municipal offices, comprising in all an equivalent of 2,500 8-c.p. lamps, has been carried out by Mr. Leo Sunderland, agent to the Brush Company.

St. Pancras (London).—At the last meeting of the Vestry the scheme for the extension of the mains to the Highgate district, the consideration of which was adjourned from the last sitting, was reconsidered and approved. The electric light mains are also to be extended to Albany-street, Regent's Park district.

Sheffield—The Local Government Board have refused to sanction the issue of irredeemable stock by the City Council for the purchase of the undertaking of the Sheffield Electric Light and Power Company. Notwithstanding this refusal the Parliamentary Committee recommend that further representations be made to the Board, in conjunction with the Corporation of Leeds, who are seeking a similar Provisional Order. Although the Committee have resolved to adopt this course, there is every prospect of an amicable arrangement between the parties being arrived at, as the solicitor to the Sheffield Company has offered to negotiate for the sale of the undertaking on certain conditions, and the Chairman and Deputy-Chairman of the Committee have been authorised to negotiate with the representatives of the Company on the condition that £220 of Sheffield Corporation Two and a-Half per Cent. Redeemable Stock is given for every £100 properly expended by the Company upon their undertaking and chargeable to capital account, provided that the basis be that the sale take effect as from Sept. 29th last, and not from Dec. 31st, and that the amount of such capital expenditure shall not in any event exceed £112,000, any further expenditure properly made being repaid to the Company with 5 per cent. interest from the date of payment. The minutes of the Committee came before the Council on Wednesday afternoon, when the various steps recommended were unanimously approved. After the electric light question had been debated, the Lord Mayor (Alderman G. Franklin) opened a discussion on the minutes of the Tramways Committee who recommended the purchase of a site at Kelham Island for a power station. He asked the chairman of the Committee to take back for reconsideration the question of providing a separate power station. Now that the Council had decided upon the purchase of the Electric Lighting Company's undertaking he thought they might fairly consider whether it was wise to embark on the provision, out of the security of the rates, of two separate undertakings each producing electric current. The Company's works were situated about the centre of the city, and were giving a continuous supply of current. It seemed to him the wisest course would be to postpone the matter and to consider the propriety of putting down in the Company's station the necessary machinery in order to produce the current needed for the tramways. Although he was interested in the electric light undertaking, he did not think he would be doing his duty to the city if he did not make his position perfectly clear as to what he claimed to be the advantages of the fusion under one roof of those two undertakings. First of all, capital outlay on land and buildings would, to a large extent, be saved. It was true new engines and dynamos would be wanted to work the traction part of the business. At present the boilers were kept on full steam 24 hours a day, ready for emergencies, and during many of those hours the waste steam would be utilised in producing the current which would run the tramcars. Another advantage would be that there would be no need for a new staff of officers or servants. There were other advantages which should appeal to the Council. First and foremost was the question of time. In the event of the Corporation acquiring the electric light undertaking they had a station ready for use, to which they would only have to bring their machines for traction work. But if a separate station for the tramways were established it would have to be built, and that would take time. After a brief discussion the Lord Mayor's suggestion was affirmed.

South Africa.—The *British and South African Export Gazette* states that the new three-phase electrical installation supplied to the Transvaal Gold Mining Estates was furnished by Messrs. Siemens and Halske, of Berlin.

The East London Town Council are considering the question of the erection of electricity supply works.

The Strike.—The strike is now costing the A. S. E. about £26,000 per week. To meet this expenditure there are weekly contributions from members amounting to £11,000, while the average from outside sources has been about £7,000, and the increased levy will bring in weekly about £2,000. There is thus a deficiency of £6,000 per week. The posting of additional lock-out notices continues, and on Saturday last the number was considerably increased in various parts of the country. It is stated that since the beginning of the new year no less than 3,000 additional men have been involved, while it is stated that prospective lock-outs would lead to another thousand men being thrown out of work. These extra lock-out notices naturally lead to a reduction in the revenue, and it is estimated that this additional locking-out will result in a falling off of income to the extent of £675, while the payment of strike pay to the same number of men is equivalent to an expenditure of £2,250. Notwithstanding these additions to the number of firms that have joined the Employers' Federation it is declared by the representatives of the men that there are signs that the employers are wavering; but, on the other hand, those who are most in touch with the movement declare that the strike is gradually subsiding through the quiet return of men—a few at a time—to work, and it seems probable that this latter will be the final determination of the struggle.

The Telephone in America.—President Calloway, of the Lake Shore Railway, ascribes the falling-off in passenger business on that and other lines in the same district to the long distance telephone!

Wallasey.—The District Council have decided to inaugurate a revised system of charging for electric current as from March 31st next, after which date the charge for all current consumed up to 15 units per annum per 8 c.p. lamp wired is to be 6d. per unit; for all units above 4d. The charge for current for power purposes is to be 3½d. per unit. The Council's electricity undertaking continues to prosper.

Wandsworth (London).—The lighting of the extensive premises of the Ram Brewery has been entrusted to Mr. Leo Sunderland, agent to the Brush Company. The installation, which will comprise an equivalent of 750 8-c.p. lamps and 7 arcs, will shortly be connected to the local supply company's mains.

Whickham.—The District Council have decided to light the Marley Hill district electrically, by means of incandescent lamps. The cost of the installation is estimated at £165, with £55. 4s. for annual upkeep.

Wimbledon.—The Local Government Board have sanctioned the borrowing of £32,000 by the District Council for electric lighting purposes.

Winchester.—The Town Council have retained the services of Mr. E. T. Ruthven Murray, of Worcester, to report upon the plans and scheme of the Winchester Electric Light and Power Company for the erection of electricity supply works.

Smoking Concert.—The first of a series of smoking concerts given by the combined staffs of the City of London, Metropolitan, and London electric supply companies, was held on Tuesday evening last at the Falstaff, Eastcheap, London. Mr. A. H. Walton, supported by Mr. F. H. Jackson, occupied respectively the chair

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and vice-chair. Mr. C. Gerhardi, of the Metropolitan Company (son of Mr. Ch. Gerhardi, of the Direct Spanish Telegraph Company) was amongst those who, with Messrs. A. Darkin, F. Moore, and S. Paine, scored the successes of the evening. Mr. A. V. Whieldon, 64, Bankside, Southwark, London, is hon. sec. to the organising committee of these concerts, and is to be congratulated upon the success of the first of the series.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

December 11, 1897.

29,328. C. HAMILTON. Glasgow. Improvements applicable to hoists worked by means of electricity.
29,361. J. H. KERRIDGE. London. Improvements in or relating to electric gas lighting and controlling devices.
29,377. E. KASELOWSKY. London. Improvements in or relating to the propulsion of railway trains and the like by electricity.*
29,390. SIEMENS BROS. AND CO. (LIMITED) and C. HOLDEN. London. Improvements in electrical apparatus for transmitting and receiving predetermined messages.

December 13, 1897.

29,429. W. EMMOTT. Halifax. Improvements in electrical-controlling apparatus.
29,493. M. BERNSTEIN, proprietor of the firm of J. F. Wallmann and Co. London. Field telephone and telegraph station.*
29,505. O. J. LODGE. London. Improvements in magnetic telegraphy.
29,507. M. ENGL. London. Method of and apparatus for producing perforated accumulator-plates.*

December 14, 1897.

29,523. C. BANNISTER. London. Improved electrical means for preventing burglaries, for external and internal use.
29,528. J. ATKINSON. Cheshire. Improvements in electric lights.
29,530. H. DAVIS. Derby. Improvements in the lighting of miners' safety lamps and the like by electricity.
29,542. J. W. DAVIES and D. LOCH. London. Improved electric storage batteries.
29,566. S. W. MAQUAY. London. Improvements in and connected with electric motors partly applicable to dynamos.
29,575. A. E. A. MORTIMER and W. J. HEAD. London. An adjustable electric light fitting with improved detachable and rotary contacts.
29,585. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in methods of and means for regulating alternating current dynamo-electric machines or distribution systems. (E. W. Rice, jun., United States.)*
29,586. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in or relating to electrical transformers. (W. S. Moody, United States.)*
29,587. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in and relating to dynamo-electric machines and electric motors for electric railways. (E. D. Priest, United States.)*
29,588. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in the method of and means for breaking alternating current induction motors. (E. W. Rice, Jnr., United States.)*
29,589. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in electric arc lamps. (E. Thomson and C. E. Harthan, United States.)*
29,590. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). London. Improvements in and relating to dynamo-electric machines and motors. (E. D. Priest, United States.)*
29,595. F. KRAEMER. London. Improvements in electric heaters or rheostats.*
29,596. J. F. GATES. London. Improvements in combination plugs or lamp heads for electric lamps.*
29,597. H. H. LAKE. London. Improvements in controlling devices for electric motors. (H. See, United States.)*
29,615. W. B. SPIKINS and A. H. MAYES. London. Improvements in electrical switches or variable resistances.*
29,651. F. BAKER. London. Improvements in or relating to joints for derricks' legs, telegraph poles, and the like.

December 15, 1897.

29,665. G. RITTER. London. Improvements in commutators for telephone plants.*
29,667. J. P. HALL and W. H. S. CRAVEN. Manchester. Improvements in or applicable to switches for electro-motors and the like purposes.
29,710. D. BROWNE and P. KAMPERDYK. London. Improvements in accumulators.*
29,726. F. LE ROY. Liverpool. Improvements in electric heating devices.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

15. DE TUNZELMANN. Electric light fittings.
425. KING. Secondary batteries.
550. BATHURST. Conduits for electrical conductors, and joints therefor.
1,521. HOLMES. Adjustable liquid resistances for starting and regulating electric motors.
11,413. ABEL (Allgemeine Elektricitäts-Gesellschaft). Electrical signalling apparatus for transmitting commands and the like.
18,122. GIBBONEY. Transmitting and receiving sounds by telephony.
18,466. BOULT (Printing Telegraph News Company). Printing telegraph apparatus.
20,497. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) (Potter). Surface contact electric railway systems.
20,498. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) (Potter). Surface contact electric railway systems.
20,499. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED (Potter). Closed conduit or surface contact electric railways.
20,503. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED (Potter). Surface contact or closed conduit electric railway systems.
20,522. OWEN, WILLIAMS and DONALDSON. Electrical signalling systems, applicable to in and out indicators and the like.
21,111. WHEATLEY (Allgemeine Elektricitäts-Gesellschaft). Attachment of pole-pieces to the armatures of dynamos.
22,044. JAMES (Bell Electric Company). Electric batteries, electrodes, and method of making the same.
22,045. JAMES (The Bell Electric Company). Electric batteries.
22,806. BRADLEY. Alternating-current dynamo-electric generators.
22,845. CLOOS. Junction-boxes for use in electric distribution systems. (Date applied for under International Convention, March 6, 1897.)
22,849. SZUBERT. Electric signal bells.
23,123. JOHANSEN. Electrolyte for carbon and zinc elements suitable for lighting and other purposes.
23,422 HEYS (The Singer Industrial Company). Electro-magnetic clutches.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

The report of the Directors of this Company for the half-year to September 30th last, to be presented to the half-yearly ordinary general meeting of shareholders on the 20th inst., states that the revenue for the period amounted to £443,727. 11s. 11d., from which are deducted £109,243. 6s. 1d. for the ordinary expenses and £31,637. 11s. 5d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £3,309. 7s. 6d. for depreciation of spare cable, £6,379. 5s. 10d. for income tax, there remains a balance of £293,158. 1s. 1d. to which is added £3,931. 9s. 9d. brought forward, making a total available balance of £297,089. 10s. 10d. From this balance there has been paid—

Interest on Debentures and Debenture Stock ...	£29,889	5	11
Dividend on Preference shares	20,296	2	8
Two interim dividends of 2s. 6d. per share each on the Ordinary shares	100,000	0	0
	£150,185	8	7

After carrying £10,000 to reserve for maintenance ships, £10,000 to the fire insurance fund, £10,000 to the land and buildings depreciation fund, and £75,000 to the general reserve fund, there remains a balance of £41,904. 2s. 3d., which is carried forward. The revenue includes £24,529. 19s. 10d. dividends for the half-year upon the Company's shares in other telegraph companies.

The Directors have made application to Parliament for leave to bring in a bill for the conversion of the existing 6 per cent. Preference shares of the Company into 3½ per cent. Cumulative Preference stock, at the rate of £18. 10s. of the new 3½ per cent. stock for each £10 fully-paid share; to authorise the Company to raise further moneys with the sanction of the members in general meeting by the creation and issue of additional Preference stock or shares not exceeding in the aggregate one-half of the total amount of the Ordinary share capital of the Company for the time being issued, and with the like sanction to create and issue Debentures or Debenture stock not exceeding in the aggregate one-third of the capital of the Company issued in Ordinary and Preference shares and stock.

The Marquess of Tweeddale and Sir Albert J. Leppoc Cappel, K.C.I.E., seek re-election as Directors, as do the auditors, Messrs. Deloitte, Dever, Griffiths and Co., and Messrs. Welton, Jones and Co.

NEW COMPANIES, STATUTORY RETURNS, &c.

INTERNATIONAL LIGHTING ASSOCIATION (LIMITED).—This Company has been registered at Edinburgh with a capital of £100,000 in £1 shares, to acquire the business carried on under the style of the Colonial Lighting Syndicate (Limited), to carry on in all or any of its branches the business of an electric light and power supply company, electricians, electrical engineers, &c. The first Directors are: Messrs. J. Hepworth, W. Haldane, J Dempster and W. Cowan.

MOTOR-CARRIAGE SUPPLY COMPANY (LIMITED).—This Company was registered on Jan. 5th with a capital of £12,000, in £1 shares, to carry on

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the business of dealers in, and proprietors of motor and other carriages, vans and waggons, also electricians, mechanical engineers, machinists, &c.

NORTHERN COUNTIES ELECTRIC AND MOTOR COMPANY (LIMITED).—This Company was registered on Jan. 7th with a capital of £10,000, in £1 shares, to manufacture, sell, hire, or otherwise deal with electric and other motors, carts, cabs, vehicles, &c., and to carry on the business of electricians, mechanical engineers, machinists, metallurgists, &c.

ELECTRICAL PIONEER SYNDICATE (LIMITED).—The statutory return to October has been filed. The capital is £10,000, in £50 shares, of which 42 have been taken up; £25 per share has been called, and £1,000 received.

ELECTRICAL UNDERTAKINGS (LIMITED).—The statutory return to December has been filed. The whole capital of £10,000, in £1 shares, has been taken up, and 7,943 shares have been issued as fully paid, while £2,507 has been received on the remainder.

NATIONAL ELECTRIC FREE WIRING COMPANY (LIMITED).—The statutory return to November has been filed. The capital is £250,000, in £1 shares; 100,000 shares have been taken up, and a call of 5s. per share has been made.

NEW PHONOPORE TELEPHONE COMPANY (LIMITED).—The annual return to November has been filed. The capital is £10,000, in £1 shares (of which 1,000 are Founders'); 5,111 Ordinary and all the Founders' have been taken up, and the latter have been issued as fully paid; 10s. per share has been called on the Ordinary.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26 1/16d. per oz. (Jan. 13). Consols (2¾ per cent.) 112⅝—112⅜ for money, 112¾—112⅞ for account; 2½ per cent. 105⅜—106 (Jan. 13). Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Days, Jan. 25 and Feb. 8; Ticket Days, Jan. 26 and Feb. 9; Pay Days, Jan. 27 and Feb. 10; Mining Share Carry-over Days, Jan. 24 and Feb. 7.

BABCOCK AND WILCOX (LIMITED).—The directors of this Company have declared an interim dividend for the six months to Dec. 31 last at the rate of 10 per cent. per annum on the ordinary shares, tax free, payable on Feb. 15.

BARCELONA TRAMWAYS COMPANY (LIMITED).—Letters of allotment for the recent issue of £100,000 Four and a-Half per Cent. Redeemable Debenture Stock have, we understand, been posted.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for Sept. were £2,684, against £3,966 in the corresponding month last year.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 3s. per share, free of income tax, being at the rate of 3 per cent. per annum for the quarter ended Dec. 31 last, payable on and after the 29th inst., setting aside £12,000 to reserve, and carrying forward a balance of £4,090. 2s. 2d. The transfer books are closed from the 11th to the 25th inst. inclusive.

DIRECT WEST INDIA CABLE COMPANY (LIMITED).—The Four and a-Half per Cent. Debentures of this Company can now be obtained in exchange for scrip. Cheques for interest on instalments to Dec. 31 will be issued with the debentures.

ELECTRIC CARRIAGES IN PARIS.—The Société des Voitures Electriques, système Kriéger, which was formed as a pioneer company in 1895, is about to be reorganised, and a new company, with a capital of 5,000,000fr., will shortly be registered in Paris. Judging from the published figures, the promoters are quite as sanguine of success as our own electric omnibus and motor car companies.

GREAT HORSELESS CARRIAGE COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company was held at Coventry on Friday, when the resolutions passed on the 22nd ult., relating to the reconstruction of the Company, by altering the shares from £10 to £1. 17s. paid, and the cession of British motor shares, were confirmed.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company was held on Wednesday to confirm the resolution passed at a recent meeting approving the arrangement come to with the holders of Founders' shares, and reducing the capital of the Company from £200,000, divided into 40,000 shares of £5 each, of which 27,900 are Ordinary shares, 12,000 are Preference shares, and 100 are Founders' shares, to £199,500, divided into 39,900 shares of £5 each, of which 27,900 are Ordinary shares and 12,000 are Preference shares. The motion for confirmation was passed unanimously.

OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAY (LIMITED).—Early in the week the Electric and General Investment Company invited applications on behalf of this Company for 4,000 Ordinary and 4,000 Five per Cent. Cumulative Preference Shares of £10 each, being the whole of the share capital of the Company. The Directorate includes Mr. Emile Garcke, who is to be Chairman of the new Company, and Mr. A. R. Monks, the Managing Director of the British Thomson-Houston Company. The prospectus states that the Company has been formed for the purpose of constructing and working an electric tramway, eight miles in length, from the boundary of Oldham, through Aston-under-Lyne, Audenshaw, and Denton to Hyde, authorised by the Provisional Order granted to the British Electric Traction (Pioneer) Company (Limited) in 1896.

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—A final call of £1 per share has been made by this Company in respect of all shares not yet fully paid up. Payment is to be made by the end of the current month, by which time the whole of the original capital of the Company will be fully paid up.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a settling day, and to grant a quotation to 30,008 shares of £2. 10s. each, and £150,000 Four per Cent. Debentures of the West Coast of America Telegraph Company (Limited) in lieu of the shares and debentures of the old Company of the same name now quoted. The Committee has been also requested to allow the further issue of £264,711 Sterling Four per Cent. 500-Year Debenture Stock of the Commercial Cable Company to be quoted in the list.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Jan. 7 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,405.

WESTERN UNION TELEGRAPH COMPANY.—This Company have issued their report for the quarter ended Dec. 31. The following statement exhibits the condition of the Company at the close of the quarter ended Sept. 30, 1897:—

Surplus July 1, 1897, as per last quarterly report		$7,647,541 06
Net revenues, quarter ended Sept. 30, 1897		1,703,851 32
		$9,351,392 38
From which deducting for—		
Dividend of 1¼ per cent. paid Oct. 15th	$1,216,972 50	
Interest on bonded debt	224,418 27	
		$1,441,390 77
Left a surplus Oct. 1, 1897, of		$7,910,001 61
The net revenues of the quarter ended Dec. 31st, based upon nearly completed returns for October, partial returns for November, and estimating the business for December, were about		1,600,000 00
		$9,510,001 61
From which appropriating for—		
Interest on bonds		224,500 00
		$9,285,501 61
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,216,975 00
Deducting which leaves a surplus, after paying dividend, of		$8,068,526 61

In view of the preceding statements, the Committee recommend that a dividend of 1¼ per cent. on the capital stock of the Company be declared payable on and after the 15th inst.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—This Company invite applications for £200,000 Three and a-Half per Cent. Debentures, redeemable in March, 1920, at par, or before at 5 per cent. premium.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Jan. 8	3,548	+471	...	...	...
Bristol Trams & Carriage	,, 7	2,463	+451	1	2,463	+ 451
City & South London Ry.	,, 9	2,174	+ 13	2	2,174	14
Dover Tramways	,, 8	117	...	18	2,049	...
Dublin United (Southern)	,, 7	390	- 67	1	390	- 67
Liverpool Overhead Rly.	,, 9	1,438	+173	2	2,795	+ 156
Sheffield Tramways	,, 9	1,013	+211	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Jan. 5.	Price Wednesday, Jan. 12.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 8. Highest	Lowest.
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	8/0	Central London Ordinary	9½ 10½	9½ 10½	2 13 6	June and December	10	9½
143,106	10	1/0½	Do. (6s paid)	5½ 6	5½ 6	3 0 0	,, ,,	5½	5½
£680,000	Stock	2½	City and South London Railway Con. Ordy.	67 69	69 71	3 14 10	January and July	70	67½
8,419	£10	5%	Do. 5% Perpetual Preference	15½ 16	15½ 16	3 2 6	,, ,,	...	—
£135,701	Stock	4%	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	138	—
54,000	10	2/8½	Waterloo and City Ordinary	12¼ 13	12½ 13	2 6 1	June and December	12½	12½
87,860	10	3%	Liverpool Overhead Railway Ordinary	11½ 11¾	11 7/8 11 15/16	2 11 11	February & August	—	—
10,000	10	5%	Do. 5% Preference	16 16½	16 16½	3 0 7	,, ,,	—	—
125,000	Stock	4%	Do. 4% Debenture xd	108 110	108 110	3 11 5	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Jan. 5.	Price Wednesday, Jan. 12.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending Jan. 8. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£923,960	Stock	14/0	Anglo-American	61 63	62 64	4 10 0	Feb., May, Aug., Nov.	62	60½
£3,038,020	Stock	23/0	Do. Preferred	109½ 110½	111½ 112½	5 2 3	" "	112½	108½
£3,038,020	Stock	5/0	Do. Deferred	13½ 14	14 14½	.. ..	— —	14½	13½
£137,400	£100	4%	*African Direct Telegraph (Red)	100 104	101 104	3 16 11	January and July	—	..
£25,000	10	..	Amazon Telegraph	5½ 6½	6 7	.. ..	—	..	..
130,000	10	3/0	Brazilian Submarine	16 16½	16½ 16¾	4 3 6	Mar., June, Oct., Dec.	16 7/16	16⅛
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112 116	112 116	4 6 2	June and December	—	—
10,000,000	$100	2⅜	Commercial Cable Capital Stock	182 187	182 187	4 5 1	Jan., Apr., July, Oct.	—	—
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	104 106	105 107	3 14 9	" "	105½	105½
16,000	10	8/0	Cuba Submarine	8½ 9½	8½ 9½	8 8 5	February and August	9¼	..
6,000	10	10%	Do. Preference 10 per Cent.	18½ 19½	18½ 19½	5 2 7	" "	..	—
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October	—	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	—	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	102% 105%	102% 105%	4 5 9	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10½ 10¾	10½ 11	5 13 9	Jan., Apr., July, Oct.	10¾	10 5/16
400,000	£10	2/6	Eastern	17 17½	17¼ 17¾	3 13 3	" "	17½	17¼
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18 19	18 19	3 3 8	" "	18⅜	18¼
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	130 133	130 133	3 0 6	May and November	132	130½
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	102 105	102 105	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension	18½ 18¾	18½ 19	3 13 8	Jan., Apr., July, Oct.	18¾	18½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	132 135	132 135	2 19 3	February & August	133½	132
£125,700	£100	5%	* Do 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99 103	99 103	4 17 3	January and July	..	—
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99 103	99 103	4 17 3	" "	100	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103 106	103 106	3 15 8	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108% 111%	108% 111%	3 12 1	May and November	—	..
180,227	10	1/9	Globe Telegraph and Trust	11½ 12	11¾ 12½	3 15 6	Jan., Apr., July, Oct.	11⅞	11⅝
180,042	10	6%	Do. 6 per Cent. Preference	17½ 18	17¾ 18½	3 5 9	" "	17⅞	17 7/16
150,000	10	5/0	Great Northern of Copenhagen	25½ 26½	25½ 27½	3 12 9	January, April, July	26 7/16	—
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	102 105	101 104	4 17 7	March & September	..	—
17,000	25	12/6	Indo-European	52 55	52 55	4 10 11	May and November	52	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	107 110	107 110	5 9 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105 108	105 108	3 13 5	June and December	105½	—
11,839	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	136 141	136 141	4 5 1	" "	139½	—
15,609	10	6/0	West African Telegraph	4½ 5½	4 5	5 0 0	—	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103 106	103 106	4 14 4	March & September	—	—
80,000	10	2/0	West Coast of America	¾ 1½	¾ 1½	.. ..	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	105 107	105 107	3 14 9	June and December	..	..
88,321	10	1/0	West India and Panama	⅜ ⅝	⅜ ⅝	.. ..	May and November	½	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7½ 8	7½ 7½	7 14 10	" "	8	7⅞
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5 7	5 7	8 11 5	" "	—	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105 108	105 108	4 12 2	January and July	—	..
64,256	15	3/0	Western and Brazilian	9¾ 10½	9¾ 10½	2 18 5	May and November	10 5/16	9¾
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½ 7¾	7½ 7¾	3 17 8	" "	7 7/16	7⅜
33,129	7½	1/6	Do. Deferred Ordinary	2¾ 3¼	2¾ 3¼	.. ..	" "	..	..
£382,230	—	4%	Do. 4 per Cent. Debenture Stock	104 107	104 107	3 14 1	June and December	105½	105
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	108 110	105 110	6 7 10	Feb., May, Aug., Nov.	—	—
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	—	..
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	3 3½	3 3½	5 14 4	August	—	—
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16 3/16	1/16 3/16	.. ..	July	—	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2 2½	2 2½	8 0 0	October	..	—
484,597	5	3/0	National	6½ 6¾	6½ 6¾	4 8 11	February & August	6 11/16	6⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15 17	15 17	3 10 7	" "	..	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14 16	14 16	3 15 0	" "	15½	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6 6½	6 6½	3 16 11	" "	..	—
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	102 107	102 107	3 5 0	June and December	105⅜	103
171,504	1	0/4	Oriental	1/16 1/8	1/16 1/8	4 2 4	April and October	—	—
58,000	5	5/0	United River Plate	3¾ 4¼	3¾ 4¼	5 17 8	July	—	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	100 105	100 105	4 14 4	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.						
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	..	1¾		March	..	—
£50,000	5	..	Do. (New Issue) £3. 10s. paid	..	..	..	..	..	—
50,000	£10	14/0	City of London Electric Lighting (fully paid)	26 27	26 27	2 11 10	February & August	26¾	26½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17 18	17 18	3 6 8	January and July	17⅞	—
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129 134	129 134	3 14 3	June and December	..	—
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12½ 13½	12½ 13½	2 8 2	February & August	13¼	13
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6¼ 6¾	3 6 8	" "	6⅝	..
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	— —	— —	—	January and July	..	—
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	10½ 11	10½ 11	3 8 2	March	10 15/16	10½
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	112 114	112 114	3 14 7	June and December	—	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	13¼ 14	13¼ 14	.. ..	..	13⅞	13⅝
20,000	£10	6/0	Do. 6% Cumulative Preference	15½ 16	15½ 16	3 15 0	March & September	15⅞	15½
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9 10	9 10	.. ..	..	9½	..
10,000	£5	7%	Do. 7 per Cent. Preference	11 11½	11 11½	3 0 11	March & September	—	..
111,000	£5	..	London Electric Supply Ordinary	2¾ 3	2⅞ 3¼	.. ..	—	..	—
48,050	£5	..	Do. Preference	6¼ 6¾	6⅝ 6⅞	.. ..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	18½ 19½	18½ 19½	2 16 5	April and October	18 15/16	18½
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	18 19	18 19	.. ..	" "	18¼	—
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117 121	117 121	3 13 6	June and December	..	—
6,452	10	8/0	Notting Hill Electric Ordinary	17½ 18½	17½ 18½	2 3 3	March	—	..
275,000	1	..	Rand Electric	1 1/16 1 1/8	1 1/16 1 1/8	.. ..	—	—	—
£125,000	Stock	5%	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90 95	90 95	5 5 3	—	—	—
150,000	$100	2/8	Royal Electric Company of Montreal Shares	145 147	145 147	.. ..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105 107	105 107	4 4 1	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	17 18	17 18	3 3 11	February & August	17⅜	..
20,000	5	3/6	Do. 7 per Cent. Preference	10 11	10 11	3 3 6	" "	..	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	101 104	101 104	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	16 17	15½ 16½	4 6 11	March & September	16	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	£3	1/6	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	—	—	2 1/16	1⅞
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	.. ..	—	2 1/16	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109 113	109 113	4 0 9	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	100 103	100 103	4 7 7	June and December	—	—
10,000	£10	..	British Aluminium Ordinary	..	—	—	—	..	—
20,000	10	..	Do. 7% Cumulative Preference	..	—	—	—	..	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7 8	7½ 8½	5 17 8	June and December	—	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	107 112	107 112	4 0 6	" "	—	—
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1½ 1⅝	1½ 1⅝	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2 2½	2 2½	—	—	—	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	86 91	86 91	5 6 5	January and July	—	—
99,261	5	1,9½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 3	2½ 3	5 10 0	February & August	—	—
17,139	5	2/9½	Do. (£5 paid)	4½ 5½	4½ 5½	5 0 0	" "	—	—
£200,000	Stock	—	Do. 4% Mortgage Debenture Stock (red.)	101 103	100 102	3 17 8	June and December	..	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅝ 2⅞	2⅝ 2⅞	4 0 0	February & August	2 7/16	2⅝
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3⅛ 3⅜	3⅛ 3⅜	4 3 4	August	—	—
91,116	1	10/0	Elmore's Patent Copper Depositing	½ ⅝	½ ⅝	.. ..	..	..	—
10,000	10	6/0	Henley's Telegraph Works Ordinary	20 21	20½ 21½	4 15 3	February & August	21	20½
3,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 12 0	" "	19½	18½
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 10	" "	112	..
80,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	23½ 24½	23½ 24½	4 1 8	" "	24	23½
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103 107	103 107	3 14 9	March & September	107	..
37,350	12	12/0	Telegraph Construction and Maintenance	36 39	36 39	4 12 4	March and July	38½	38
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	101 104	101 104	4 15 3	January and July	—	—
£22,500	£5	3/6	Willans and Robinson Ordinary	7⅜ 8½	7⅜ 8½	4 4 10	April and October	—	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	6⅞ 7½	6⅞ 7½	4 2 0	" "	—	—

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NOTES.

How rapidly electric traction has developed in the United Kingdom during the past year may be gathered from a comparison between the Table of Electric Railways and Tramways we publish this week as a Supplement and the corresponding Table published a year ago. The items in the present Table show that there are some 23 lines in operation, that the construction of 25 others is sufficiently far advanced to make it probable they will commence running before the year is ended, and that there are now projected schemes for the construction of 10 underground electric railways in London, and 48 light railways and tramways in London and the provinces. The lines in actual operation, together with such as will commence running in a very few weeks comprise over 150 miles of track, while the aggregate track-mileage of the lines working and in course of construction approximates to 400 miles.

By far the greater number of the concerns embodied in the Table, whether as being in operation, in process of construction, or merely projected, relate to the overhead trolley system. In the great field of the electrical equipment of town tramways neither the battery car nor the conduit system has advanced, and no instance exists of a public tramway being worked on a surface contact system as regards the United Kingdom, while the third-rail conductor system has been reserved exclusively for underground and overhead railways. Nevertheless, electric traction construction shows no sign of crystallisation, for newer methods and improved details of plant are continually being introduced. Perhaps the most interesting illustration of this is the decision of the New General Traction Company to depart from the custom hitherto universal in this country of mechanically jointing and bonding tramway rails, and to adopt, in the new lines about to be equipped at Coventry and at Norwich, the FALK system of cast-welding rail-joints, which has proved so successful at Chicago and in other parts of the United States. British tramway engineers, whether directly interested in electric traction or only indirectly, will watch closely the process of acclimatisation of cast-welding in this country. Probably, on the whole, our fickle climate will prove less trying to the cast-welded joint than the great extremes of temperature it has had to withstand in the climate of some parts of America.

BESIDES electric traction, electro-chemistry invites attention from our readers this week. In a sense the two subjects are not utter strangers to one another; there has been, perhaps, a trifle too much electro-chemistry around gas and water pipes in the neighbourhood of badly-constructed electric lines. We commence a reprint of Mr. J. WILSON SWAN'S Presidential Address to the Institution of Electrical Engineers, in which the past development and present state of the electro-chemical industry are succinctly reviewed. A later part of this address is directed to a consideration of the electrolytic production of bleaching compounds—a subject that is more amply dealt with in a Paper by Mr. M. C. BEEBE, which we reprint and comment upon in our leading article this week. We are apparently in the midst of a revival of interest in electro-chemistry, for the next Paper announced for reading at the Institution is on "The Electro-Chemical Treatment of Ores containing the Precious Metals," and will be read next Thursday by Major-General WEBBER.

"SIXTEEN years is but a short time in which to create and develop a new industry," but it is quite long enough, seemingly, to destroy the memory of an old Society. This reflection must have occurred to Mr. SWAN when, speaking of the rise and progress of Electric Lighting last Thursday night, he cast his eyes round the assembly of Electrical Engineers in the almost vain search for the Telegraph Engineers who had listened to his startling utterances sixteen years ago. Probably he remembered also that they gave him not only a patient but an enthusiastic hearing; and some feeling of pain, if not of indignation, must have disturbed this opening of his Presidential career by reason of the ungenerous reception given to Mr. LATIMER CLARK while Sir HENRY MANCE still occupied the chair. Both these well-known Telegraph Engineers are in the front rank of those eminent pioneers who have carried British telegraph enterprise throughout the whole world, and to whom the present Society owes its very existence.

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Mr. Latimer Clark had a very handsome and valuable present to make to the Society in the shape of several volumes of memoirs and memoranda relating to the life and work of the late Mr. Jacob Brett, the father of submarine telegraphy; and no more appropriate moment could have been found for the presentation than the occasion of Sir Henry Mance's retirement from the Presidential office. That a considerable section of the audience received the donor's formal *résumé* of the leading features of his gift with undisguised impatience was, perhaps, not so much a sign of bad manners as a proof of the total change which has come over the Society since it was devoted solely to affairs telegraphic. The unruffled good humour with which Mr. Latimer Clark confronted the interrupters was the best comment that could be made upon the incident.

Three little green kiosks have been erected in Holborn and New Oxford-street; one near "The Royal" Music Hall, the second at the top of Shaftesbury-avenue, and the third at the top of Tottenham Court-road. These wooden structures resemble in outward appearance the little newspaper kiosks so common on the Continent, but their internal economy is somewhat different. On knocking at the door of one of these telephone kiosks and gaining admission we found within only a boy, a messenger call, and a telephone connected to the National Company's exchange. Making use of the latter we found that the noise of the street traffic, though considerable, in no way lessened the distinctness of conversation, whether we were speaking over one or five miles of line. The instruments are of the Ericsson desk pattern, the transmitter and receiver being mounted on the same handle, and a second receiver of the Ader type being provided. It may be mentioned that the peg for the suspension of the latter might with advantage be converted into a hook. Several little boys were listening outside in order to catch snatches of the conversation going on within, but they did not appear particularly successful, perhaps mainly owing to the noise of the traffic. The kiosks are the property of the District Messenger Service Company, but the charge for telephonic communication is the same as that at the National Company's call-offices. The wires leading to the instrument are at present overhead, and are rather unsightly, the little tower being not very high; we trust it will soon be found possible to place the wires underground. Finally, it may be mentioned that the kiosks are open from 9 a.m. till 6 p.m., and are lighted after dark by three "Sunlight" gas-burners. This prodigality of light appears due to the fact that the notices and advertisements which cover the windows are transparencies. We trust that the public will not fail to make sufficiently frequent use of this convenient means of communication to warrant the erection of many more similar call-boxes in our streets.

Of the all-British cables, which are being so strenuously advocated just now, by far the most feasible is the one favoured, we are glad to notice, by the Afrikander Bund, and which, while satisfying the patriotic sentiments of Cape Colonists, might be extended to Australia for similar reasons. Such a cable, following the existing trade routes, could be laid in safe waters throughout, might be easily protected, and would afford alternative and multiple channels of communication to some of our most important naval, military, and commercial stations on the way. Nothing of this kind can be said for the much-talked-of Pacific cable, a fatal objection to which is that, being removed from the route of commerce requiring the protection of British warships, it would be defenceless and useless for those strategical purposes the fulfilment of which can alone justify the heavy subsidy such a cable confessedly demands. Even if the electrical and financial difficulties could be overcome, one cable, which could offer no certainty of continuous communication would be rather worse than none; and to lay several of them in such waters as the Pacific, and for such traffic as could be reasonably expected, is utterly out of the question, the more so that the extreme length of one of the sections would make the line very expensive.

Jubilee Bonus.—The directors of "The Electrician" Printing and Publishing Company (Limited) decided, in December last, to commemorate the Diamond Jubilee of Her Gracious Majesty by presenting the heads of departments and the administrative staff with a bonus, calculated on a salary basis. The distribution has now been made.

Direct West India Cable.—The Direct West India Cable Company announce the completion of the laying of cable from Bermuda to Turk's Island, and that messages can now be accepted in Great Britain and Ireland for these places. It is anticipated that the cable right on to Jamaica will be completed and in working order at the latest by the 31st inst.

New Cable Steamer.—The Marquis of Tweeddale, in his remarks to the shareholders at the meeting of the Eastern Telegraph Company yesterday (Thursday), announced that it had been decided to put in hand the construction of a new cable steamer. The new vessel will be larger than any of the ships at present the property of the Company, and a considerable increase in speed is also to be provided for.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Bundaberg—New Caledonia ...	Nov. 4, 1897	... Jan. 20, 1898.
Ceara—Maranham	Dec. 23, 1897	... —
Teneriffe—St. Louis (Senegal)...	Dec. 24, 1897	... —
Para—Maranham	Jan. 3, 1898	... Jan. 15, 1898.
Curaçao—La Guayra...	Jan. 5, 1898	... —
Para—Caminha	Jan. 13, 1898	... —

Landing Rights for Submarine Cables.—The question of landing rights for submarine telegraph cables in the United States has been under the consideration of the acting Attorney-General, and he has decided that the President has power, failing specific legislation, to control the landing of a "foreign submarine cable." It will be remembered that the question was raised owing to the French Company having landed a cable at Cape Cod without express permission.

The Webb Testimonial.—It is intended to make the presentation of the Webb testimonial at a subscription dinner, to be given to Mr. and Mrs. Webb by contributors to the Testimonial Fund, on Monday, February 14th, at the Whitehall Rooms of the Hotel Métropole. Tickets may be had from the Hon. Secretary of the Fund, Mr. Henry Edmunds, 39, Victoria-street, Westminster, S.W., the price of single tickets being one guinea, and that of double tickets (for a lady and gentleman) 36s.

The Sir John Pender Memorial Fund.—The Hon. Secretary of the International Submarine Telegraph Memorial has received from Mr. D. H. Keeley, general superintendent of the Canadian Government Telegraph Service, the following letter, dated Jan. 10, 1898:—

Dear Sir: Though the action has been attended with a great deal of delay I sincerely hope I am not altogether too far behindhand to comply with the request conveyed in your note of Aug. 13 last. By the kind co-operation of the Hon. the Minister I am enabled to send you herewith a cheque for the equivalent of $150 as a contribution to the Sir John Pender Memorial Fund from the Canadian Government Telegraph Service. Will you please receive this enclosure, and present my respectful compliments therewith to the Marquis of Tweeddale, who, as Chairman of the General Committee, favoured me with an invitation to take part in the work that the Memorial Committee had in view.

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Another Edison Invention.—We have already referred, in our issues of November 5th and 19th last, to Edison's iron-ore works in New Jersey, in which he obtains a utilisable concentrate from a low-grade iron ore by means of magnetic separators. It is not, however, mere commercial enterprise that is expected of Edison, but sensational invention, and this appears to have been supplied either by the great man himself or by someone equally endowed with the inventive talent, if we may judge from the following note in the *Standard*:—

> The last castings by Edison's magnetic ore-separating process, it was found, could not be broken by 15lb. sledges in the hands of a strong man; 25lb. sledges equally failed. This was so remarkable (*sic*) that Mr. Edison chemically analysed the specimens and discovered either a new element or a new combination of elements, which point to the possibility of reproducing iron castings at will with the best characteristics of wrought metal, and surpassing malleable iron, both in respect to cheapness and rapidity of production.

The Budapest Tramways.—Since December 18th last, says the *Elektrotechnische Zeitschrift*, all the lines of the Budapest tramway network have been operated by electricity. There is in that town about 110 miles of track, of which a third is worked on the underground conduit system and the remainder with overhead line-wires. The oldest of the electrically-equipped lines is one built in 1889 on the underground conduit system, and it succeeded so well that more lines were immediately started, and already in 1891 there were 16 miles of track worked on this system. There are now three power stations, these providing power to the 2·3 miles of underground railway as well as to the tramways. The plant capacity is about 8,000 H.P., and the total number of motor cars is at present 400, of which 160 are equipped with single motors, and the remainder with two motors. Trailers are also used extensively.

Life of Motor Gearing and Trolley Wheels.—The United Traction Company, of Pittsburg, reports to the *Street Railway Journal* that the average life of its wheels is 35,000 miles, and it estimates that about one-third of this life is secured by prompt grinding of the wheels when flat spots are developed. The Consolidated Traction Company of the same city buys its wheels on a mileage basis, the manufacturers guaranteeing a life of 30,000 miles for each wheel, replacing those which have a shorter life and obtaining credit for those which have a longer life. The general manager of the United Traction Company, of Pittsburg, is somewhat less precise, and reports the average life of motor gears on his line as two years, and the average life of pinions, nine months. The latter service is an exceedingly severe one on account of the many grades on the line. The average life of trolley wheels of this company is 1,000 miles, and the conditions under which they operate are quite severe, as the company has on its main line 18 railroad crossings. A tempered copper wheel is employed. In Mr. Philip Dawson's recent Paper read before the Institution of Mechanical Engineers, as the average experience with over 7,000 tramway motors, cast-iron gearing was said to last somewhat over 30,000 miles, and steel gearing nearly twice as long.

Battery Traction in Chicago.—The Englewood and Chicago Electric Street Railway Company, says the *Street Railway Journal*, has been actually in operation exclusively by storage-batteries for slightly more than one year, and its cars have just completed 400,000 miles of service. This road was built in the most solid and substantial manner expressly for storage-battery work. Late in 1896, a few cars from the Madison Avenue (New York City) line were put in service, but it was not until January 1, 1897, that the first lot of new cars, built expressly for the road, commenced running. This number was increased as rapidly as possible, and last summer, on the heaviest days, twenty 30ft. motor cars, each with a trailer, have been required. The Company owns 44 sets of batteries, and up to the present time these batteries have averaged nearly 9,500 miles of service each, the maximum being about 13,500 miles. So far there is no perceptible depreciation of the plates, and to all appearances they have yet a long lease of life. Nothing has been spent on maintenance account. The receiver, G. Herbert Condict, states that the entire operating expenses of the road in 1897 amount to but 8c. per car mile, or 8½c., including the expenses of the receivership. This is an extraordinarily low figure, even for a trolley line, and one which has never hitherto been approached in storage-battery work. The cars run about 200 miles each per day, which is responsible for the low cost per car mile of "car service" labour. Mr. Condict, who is most fair and conservative in his statements, is unwilling as yet to say positively that storage-battery traction is on this road cheaper than the overhead system would be, but says that if the batteries, which, as before stated, are apparently in as good a condition as when first installed, will last from 8,000 to 10,000 miles more, a distinct economy in comparison with the overhead system would be shown.

A Method of Determining the Efficiency of Dynamos.—Cases often occur in which two precisely similar dynamos cannot be obtained for an efficiency test by Hopkinson's method, and in such cases our contemporary, *l'Electricien*, recommends a method due to M. Routin. It consists in determining each of the losses in the machine independently. The copper losses are, of course, calculable, and it only remains to measure the losses due to hysteresis and Foucault currents and those due to friction, &c. The machine is first run as a motor to a speed considerably above its normal, the current is then switched off, and readings with a speed indicator are taken while the machine slows down, enabling a curve to be drawn connecting angular velocity with time. If a tangent be drawn to the curve at the point representing the required speed, the power absorbed by friction $= p_1 = MR^2 \tan \alpha$, where M is the mass revolving, R is the radius of gyration, and α is the angle made by the tangent with the abscissa (time). It is, however, unnecessary to know M and R, as these can be determined by adding a small Prony brake absorbing a power q, and making the same observations as before. Then $p_1 + q = MR^2 \tan \alpha'$; and, combining the two equations, $p_1 = q \tan \alpha / (\tan \alpha' - \tan \alpha)$. The iron losses are determined in a similar manner by running the machine as a motor, and, after breaking the armature circuit only and maintaining the excitation, obtaining a third curve giving the rate the machine slows down. Then if p_2 be the iron losses, and $\tan \alpha''$ the new rate of decrease in angular velocity, $p_1 + p_2 = MR^2 \tan \alpha''$, and $p_2 = p_1 (\tan \alpha'' - \tan \alpha) / \tan \alpha$. The method as described takes no account of the increase, both in the friction and iron losses, at full load; our contemporary states that M. Routin modifies the method to make allowance for the latter, but the modification is not detailed in the article in question, it being considered that this increase is relatively small. No figures are given, however, to enable one to judge of the accuracy under these conditions. The method has at any rate the advantage that very little electrical horse-power is needed for the test and no second machine, and, as in Hopkinson's method, it is the losses themselves that are measured and not merely the input and output of power.

Model Testing Tank in the Washington Navy Yard.—A number of electrical appliances will be used in the equipment of the large experimental tank now being erected in the Washington Navy Yard for the purpose of testing models. From an article in the *Western Electrician* it appears that the towing carriage which spans the basin is to be driven by electric motors taking current through a trolley. There are four motors, and the speeds will vary from 1 to 20 knots an hour. "The dynamometer for measuring the resistance of the models," says our contemporary, "together with the apparatus for recording the results and the necessary fixtures and electrical instruments required, will be grouped on a platform at the centre of the carriage. This platform can be raised or lowered to suit the various models. The dynamometer consists of a very clever adaptation of the spring balance under electrical control. The model is attached by a towing rod to one end of a spring, while an electric motor moving a threaded shaft holds the other end under control. The moment the carriage starts an electrical contact, working automatically, throws the motor in gear and starts the tension of the spring and keeps it up till the pull of the motor at one end exactly balances the pull of the model at the other end; another electrical contact preserves this counterpoise. The position of the motor-moved end of the spring denotes the tension or resistance of the model; and

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an arm reaching up to a cylinder carrying a sheet of paper traces with a pen a record of this resistance and its variations. This cylinder, before which one of the operators sits, revolves at a fixed ratio to the advance of the carriage. Other pens register any change of trim, settling by the bow or the stern, at regular periods, and the actual distance and position of the carriage at every interval of the run. These latter elements are checked electrically from the track and must be positive, and, by the combination with the time record, determines the actual speed of the carriage at any point in its run. The result is a diagram of simultaneous records from which everything can be read and checked with ease."

Electrical Power Transmission.—At a meeting of the South Staffordshire Institute of Iron and Steel Works' Managers at Dudley on Saturday, Mr. H. W. Ravenshaw read an interesting Paper on "The Application of Electricity to the Transmission of Power." The President (Mr. Hall) prefaced the Paper by remarking that in the iron trade they could not expect any material rise in price in the near future, and therefore what they had to look to was greater economy and more perfect methods of working. In 1895 the output of iron was 8,000,000 tons, in 1896 8,500,000 tons, and in 1897 9,000,000 tons. That was satisfactory, but the fact remained that the average price in 1897—with a greater output—was positively lower than in 1896. The author, in his Paper, said that for years in an engineering works, mill, or colliery immense quantities of coal were uselessly consumed in wearing out belts and bearings and in raising steam which was to be condensed in long lines of steam pipes, and perhaps re-evaporated in the cylinders, without any useful purpose. Transmission of power by electricity was decidedly economical; the loss in a good dynamo was not more than 7 per cent., only another 5 per cent. need be lost in the cables within a radius of, say, half-a-mile, and the loss in the motor and gear for reducing the speed to, say, 100 revolutions per minute need not be more than 12 per cent. These figures gave a total efficiency of about 76 per cent., and with boilers evaporating 8lb. of water per pound of coal, and engines using 24lb. of steam per brake-horse-power hour, a consumption of less than 4lb. of coal per brake-horse-power delivered to machines could be obtained. In collieries 500 volts were generally employed, and with this pressure several hundred horse-power could be transmitted over a radius of at least one mile without difficulty. In a works covering a comparatively small area, however, both lighting and power could be obtained from a 200-volt circuit with economy. A good many works and mills had been fitted for 100 volts, but there was no advantage in so low a pressure, while with 200 volts a very great saving was made in the cost of cables. Mr. Ravenshaw then showed on the screen a very interesting collection of applications of electricity to the driving of machinery. He explained that electric appliances were peculiarly well fitted for cranes, whilst electricity was largely used in and was very useful for the purpose of pumping. In the discussion which ensued the chairman said that at one time nobody was more prejudiced against electricity as a motive power than he was; but during the last few years he had followed more closely what was being done in the electrical world, and he was now a complete convert. If he had to put down works on the morrow he should adopt electrical transmission. Mr. Ravenshaw is to be congratulated on having made a worthy convert.

Water-Power Utilisation in the Sierras.—The *Journal of Electricity* of San Francisco has a long description of a water-power utilisation plant which has been put down amongst the Sierra Nevadas in California by the Blue Lakes Water Company. The Blue Lakes are situated near the summit of the Sierra Nevadas, and are drained by the Mokelumne river, which, with the Amador canal and a length of open conduit, serves to convey the water to a steel pipe line laid on a grade averaging about 40 per cent., the total length being about 1,000 yards, the diameter of the pipe contracting from 48 inches at the intake to 22 inches at the branches near the power house. This pipe line follows down a contour of bed-rock to which it is securely anchored, its final section being composed of lap-welded steel pipe $\frac{3}{8}$in. to $\frac{1}{2}$in. thick, with socketing flanges packed with sheet lead gaskets. This construction remained tight till a test pressure of 1,200lb. per square inch was reached. The head secured by this pipe line is 1,043ft. at the wheel nozzles, and although the water column is so long, no receiver or air-vessel is provided to relieve any water-hammer. It is stated, however, that the nozzles cannot be opened or closed within three minutes. The power house measures 35ft. by 100ft., but only about half the space is now utilised. The wheel and generator sets have their axes horizontal, as is usual with impulse wheels, each unit set being contained within a space 11$\frac{1}{2}$ft. by 12ft. by 7ft. There are three such sets, each consisting of a four-foot Doble wheel running at 600 revolutions per minute and rated at 700 H.P., encased in a cast-iron housing, and directly coupled to a 450 kilowatt two-phase Stanley inductor generator. The water-wheels and flywheels on these sets overhang outside the bearings on either side of the generators and have no outboard bearings. The weights on the shafts of each set is about 20,000lb., of which the water-wheel weighs 2,000lb., the indicator 14,000lb., and the flywheel 4,000lb. There are four nozzles to each wheel, which at present is governed by hand, though governors are to be so arranged that two nozzles of each wheel will be hooded by the governor and the remaining two throttled by hand as required. The frequency of the current from the generators is 120 alternations per second, and the pressure from 2,000 to 2,400 volts. There are two exciters, each of 10 H.P. capacity, of the multipolar type, furnishing current at 60 volts, and each capable of exciting the fields of all three 600 H.P. generators. Since in a polyphase plant the phases are fixed in relation to one another, in this plant the leading phase only is taken to the synchronising apparatus, which is of the usual kind used in single-phase work. On a trial, the three generators were first run independently, then synchronised, after which the water was cut off from the wheels of two generators, which were run as motors for the rest of the evening, taking two-phase current from generator No. 3. The transmission lines, it is needless to add, are of overhead pole construction, but substantially carried out.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, January 21st.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House, W. Agenda: (1) "On Electric Signalling Without Conducting Wires," by Prof. O. Lodge, F.R.S. (2) A Tesla oscillator will be exhibited by Prof. S. P. Thompson, F.R.S.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Lecture on "Laboratory Testing Machines: and the Latest Example," by Prof. A. C. Elliott, of Cardiff.

SATURDAY, January 22nd.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to the Engineering Laboratory of the Central Technical College, South Kensington. Demonstration by Prof. W. C. Unwin.

MONDAY, January 24th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Palatine Hotel, Hunt's Bank, Manchester. Paper to be read: "The Cost of Heating and Cooking by Electricity," by W. P. Adams.

THURSDAY, January 27th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Notes on the Electro-Chemical Treatment of Ores containing the Precious Metals," by Major-General Webber, Past President.

FRIDAY, JANUARY 28th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting at 25, Great George-street, Westminster. Paper to be read: "Condensing Apparatus," by H. Williams.

SATURDAY, January 29th.

INSTITUTION OF JUNIOR ENGINEERS.

7 p.m. Anniversary Dinner at the Westminster Palace Hotel. The President, Mr. John A. F. Aspinall, in the chair.

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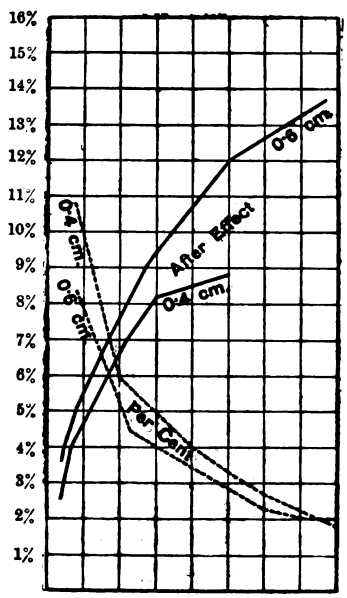
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Theory of Polarisation.—In a recent Paper read before the Vienna Academy, F. Streintz came to the conclusion that "the determination of the galvanic polarisation in the original circuit is an impossibility." This discouraging conclusion extended also to the methods in which alternating currents are employed. A. Oberbeck now shows, by some simple but telling arguments, that the actual polarisation may be closely approached along several lines of experiment. There are two limiting cases—polarisation by very strong and by very feeble currents. When exposed to the latter, a cell behaves practically like a condenser, or rather like two condensers in series. As the polarising force increases, active polarisation sets in, which increases with the capacity. The capacity may be regarded as some function of the polarisation. It becomes infinite when a certain superior limiting value of the polarising force is reached which produces the maximum polarisation. After that the polarised cell behaves like a constant cell opposed to the main current. These considerations, and the equations in which they are embodied by the author, lead to the experimental determination of all the quantities involved. There remains only one process which is as yet insufficiently understood. It is called bythe author "spontaneous depolarisation," and means that a portion of the polarising ions becomes ineffective in time.

[Oberbeck, *Wied. Ann.*, No. 13, 1897.]

Magnetic After-Effect.—Soft iron when exposed to a weak magnetic field does not at once assume the maximum temporary magnetisation, but sometimes only after the lapse of



several minutes. This phenomenon has variously been termed creeping, viscous magnetic hysteresis and magnetic after-effect. I. Klemenchich has shown that, instead of disappearing in stronger fields, this after-effect goes on increasing, but not at the same rate as the total magnetisation. In other words, the portion of the magnetisation which "oozes in" becomes small in comparison with what is instantaneously established, when the magnetising force grows stronger. Two typical cases are shown in the diagram, where the continuous curves show the creeping of the magnetometer needle between 2·8 and 60 seconds, and the dotted curves the percentage of this after-effect in the total change of magnetisation.

[Klemenchich, *Wied. Ann.*, No. 13, 1897.]

Electrostatic Vibrations.—F. Melde, who has devised some beautiful acoustic experiments with long threads, has made electric discharges available for producing vibrations of strings which hitherto have been produced by electromagnets and troublesome mercury contacts. His arrangement recalls the familiar device of setting bells ringing by means of a little metallic ball which works to and fro between two bells until the charge is exhausted. Instead of bells there are the knobs of an influence machine or a battery of jars, and an insulated metallic thread, such as embroiderers' "gold thread," is stretched out horizontally between them. By suitably arranging the distance between the knobs, the string may be made to vibrate as a whole, or harmonic vibrations may be produced by damping it at the nodes. If this method could be made available for musical notes, a new musical instrument worked by electrical means would be at our disposal.

[Melde, *Wied. Ann.*, No. 13, 1897.]

Atomic Magnetism.—G. Jäger and S. Meyer have found a new and simple relation between the paramagnetic metals which promises to be of great interest. They investigated the magnetic susceptibilities of the chlorides, sulphates, and nitrates of iron, nickel, cobalt, and manganese in an aqueous solution at various temperatures. The method used was that of Quincke's manometer, but instead of reading the differences of level, the pressure was measured which was necessary to reduce the meniscus to its former level after the magnetic field had been excited. The "magnetic pressure" was measured for fields ranging from 10,000 to 18,000 C.G.S. units, and for half a dozen temperatures between the boiling-point and the freezing-point of water. It was found that the nature of the salt does not matter, only the metallic atoms being of influence. The absolute values of $\kappa \times 10^6$ for one gramme-atom of each of the metals are:—Nickel 4·95, cobalt 10, iron 12·5, manganese 15·0. Hence the "atomic magnetisms" of these four elements are strictly in the ratio $2:4:5:6$. There is a gap between nickel and cobalt. A comparison with Quincke's work makes it extremely probable that chromium fills up this gap. There is thus a new relation between the paramagnetic metals which may shed a new light on the magnetic behaviour of the elements. It remains to be seen whether any other elements are capable of entering this series. It must be remembered that G. Wiedemann suspected this numerical relation long ago, and put down the series $a:(a+b):(a+\frac{3}{2}b):(a+2b)$. It is now seen that $a=b$.

[Jäger and Meyer, *Wied. Ann.*, No. 13, 1897.]

Stratified Discharge in Open Air.—When the discharge of large batteries is retarded by high resistances an indistinct stratification of the discharge is often seen. Max Toepler has succeeded in obtaining a sharply-stratified discharge, even at atmospheric pressures, which closely resembles the stratified anode light. When the long slow spark is allowed to pass freely between the knobs there is usually a singular point along its length which appears to divide off the negative from the positive light. This division may be emphasised by interposing a semi-conducting plate of dry slate, granite, syenite, or basalt. The negative portion then appears distinctly stratified. In all the observations the following jar circuit was used: Positive influence machine terminal, inner coatings of two jars, large water resistance, positive knob, spark gap with semi-conductor, negative knob, inner coatings of two jars, negative machine terminal. By a 60-plate Toepler machine the jars could be so far charged that a voltage of 80,000 was available. The duration of the slow discharges was about ¼-second. The residual discharge was about 90 per cent. of the total. The best arrangement for stratification consisted in bringing the plate rather nearer the anode. The negative portion of the spark consisted invariably of a bright whitish-violet emanation surface on the cathode and a series of strata up to 6. The colour of the latter is a pink violet at the feebler discharges, which shades into a yellowish pink as the discharge increases in strength. The positive light is usually continuous, but sometimes shows a faint stratification, and the plate acts towards it as an independent cathode, just as does the metallic net in the vacuum tube of Ebert and Wiedemann's experiment. Between the emanation surface and the first stratum of the cathode light there is a sharp black space, usually very narrow. This is a remarkable analogy with the vacuum phenomenon. When

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the arrangements remain the same the strata appear at the same places, as is beautifully shown by a photograph containing 10 superimposed discharges. The strata correspond roughly to equipotential surfaces round the cathode. When the cathode is removed it takes its strata away with it, and when the semi-conducting plate is moved the strata remain unaltered in position. The general conclusion is that there is no essential difference between ordinary spark discharges and vacuum discharges.

[TOEPLER, *Wied. Ann.*, No. 13, 1897.]

ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.*

BY J. ELTON YOUNG.

(Concluded from page 379.)

Correction by Derived Circuit.—Applying the "resultant fault method" to compute the error in A's loop and potential results (5) in the foregoing five cases, it will be seen that its efficiency depends on the ratio $\frac{f_2}{c}$. Thus in Case I. we have

$$\text{Error } k = \frac{cf}{f_2 - f}, \text{ where } f = \frac{f_1 f_2}{f_1 + f_2} = 9{,}615$$

and $c =$ say 1,928. Hence K = 76·9, or the corrected result, is practically exact. Treating the other cases similarly, and tabulating, we find:—

Case.	$\frac{f_2}{c}$	Error in correction of result (5).	Value of correction.
I.	125	+0·4 ohms.	Exact.
II.	2	−81 ohms.	Some advantage.
III.	10	−4 ohms.	Good.
IV.	0·2	(−1,920 ohms.)	(Useless).
V.	1	−200 ohms.	No advantage.

So that roughly it may be said that the "resultant fault method" is of no advantage unless $\frac{f_2}{c}$ be greater than 1, and that it is approximately exact when $\frac{f_2}{c}$ is greater than 10.

When the resistance of the second fault is not greater than that of the line between the faults—or indeed in any case where it is desired to estimate the allowance to be made for an interfering fault, of which the position is known and the resistance during the tests may be roughly guessed—a correction may be arrived at by derived circuits.

Thus, taking Case V. for instance (Fig 49):—

To correct A's Free reading (600 ohms).—Assuming the apparent values $a = 384$, $c = 816$, $f_1 = 216$, assigned by the Blavier result, the required error is found by computing the shunting effect of $(c + f_2)$ on f_1. The joint resistance of these being $\frac{216 \times 1{,}816}{216 + 1{,}816} = 193$, the error is 216 − 193 = 23 ohms, and A's corrected reading = 623 ohms.

To correct A's Earth reading (592 ohms).—As before assuming $c = 816$, $f_1 = 216$, calculate the joint resistance

$$\frac{f_1(c+b)}{f_1 + c + b} = 208.$$

Substitute $\frac{bf_2}{b + f_2}$ for b and this becomes 191; thus the error introduced by f_2 is 17 ohms, which is the amount to be added to A's reading, making it 609 ohms.

From these corrected readings a more accurate Blavier result can now be found; and using the new apparent values of a, c, f_1 thereby furnished, a second closer approximation may be made to the correction sought for.

In dealing with B's readings, the allowance can be arrived at more directly, but is on the other hand of greater magnitude. Referring again to Case V. (Fig. 49):—

To correct B's Free reading (5,400 ohms). We have a joint resistance beyond f_2 of 600, of which the component $f_2 = 1{,}000$ is roughly known; it follows that the part $c + f_1 = \frac{1{,}000 \times 600}{1{,}000 - 600} =$ 1,500. The corrected reading therefore is about 4,800 + 1,500 = 6,300 ohms.

To correct B's Earth reading (5,333 ohms). We treat the resistance 5,333 − 4,800 = 533 in the same way; thus $\frac{1{,}000 \times 533}{1{,}000 - 533} = 1{,}141$. The corrected reading would therefore be about 4,800 + 1,141 = 5,941 ohms.

Leakage Allowances in Loop Tests.—Considering a single interfering leak f_2, as in Fig. 44, it is evident, from the equations in Case I., that the error in L, *i.e.*, the difference between its true and apparent values, is

$$c - \frac{c(f_1 + f_2)}{c + f_1 + f_2},$$

from whichever end it be observed. It will also be seen that the difference between the observed and the true values of r is

$$\mp \left\{ c - \frac{c(f_2 - f_1)}{c + f_1 + f_2} \right\},$$

according as A or B is balancing. It follows that the error in the result $\frac{1}{2}(L - r)$ is

$$\frac{1}{2}\left\{ \frac{c(f_1 + f_2)}{c + f_1 + f_2} - \frac{c(f_2 - f_1)}{c + f_1 + f_2} \right\} = \frac{cf_1}{c + f_1 + f_2},$$

when A is localising; and

$$c - \frac{cf_2}{c + f_1 + f_2}$$

when B is localising.

Thus A's error vanishes when f_1 the resistance of the fault is negligible, whilst both errors disappear when c the distance between the fault and leak becomes zero. Applying these two formulæ to the figures of Case II., using the value of c

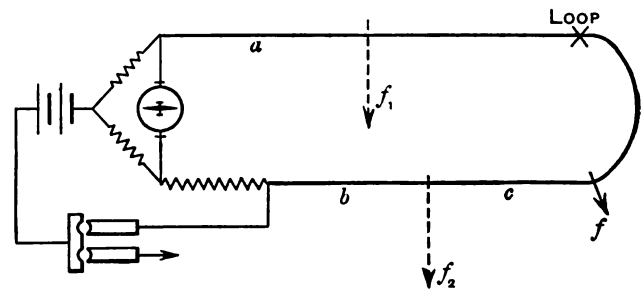

FIG. 50.

furnished by the result (5), say 4,840 ohms, and assuming $f_1 =$ 800 ohms as a guess, we should find the approximate correction for A's loop localisation to be

$$\frac{4{,}840 \times 800}{4{,}840 + 800 + 10{,}000} = 96 \text{ ohms};$$

whilst that for B's would be 1,648 ohms, making the corrected distances 265 ohms and 332 ohms respectively. A second approximation to c and f_1 would still further reduce the error.

The problem of correcting rigorously for *two* leaks, one on each limb of the loop, leads to lengthy formulæ, the labour of which is not repaid practically, since the data are not known with sufficient accuracy. It may, however, be solved approximately when the resistance of the fault is *low* by the following simple method, pointed out by Murphy: Let f (Fig. 50) be the fault under localisation, $f_1 f_2$ a pair of leaks on the limbs of the loop, *i.e.*, the N.R.F.'s of the portions of the loop on either side of f. Then, provided f be *small* relatively to f_1 and f_2, the error in the observation of L is the sum, and that in the observation of r is the difference of the leakage effects on either side of f. It follows that the error in $\frac{1}{2}(L - r)$ amounts to the leakage effects on the *short limb only*; in other words it equals the difference between the true and apparent C.R.'s of the line up to the fault. Thus, in Fig. 50 the approximate error in localisation is

$c - \frac{cf_2}{c + f_2}$, or practically $\frac{c^2}{f_2}$, c being small relatively to f_2.

The localisation thus yields the apparent C.R. up to the fault, to which the above amount must be added to find the true C.R.

* *Extracted* from a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights reserved.

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For example, the Varley loop test for a fault in an ocean cable, made from the station nearer the fault, gave $r = 3{,}772$ ohms. A leak was known to exist within 200 ohms of the testing station, having a resistance of roughly one megohm. The true distance of the fault was therefore, assuming the leak 100 ohms distant,

$$3{,}772 + \frac{(3{,}672)^2}{1{,}000{,}000} = 3{,}785{\cdot}5 \text{ ohms.}$$

On an overhead line, since the loop localisation gives the apparent C.R. to the fault, its distance in miles would be determined, in the case of a line of uniform gauge, by dividing x by the *apparent C.R. per mile*. This would either be estimated by reference to a C.R. test taken in similar weather and temperature, or by observing the apparent C.R. per mile of the good line at the time of localising, and allowing for the usual ascertained difference between the two wires.

Since we are thus only concerned in the case of a low resistance fault, approximately, with the leakage effect on the short limb—*i.e.*, between the testing station and the fault—it is evidently best to localise from the end *nearest* to the fault. It is true that when the fault is near the testing station the error in the observation of r tends to a maximum; but since at the same time it tends to become equal to that in L, the error in $\frac{1}{2}(L - r)$ tends to a minimum. On the other hand, when the fault lies near the looping station the errors (that in the observation of r tending to vanish) become very unequal, and the resulting error in $\frac{1}{2}(L - r)$ tends to become a maximum.

If, instead of the apparent, were used the true value of L, found from records, the only error to be considered would be that in the observation of r. In this case it would be best to localise from the end furthest from the fault, so that the leakage effects on either side might tend to balance each other. Results thus obtained are, however, generally less accurate than those arrived at with L apparent and fault near testing station.

In short, if no leakage correction is to be applied, a loop localisation made from the end nearest the fault is more accurate when L is apparent, and when made from the further end is more correct when L is true. But the proper plan is to make the leakage allowance as above indicated.

When, however, f is a *high resistance* fault the foregoing rules are inadmissible, and the best plan is to apply the N.R.F. method of correction to the result of localisation. Here, since the error varies as c, the distance between the fault and the N.R.F. of the loop, it is best to test from the end *furthest* from the fault, so as to reduce c as much as possible.

Correction of Potential Test.—When the leakage is at a point it has been shown that the error in the results of Clark's potential test is the same as that in the loop results (with L apparent). The correction of v_1 for the leakage when it is *distributed* along the part of the line beyond the fault is given by the following formula, given by Kennelly:—*

$$\text{Corrected } v_1 = v_1 \times \frac{K\left(\frac{Rm}{r} + 1\right) + \frac{1}{K}\left(\frac{Rm}{r} - 1\right)}{\frac{2Rm}{r}}, \quad \ldots \quad (35)$$

where $\log K = {\cdot}4343\, m\, y$,

$$m = \sqrt{\frac{r}{i}},$$

r = C.R. of unit length of the line,
i = D.R. " " "
y = distance of fault from *further* end,

and R = high resistance through which line is earthed at the distant end for the observation of the potential v_1. This supposes that the potential v_1 is measured by a high resistance and galvanometer. If measured by electrometer or condenser the above expression reduces (R being ∞) to

$$\text{Corrected } v_1 = v_1 \frac{K + \frac{1}{K}}{2}. \quad \ldots \quad (36)$$

* See *The Electrician*, Vol. XI., p. 85, and Kempe's "Handbook of Electrical Testing," p. 454 (5th Edition).

Kempe's Potential Tests.—Mr. Kempe* has worked out an exact solution of the problem of localising a high resistance fault by fall of potential, assuming the leakage uniformly distributed along both x and y. It is as follows. Let

x = distance of fault in *nauts* from the battery end,
R = resistance inserted between battery and cable,
V, v = potentials observed (as in Clark's test) at battery end,
v_2 = ditto ditto at distant end,
l = length of cable in nauts,
m = true D.R. of cable per naut,
r = true C.R. of cable per naut,
ϵ = base of Napierian logs.; then

$$x = \frac{1}{2m} \log_\epsilon \frac{(V - v) + (v - v_2\epsilon^{ml})\, R\frac{m}{r}}{(V - v) - (v - v_2\epsilon^{-ml})\, R\frac{m}{r}} \text{ nauts.} \quad (37)$$

Should m and r be unknown, if R_i and R_e be the *apparent* total D.R. and C.R. of the cable before the fault occurred, the above equation may be solved by means of the relations:—

$$\frac{1}{2m} = \frac{l}{\log_\epsilon \frac{\sqrt{R_i} + \sqrt{R_e}}{\sqrt{R_i} - \sqrt{R_e}}}, \qquad \epsilon^{ml} = \sqrt{\frac{\sqrt{R_i} + \sqrt{R_e}}{\sqrt{R_i} - \sqrt{R_e}}},$$

$$\frac{m}{r} = \frac{1}{\sqrt{R_e R_i}}, \text{ and } \epsilon^{-ml} = \frac{1}{\epsilon^{ml}}.$$

He also shows that if the test be made by applying the battery direct to line through a galvanometer, and observing the value of the resistance R_n of the cable by direct deflection, at the same time that the potentials v, v_2 at its ends are measured, then

$$x = \frac{1}{2m} \log_\epsilon \frac{v + (v - v_2\epsilon^{ml})\, R_n\frac{m}{r}}{v - (v - v_2\epsilon^{-ml})\, R_n\frac{m}{r}}. \quad \ldots \quad (38)$$

In the foregoing Mr. Kempe assumes that if high resistances are used for the potential observations they are so high as to be negligible, the D.R. of the cable being low.

MR. J. W. SWAN'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.

Sixteen years ago I had the honour of bringing under the notice of the Society of Telegraph Engineers the question of a new mode of electric illumination by means of incandescent lamps. Mr. Preece was in the chair. I am sorry he is not with us to-night, and especially for the cause of his absence; may he soon return with renewed health! There was placed outside this building, at the back, a portable engine, of the farmyard type, and a Gramme dynamo, built—as all the dynamos of that time were—for lighting one or two arc lamps. This apparatus was managed by Mr. Radcliff Ward, who had the not easy task, marvellously well accomplished, of running the dynamo at the exact speed required for the lighting-up of a number of incandescent lamps attached to a kind of fitting that has since become generally known as an "electrolier." This, the first installation of incandescent lamps in London, was carried out by Mr. Fleetwood. When the gas was lowered and the current was turned on there was an audible expression of surprise as the lamps lighted up; and when, after a breathing space, it was realised that the room was for the first time entirely lighted by incandescent lamps, the manifestation of satisfaction was, I remember, very strongly pronounced. That occasion marked in an emphatic manner the beginning, or almost the beginning, of a movement that has gone on with increasing activity; until now it may be truly said that a great revolution in the means of producing artificial light for common use has been accomplished, a new and profitable industry has been created, and, incidentally, an impulse and inducement given to the larger and

* "Handbook of Electrical Testing," Chap. 22 (5th Edition).

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more general utilisation of electricity. We are confronted at almost every turn with evidences of beneficial change flowing, in some measure, from this source. Such change, for example, as that from the depressing darkness of the streets of London at night in the pre-electric light time to the almost daylight brilliance of many of them now—a change, I admit, not wholly affected without the aid of the arc light, nor even of the gas lamp; but that the gas lamp shines with an unwonted brightness, and that the arc lamps are there at all, are facts not distantly connected with the very general use of these unobtrusive little bulbs which were thought so wonderful at the time to which I am looking back, and are such universally familiar objects now. Sixteen years is not a long time in the history of industrial evolution, and yet what changes have occurred in the last 16 years! The entire space is crowded with electrical invention and electrical work, not confined to electric lighting, but extending over the wide and varied fields of electrical power transmission, electric traction and electro-chemistry. The successful introduction of electric lighting, and the great incidental improvements made in the machinery for transforming dynamic energy into electric energy, gave the impulse required to produce the immense activity that we witness to-day.

The domain of electrical engineering has broadened. When this Institution was founded, telegraph engineering was its principal feature; later, there grew up the new branches of electric lighting, electric traction, and the electrical transmission of power. These have so flourished that, if they have not over-shadowed the older branch, they have at least sheltered and supported it; and there is another branch vigorously growing and giving promise of immense enlargement—that of electro-chemistry.

This brings me to a subject of great interest to the electrical engineer, and especially to the young electrical engineer—"the world is all before him, where to choose"; and, in my belief, a moderate proportion of those who are aspiring to make their mark as electrical engineers would choose wisely in making a very special study of that portion of the field within which lies the application of electricity to chemical manufactures. The field is a wide one, and so far only a small corner of it has been cultivated, but that portion is already yielding rich harvests. There are now three or four flourishing electro-chemical industries of capital importance—the electrolytic refining of copper, the electrolytic extraction of aluminium, the electrolytic recovery of gold, and the electrolytic production of chlorine and of soda. Besides these, there are *other* successful chemical manufactures which rest on an electrical basis. Their importance is great even now, and is increasing. They afford opportunities for the advantageous exercise of special knowledge and skill on the part of the electrical engineer, who may be called upon to design suitable apparatus for carrying out known processes, or to invent new or improved means of effecting some unattained but desirable end. Considering the importance of this branch of electrical engineering, it seems to me—and I hope you may take the same view—that the time custom places at my disposal to-night will not be ill spent in a general review of *the rise and progress of electro-chemical industries.*

Early Work in Electro-Chemistry.

Two years hence there should be celebrated, in the city of Como, the centenary of Volta's great discovery, to which we owe the origin of electro-chemistry. Electrical phenomena had been diligently studied long before this time. But, if we except the action of the electric spark utilised by Cavendish to induce the combination of gases having an affinity for each other no marked electro-chemical effect had been observed up to Volta's time. There was, in fact, no knowledge of phenomena due to the sustained operation of an *electric current*, as distinct from those due to *intermittent discharges*. Closely following upon the announcement of the discovery of the voltaic pile, its analytical power was made known through the electrolysis of water by Carlisle and Nicholson. But it was Davy who first fully realised and demonstrated the transcendent power of the voltaic current to effect chemical decomposition. Davy made for ever memorable the year 1806 by the electrolytic extraction of potassium from potash. Distinctly prophetic as this was of other far-reaching kindred discoveries, I suppose that not even the imaginative mind of Davy ever entertained the idea that out of this embryo would grow any of these great manufacturing processes that are to-day shaking the foundations of some of the oldest and most important of our chemical industries. The method used by Davy in this historic experiment has so close a bearing on my subject, and is so intensely interesting in itself, that I think you will not grudge the moment it will take to read an account of it in Davy's own words. He says: "A small piece of pure potash which had been exposed for a few seconds to the atmosphere, so as to give conducting power to the surface, was placed upon an insulated disc of platinum, connected with the negative side of the battery of the power of 250 of 6 by 4, in a state of intense activity; and a platina wire communicating with the positive side was brought in contact with the upper surface of the alkali. . . . Under these circumstances a vivid action was soon observed to take place. The potash began to fuse at both its points of electrisation; there was a violent effervescence at the upper surface; at the lower, or negative, surface there was no liberation of elastic fluid; but small globules having a high metallic lustre, and being precisely similar in visible character to quicksilver, appeared, some of which burnt with explosion and bright flame, as soon as they were formed, and others remained, and were merely tarnished, and finally covered by a white film which formed on their surfaces."

Davy, fortunate in almost everything, was supremely fortunate in his *assistant, Faraday*. Never, surely, in the history of experimental science did the mantle of genius fall on worthier shoulders than when Faraday became the successor of Davy, and the inheritor of his methods and of his work. Great, immensely great, as is the debt owed by electrolytic chemistry to Davy, the debt is doubly great to Faraday. To Faraday we owe the discovery of the law of electrolytic conduction, without which knowledge industrial progress in the field of electro-chemistry would have been impossible; and, above all, it is to Faraday that we owe the first principles of the dynamo—principles applied to practical electrolytic work much earlier than is commonly supposed. Even as early as 1842 there were at work in Birmingham, for the electrolytic deposition of silver and gold, power-driven electric current generators, based on the dynamo-magneto-electric principle discovered by Faraday. One of these machines I saw not long ago, still doing duty at Messrs. Elkington's factory. These ancient machines were not called dynamos; the term "dynamo" had not issued from that mint which, by the coinage of a word, seems to create the thing signified. But these so-called magneto-electric machines were, to all intents and purposes, dynamos; they transformed mechanical power into electrical power through the medium of magnetism, and the dynamo of to-day is their direct descendant. During the 30 years following Faraday's discovery of magneto-electric currents, and its primitive application to electro-plating, I cannot recall in this connection any of those striking events which make a moment memorable, but the tools were being fashioned wherewith the way was to be cleared and the work of progress carried on.

Towards the end of that quiescent period, Wilde was building powerful machines for the electro-deposition of copper; and those great incentives to electrical engineering enterprise and progress, the telegraph and electric lighting, were already beginning to quicken the pace along the collateral lines of scientific and industrial advancement. To speak only of electric lighting, it should be noticed that in the fifties Holmes and De Meritens had designed efficient, if costly, magneto-electric apparatus for lighthouse illumination. The principle of magnetic self-excitation in an electro-magnetic generator was made known in 1867, and four years later the first really practical continuous-current machine was constructed by Gramme.. The two succeeding decades saw the evolution of the modern dynamo; and at the end of this period the critical point was reached when there was demonstrated, with sufficient clearness to captivate the commercial mind, the fact that for lighting, for transmission of power, and for effecting several important chemical operations, electricity, as produced through the dynamo, by the steam

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engine or by water power, was a thing of utility, and could be turned in all these ways to commercial advantage. These great uses of electricity have been for several years established on the secure basis of commercial success. This result has been reached through the co-operation of many minds, and especially by the union of the skill of the mechanical engineer with the specialised knowledge of the electrician the chemist. Out of this combination and concurrence of forces electrical engineering has grown, and, by making new demands, has reacted beneficially on purely mechanical engineering. The requirements of electric lighting have largely contributed to those great improvements and economies in electric power producing machinery, and in the steam engine itself, which have materially assisted in bringing about the degree of success which has now been reached in electro-chemical industries.

Copper Refining.

At the outset, 60 years ago, the only electrolytic industry then in existence was comprised in that small and closely-related group, electro-plating, electro-gilding, and electrotyping. Since then, and comparatively in recent years, the principle of electrotyping has been applied to copper refining. This has developed to such an extent that now one-third of all the refined copper required in the world is produced electrolytically. In 1896 the production was 137,000 tons. The product of one works alone—the Anaconda works—was over 80,000 tons. One great advantage of electrolytic copper refining over the old method is the saving of the gold and silver from the unrefined copper. But there is a further advantage, and one that electrical engineers especially appreciate, viz., the *higher conductivity* of electrolytic copper. The first Atlantic cable was made with copper that had a conductivity only 40 per cent. of that of pure copper. At that time it was difficult to buy copper free from arsenic. So completely has the electrolytic method of refining copper altered the old state of things, that lately, when I wanted a small quantity of arsenical sheet copper, I had much trouble in procuring it. The process of electrolytic copper refining is, as you know, simply electrotyping on a grand scale. An impure copper anode is dissolved, and pure copper is deposited upon a cathode in an electrolytic bath of acid sulphate of copper solution. The amount of power expended in copper refining relatively to the product is small. In this respect it is greatly different from that other electro-chemical industry—perhaps next in importance to copper refining—the extraction of aluminium. In electrolytic copper refining almost the whole of the electric energy is expended in overcoming ohmic resistance, therefore the power required for a given output may be reduced to a small amount by increase of the size of the apparatus. Hence the location of copper-refining works is not greatly influenced by the consideration of the cost of power; other considerations generally prevail in the choice of locality. The range of current-density within which reguline copper can be deposited is extremely wide. The size of the apparatus—regulated by a law analogous to Kelvin's law of balance, of the *cost of capital* against the *cost of power*—is, for a given output, usually large. It is found most economical to use a low current-density; the greater purity of the copper deposited under those conditions is an additional consideration determining that practice. In electrotyping, where *power* is a less important consideration than *time*, current-density is usually much higher. In this connection, I may mention experiments I made to ascertain how far it is possible to go in the direction of increase of current-density without detriment to the physical properties of the metal deposited. I found that under proper conditions it was possible to obtain tough copper with a current-density ranging from 1 ampere to 1,000 amperes per square foot of cathode surface. The conditions necessary to be observed were, to adapt the strength of the solution to the strength of the current, using, of course, the strongest solution with the largest current; and, when the current-density was high, to take suitable means to obtain extremely rapid circulation of the electrolyte. I found that regularity and smoothness of deposit were almost entirely dependent on the absence of solid particles held in suspension in the electrolyte, and that excrescences could be entirely avoided by taking care that the electrolyte was free from solid floating particles. I found also that an exceedingly rapid flow of the electrolyte over the cathode surface tended to the suppression of a crystalline condition of the deposit. This effect was most strikingly shown when the electrolyte was projected against the cathode surface with considerable force from a submerged jet. In the *Philosophical Magazine*, 1881, Vol. XII., p. 300, Tribe published an exceedingly interesting series of observations on the distribution of the lines of conduction in a liquid undergoing electrolysis; these showed me the causes of the wasteful growths round the edges of electrotypes. By applying remedies suggested by Tribe's results, I was able almost wholly to prevent this waste, to obtain nearly complete uniformity in the thickness of deposits, and entirely to prevent excrescent marginal growths. The general principle followed was the restriction of the sectional area of the electrolytic bath to, as nearly as possible, that of the plate intersecting it, so as to prevent curvature of the lines of flow.

In considering this branch of the subject, the question occurs whether it is economically possible to take advantage of the greater purity and higher conductivity of electrolytic copper that has not undergone fusion after electro-deposition. The common practice is to fuse electrolytic copper and cast it into ingots, and then proceed to roll and draw the ingots into the various sizes of bars and wire required in electrical work. This treatment results in a slight loss of conductivity. Some years ago I worked out a process in which a copper wire stretched in an electrolytic bath was, whilst receiving a deposit of copper, continually subjected to the action of wire draw-plates. This resulted in unlimited extension of the wire without increase of its thickness; all the deposit went to increase the length; and this might go on to an indefinite extent. The original wire formed a core, which as the process proceeded, dwindled towards nothing. There are on the table some pieces of wire made in this way, in the different stages of its growth. I ascertained the possibility of producing wire in this manner; but even with a rapid rate of deposit, such as I was able to use, I found the apparatus would be excessively costly, relatively to the output; and, being allowed, by the kindness of Messrs. Bolton, to witness the method of wire-drawing employed at their works, I was so impressed by the rapidity and simplicity of their process as to feel that, looking at the matter from a non-scientific point of view, unless there was something much more to be gained than 1 or 2 per cent. extra conductivity, the play was not worth the candle. I do not know whether, by the method proposed by Mr. Elmore of cutting a spiral from an electrolytically-deposited copper cylinder, a sufficient degree of economy of production can be obtained; but, so far, the ordinary process has not been interfered with by direct electrolytic methods of producing wire. Nevertheless, the greater purity and slightly higher conductivity of electrolytic copper that has not been subjected to the fusion treatment common in commercial practice, give to those attempts to produce wire from electrolytic copper that has not undergone fusion, at least a scientific interest and value.

Before I leave this subject of copper deposition, I must draw your attention to this mirror—one of the latest results of industrially applied electrotyping. It is made by depositing a thick backing of copper on a silvered glass matrix, and, after separation, coating the surface with palladium. This kind of mirror is intended as a substitute for the glass mirrors hitherto used in light projection. It has the great advantage over a glass mirror that a shot would not destroy, though it might damage it. The process has been worked out and patented by Mr. Cowper-Coles.

Similar methods to those used in copper refining are now being followed in electro-zincing. The words "galvanising" and "galvanised" are much abused in their application to that useful material *galvanised iron*. The coating of iron with zinc in the ordinary process of galvanising is, as we all know, not effected by electrolytic action, but there are, in practical operation, true galvanising processes, by which a hard and very adherent coating of zinc may be obtained without impairing the strength of the iron. The process is largely in use for galvanising boiler tubes. In one of several works where it is in

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operation, over 500 tons of tubes were galvanised in this way last year.

A characteristic feature of electrolytic copper refining is that the anode is formed of the same kind of metal as that deposited, and dissolves to keep up the supply of metal in the electrolyte. There is an equal and opposite action going on at the cathode and anode. But there is another class of electrolytic operations of perhaps even greater interest to the electrical engineer, and certainly of great economic importance, namely, that class in which the *ore*, and not the already reduced *metal*, furnishes the metallic supply to the electrolyte. This opens a very large subject, since there is included in it not only the extraction of copper, nickel, zinc, gold, aluminium and sodium, but also the great question of the electrolytic production of caustic soda and chlorine, and other substances hitherto produced by purely chemical operations. There have been many attempts to utilise the fact that copper matte or sulphide can be *cast* in the form of *plates* or *slabs*, and that such plates have a sufficient degree of conductivity to allow of their being used as anodes in an electrolytic bath. These attempts have not always been successful, but there is an interesting exception in the case of the copper-nickel mattes worked by the Canadian Copper Company, who refine copper and nickel electrolytically, and use the matte as anodes. The mattes contain about 40 per cent. each of copper and nickel, and 14 per cent. of sulphur, together with small quantities of silver, goid, and platinum. The power used in the production of 1lb, of nickel is nearly 1 electrical horse-power-hour.

Gold Extraction.

Before the introduction of the cyanide process for the treatment of gold ore various electrolytic methods, chiefly based upon the solvent action of electrolytic chlorine, had been proposed and worked; but the purely chemical cyanide process has largely, if not wholly, superseded these electrolytic methods for the primary treatment of gold ore. Messrs. Siemens and Halske, however, have patented and successfully introduced a method for treating the cyanide liquors from the tailings, or waste sludges, produced in cyanide gold extraction, and containing a very small amount of gold. An extremely dilute solution of cyanide is employed to dissolve the gold. This is afterwards subjected to electrolysis, with iron anodes and thin lead cathodes, with a current density of one or two tenths of an ampere per square foot. This results in an almost complete recovery of the gold in an adherent form upon the lead cathode. When the required amount of gold has been deposited the cathodes are removed, and the gold separated by cupellation This process appears to be exactly suited to the clean quartzite ore of the Transvaal. Over 1,000,000 tons a year of tailings, such as were formerly discarded as useless, are now profitably treated by this process.

Zinc Extraction.

The extraction of zinc from its ores by electrolysis is a problem on the solution of which much ingenuity and a considerable amount of money have been expended. It is a tempting problem, inasmuch as the method in common use of reducing the native sulphide or the carbonate of zinc to the state of oxide by calcination, mixing this with non-bituminous coal and distilling in clay retorts at an extremely high temperature, is absolutely barbaric in its primitiveness and its wastefulness. The quantity of coal consumed in the smelting of zinc is more than five times the weight of the metal produced. The cost for smelting involved in the production of a single ton of zinc, including coal, labour, pottery and stores, is generally not less than 80s.; and, as about 16 per cent. of the metal contained in the ore is unextracted, the loss of this at the present value of zinc ore makes an addition of 56s. to the cost of production, and a total of about £7. 16s. for smelting one ton of zinc. These figures are, of course, variable with the market value of zinc ore, also with the locality of the smelting works, and are based on the present value of zinc ore and the present cost of material and labour in England. Here would seem to be a great opportunity for the introduction of an improved method, and it is well worth considering again and again, notwithstanding past failures—and they have been many—whether this is not a case in which amelioration may be obtained by electrolytic methods. A step has been recently taken towards this object by means of a process (the invention of Dr. Hoepfner) at present being worked by Messrs. Brunner and Mond. In this process zinc chloride is electrolysed; the products are chlorine and zinc. Such zinc is purer than ordinary commercial zinc, and will no doubt be welcomed by the users of zinc in primary batteries. A specimen ingot is lying on the table. For the electrolytic treatment of that hitherto intractable class of ore such as the Broken Hill mine produces—the mixed sulphides of lead and zinc—two processes deserve mention—one, the Ashcroft process, because very extensive preparations have been made for carrying it out on a large scale; and the other, that of Cowper-Coles. This process is in actual operation on a small scale, and we have here some of the results. An interesting feature of these deposits (there is an example on the table) is, that they have been made on aluminium cathodes and stripped off, the film of oxide preventing adhesion. These bold attempts in new directions deserve success.

Aluminium Extraction.

One of the largest, the most important, and in many respects, the most interesting, of the electro-chemical industries is that of the production of aluminium. In 1855 the price of aluminium was not far from the price of *silver*, when silver was twice its present value; now, bulk for bulk, it is the price of *copper*. It is no longer bought by the *ounce*, but by the *pound* or *ton*. The full measure of change has been brought about by the employment of electrolytic extraction. The purely chemical method had been highly elaborated before the electrolytic process was brought into competition with it, but the lowest price of the chemical product was three or four times the present price of the metal. It is an instance of an electrolytic method displacing a thoroughly elaborated and established chemical method, and of the enormous increase in demand that has followed a reduction of price. The production at the present time is, I estimate, not less than 2,000 tons a year. At least 10,000 H.P. is absorbed in this industry alone, and power to double that amount is about to be applied to it. There is every probability that new uses will be found for the metal, and that the manufacture will become a much larger one than it is at present. Prof. Richards, well known as the author of the most complete work on aluminium, says, in a letter I recently received from him: "The end of the century sees another metal added to the list of *common* metals; a metal whose ore is as plentiful as that of iron, whose cost of production is steadily decreasing, and whose uses are just as steadily increasing. It is bound to stand next to iron in its production and in its usefulness to mankind." Although English enterprise was prompt to adopt and improve the original chemical process, the production of aluminium had wholly departed from us until the British Aluminium Company recommenced the manufacture in the electrolytic form, across the Border, attracted there by the advantage of cheap water power.*

The process by which aluminium is extracted in America, on the Continent, and in Scotland to-day, is in principle exactly similar to that by which Davy extracted potassium from potash 92 years ago. The electrolyte is kept in a state of fusion by the electrically-generated heat. There are nominally two processes in use, but the difference is extremely small—chiefly a slight difference in the composition of the electrolyte. That known as Hall's process has as its distinctive feature an electrolytic bath composed of potassium fluoride in which alumina prepared from bauxite is continuously dissolved; while in Heroult's process the solvent of the alumina consists of cryolite, the double fluoride of aluminium and sodium. The electrolytic furnace consists of a carbon-lined iron box connected with the negative pole of a dynamo; this contains the electrolytic bath. Massive blocks of carbon are connected with the other terminal of the dynamo, and form the positive pole. These are immersed in the bath of fused material, and nearly reach the bottom. The carbon used in the manufacture of the

* (Mr. Swan here called attention to a carbon anode and a number of most interesting aluminium products illustrating the manufacture, kindly supplied for the occasion by the British Aluminium Company, through the managing director, Mr. Ristori, to whom he tenders his thanks.)

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anodes and for lining the furnace is required to be of great purity and hardness. The current-density employed is very large—about 700 amperes per square foot of cathode surface, about 8,000 amperes per cell. A difference of potential of 5 volts is maintained between the electrodes. In practice, 14 E.H.P. hours are expended in the production of 1lb. of aluminium. If a mean pressure of 5 volts is assumed, the theoretical yield should be nearly ⅓lb. more; there is, therefore, some secondary and wasteful action as well as true electrolytic action, going on, and room for further economy.

Sodium Extraction.

The experiment by which Davy set free the few minute globules of metallic potassium in the little pool of fused potash has to-day its fruition in the electrolytic process of Castner for the extraction of *sodium*. In the Castner sodium process an electrolyte of fused caustic soda is employed, with an anode of iron and a cathode of copper. The sodium is reduced at a comparatively low temperature, and while in a fused state is run off into moulds. By this process there is produced in one works 260 tons of sodium a year. Sodium is also extracted electrolytically in Germany, and, I believe, in America also. The electrolytic process of sodium extraction is so much more economical than the chemical process as to have almost completely displaced it.

(To be concluded).

THE "OERLIKON" ELECTRIC LIFTS.

The Maschinenfabrik Oerlikon manufacture a type of electric lift which carries its own motor, a system referred to by Mr. E. K. Scott in the discussion on Mr. Ravenshaw's recent Paper

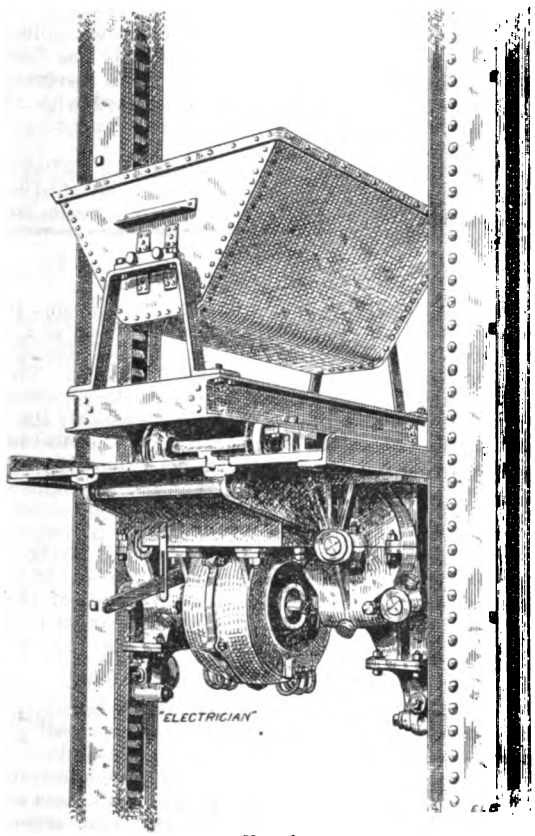

Fig. 1.

at the Institution of Civil Engineers. This system was first tried by them for a 1-ton lift in 1894, and its success was such that the method has been constantly employed since. Two lifts constructed on the Oerlikon Company's principle are shown in Figs. 1 and 2. An electric motor is attached to the under-side of the cage, and drives a worm gear at each end of its shaft. There is a spur wheel attached to the shaft of the wheel of the worm gear on each side, and this gears into one or two pinions which work in the rack on the upright girders, the latter serving also as guides for the cage. Sometimes the connection between the motor and the spur wheel is effected through two worm gears instead of a single one.

The lifts are all worked with three-phase current, the motors having thus the same speed whatever the load. If the current is interrupted in any way, an electric brake comes automatically into action, and, to ensure absolute certainty in working, the gear is duplicated and there are two pinions working in each rack in the latest pattern. When counterweights are used, at least two independent ones are employed, and the motor can furnish enough power to bear the lift even if one of the ropes break.

If silent running is essential, double-helical teeth are used for the rack and pinion, but in many cases a rack built up with studs, and a pinion with straight teeth is sufficient. The rack of the 1-ton lift shown in Fig. 1 is built up in this way, and the 1½-ton lift in Fig. 2 has double helical teeth. It is claimed by the makers that not only are these lifts considerably cheaper to manufacture and erect than the pattern described by Mr. Scott, in which screwed spindles and nuts are used instead of racks and pinions, but that the working is more economical, as worm-gearing of very high efficiency can now be produced.

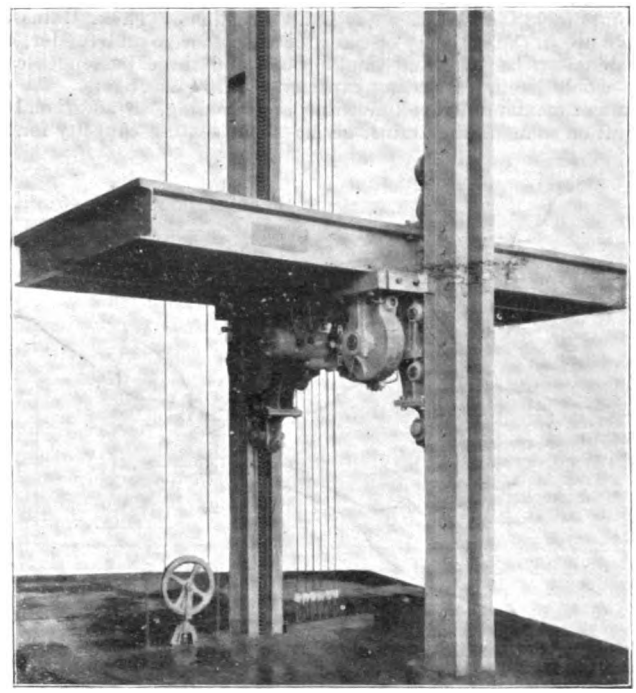

Fig. 2.

A PROBLEM IN ELECTRIC TRACTION.*

BY CHARLES T. CHILD.

This article proposes to deal, in a general way, with the problem of adopting electric means for the operation of one of the most complete suburban systems of transit in existence, that of the Pennsylvania Railroad centring in the Broad-street station in Philadelphia. Within the limits of space necessarily imposed it is manifestly impossible to go into much of the interesting detail of such an extended subject. It can here be discussed only from the engineering side.

Description of the System.

The passenger trains entering and leaving the Broad-street station may be divided into three classes: Expresses, which run long distances at high speeds, making but few stops; local expresses, which run at intermediate speeds, stopping only at the more prominent stations; and local trains, making comparatively short runs and stopping at all stations. The present discussion will

* Abstract from the *Electrical World* of New York.

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confine itself to the case of the local trains, the limit of distance operated being about 32 miles. Referring to the map, Fig. 1, it will be seen that the system consists of five branches or divisions, converging to a point on the west side of the Schuylkill River, from which they run on an elevated structure to Broad-street, a distance of about 1·3 miles. The whole system comprises 160·4 miles of double track, with 159 stations. The following table gives the lengths of the various sections, and the average distances between stations on each.

—	Stations.	Lengths. Miles.	Average distance between stations. Miles.
Maryland division to Wilmington	29	26·8	0·956
Central division	26	27·4	1·096
Main line	32	32·4	1·045
West Chester branch	6	6·7	1·340
Phœnixville to Fraser	10	11·2	1·244
Schuylkill Valley to Phœnixville...	28	28·0	1·037
Chestnut-hill branch	11	6·6	0·660
New York division to Bristol	21	22·4	1·120
Bustleton branch	5	3·1	0·775

With the present steam service there are operated on this system a total of 398 local trains a day in all directions. These trains are made up, in the majority of cases, of a locomotive and tender, one combination baggage and smoking car, and three passenger cars, the whole having a seating capacity of 210 passengers. At the hours of maximum travel, morning and evening, an additional car is put on some of the trains, giving them seating capacity for 270

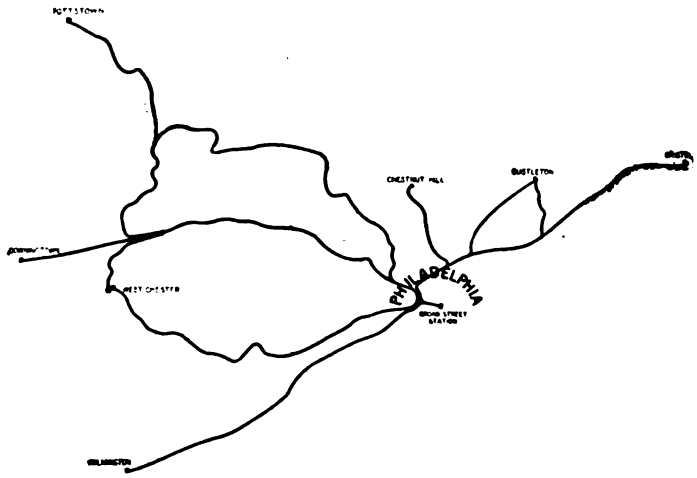

Fig. 1.—Outline Map of Electrical Railway System.

passengers each. The minimum headways, under present conditions, are between the hours of 4.30 and 6.30 p.m., and range from 30min. on the Schuylkill Valley division to 12min. on the main line.

Conditions Determining the Design of an Electrical Equipment.

It is proper here to briefly indicate the objects to be attained by the equipment of these railways with electricity. First and foremost comes the possibility of higher average speed, reducing the time of transit to any given point, and thus popularising the service. Second, and scarcely less important, is the ability to run a larger number of lighter trains at more frequent intervals, practically eliminating the schedule during the crowded hours of the morning and evening. It is hardly necessary to speak of the further advantages of electric traction for this service, the increased cleanliness and quiet of the trains, the flexibility of the system, or its convenience and simplicity of operation. For higher speeds the needed requisites are comparatively light trains and large power available for acceleration. Running at frequent headways the trains could be reduced to three cars, one of them being equipped with motors, having a total seating capacity for 150 passengers. Such trains complete with motors and a load of passengers would weigh 72 tons, the cars being of about the type now used on the Manhattan Elevated Railway in New York. The calculations and figures given hereafter are based upon this train weight and a running speed of 40 miles an hour. The electrical equipment of such a system should be undertaken only after due consideration is given to the present status of electric traction methods and the future promise of those now under exploitation. It is manifest that the first and most important requirement is absolute certainty of operation. The system must be so designed that no ordinary accident can interfere with its continuous and successful working. A reserve of power sufficient to clear the tracks of electric trains in case of a disaster at the power-house is absolutely essential. Similarly a provision for an unexpected increase in the service should be made at the beginning, and every precaution against interference with steam trains on the same tracks should be taken. All of these considerations point to the selection of a system departing as little as possible from that whose excellence has been so abundantly proven in connection with street railways, but in which due provision must be made for extension of the electric service to the express trains, and for any changes in operative methods that may seem to be foreshadowed by present electrical knowledge. Of this it may be said that the use of polyphase motors is the only radical innovation that seems to be in prospect, and that this is a long way in the future.

Taking these various matters into consideration, the systems of generation, conduction and transformation described below may be recommended as safe, practical and satisfactory, capable of almost indefinite extension, and, with slight modification, adaptable to the uses of polyphase motors should these ever be employed. It may be said here, however, that the advantages of commutatorless motors are small compared with the flexibility of the proposed direct-current and storage system outlined below.

The Electrical System.

In order to attain the maximum of economy in the generation and distribution of the power it is necessary to work boilers, engines, dynamos, and line under steady load and at their maxima of efficiency. It is also necessary to consolidate the power-generating plant in a single station so that the wages account may be reduced to a minimum, and also in order to reduce first cost and operation expense by increasing the size of the steam and electrical generating units. An inspection of the map shows that at the point of convergence of the various lines in West Philadelphia—a point conveniently near the Schuylkill River, so that ample water for condensation may be had—is the place for the station. The general plan recommended is to generate here three-phase current at 5,000 volts, distribute this along the lines to sub-stations situated at convenient intervals, reduce the pressure by static transformers and by means of rotary converters feed it into the track-conducting system as direct current at about 750 volts. At each rotary converter station there should be provided a storage battery and a booster driven by the rotary, the field of this being compounded so that it would charge the battery when demand for current from the trains became small, and help the battery to a discharge at constant potential when the load increased. The rotary converter would be, of course, connected with the track system, so that it would aid the battery in supplying current to the trains.

The various elements of the system will now be taken up in detail, and, after their consideration, the total cost of construction and operation and the earning power of the improvements will be briefly touched upon.

The Cars and Motors.

The cars for this service should be light and strong, somewhat smaller than the usual type of railway passenger car, and provided with flush platforms. Cars 48ft. long, seating 50 passengers each, and weighing, loaded, 20 tons each, would be ample. The motors should be, preferably, four in number, and of capacity sufficient to give a sustained draw-bar pull of 8,000lb. Probably the best size would be those rated at 125 H.P. each. There is no reason why these motors should not be mounted directly upon the axles, thus eliminating at once all the difficulties of gears. A control method of the simplest variety is indicated by the conditions of service, and nothing better than the series-parallel system is needed. With these motors an acceleration of 1·76ft. per second can be had with a current of about 500 amperes, and a schedule speed of 22·2 miles per hour maintained on the most difficult section of the system (the Chestnut Hill branch, where the stations average only two-thirds of a mile apart), allowing 20sec. actual stop at each station.

The Track and Conducting System.

The only alteration in the existing tracks necessary for the service is careful and thorough bonding, and occasional grounding to obviate the danger of shocks to workmen if the track potential should rise in dry weather. The question of the conducting system, which would be easy if the right of way was in all cases absolutely private, is rendered somewhat difficult by grade crossings. A simple and effective system, however, can be easily constructed in the following manner: The conductor is a steel bulb rail with a flat lower flange about 5in. wide, somewhat similar in shape to the ordinary high T rail and weighing 100lb. per yard. This can be had in 60ft. lengths, although the calculated drop given below assumes it to be in the usual 30ft. lengths, with one 0000 bond about 1ft. long at each joint. With an initial pressure of 750 volts the drop over this conductor, with a return through the tracks, similarly bonded, would be, with the train running at 40 miles per hour on a level, 35 volts per mile. The actual drop at the time of maximum acceleration with a train half-way between two of the sub-stations to be described below, would amount to about 52 volts, or

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7 per cent. The conductors, one for each track, should be supported in the space between the double tracks in the manner shown in Figs. 2 and 3. A hollow iron casting set 3ft. in the ground and surrounded by cement sustains the insulators, which carry their dependent rails at a height of 24in. above the ties. The insulators, of porcelain, somewhat similar to those used in recent

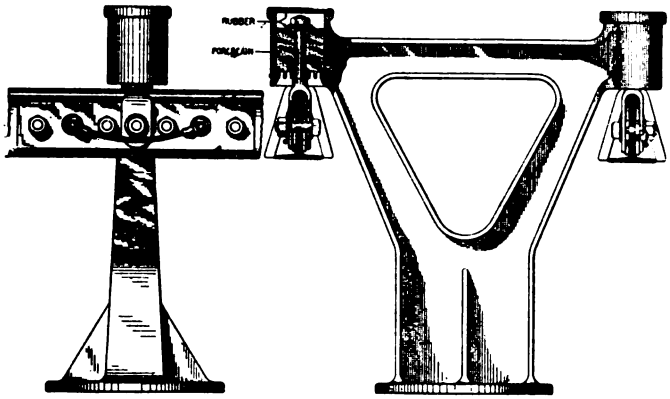

FIG. 2.—Suggested Form of Insulators and Supports for Conductor Rails.

conduit work, are contained in a cast-iron cup. Upon the rail are placed hard terra-cotta tiles, of the shape shown in the detail drawing, Fig. 4, these serving to effectually prevent accidental contact with the working conductor. The insulators are spaced 30ft. apart, the rigidity of the conductor-rail being sufficient to prevent any great degree of vertical sag or movement from the upward pressure of the sliding contact in this

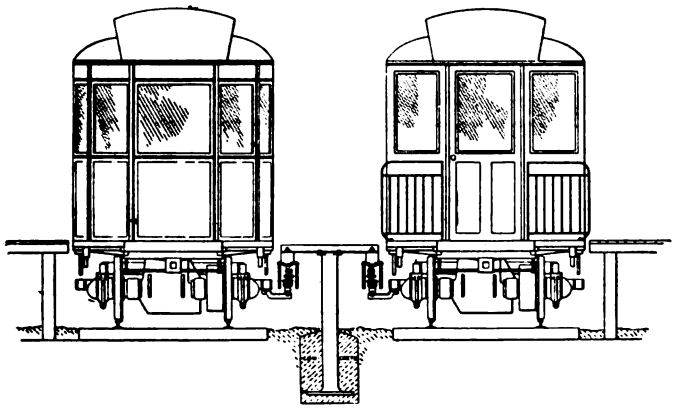

FIG. 3.—Cross-section of Tracks, showing Platforms, Cars and an alternative form of Support for the Conductor Rail.

length. A bronze shoe of about 15in. length gives a contact area of 75 sq. in., or over 1 sq. in. for each five amperes of current required to be taken off, assuming that two such shoes are used on each train, one on the front and the other on the rear truck. At grade crossings, switches, &c., the conductor rail is omitted, buried copper conductors of the proper capacity taking its place. The

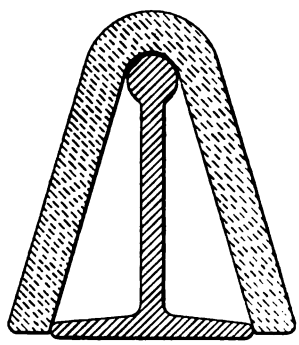

FIG. 4.—Cross-section of Conductor Rail and Tile Covering.

length of a three-car train is 144ft., so that a break of about 135ft. in the continuity of the conductor rail would not cause a rupture of the supply current or deprive a train at that point of motive power. A two-car train could pass a 70-foot break in the same way. The propriety of cross bonding one conductor rail to the other may be open to question, because a short-circuit or accident on one track with these rails so bonded would result in a stoppage of trains on the other track of the same section, but the great value of these connections in increasing the conductivity of the system overweighs this objection. A fuse in the bond would be a sufficient precaution. With the system of sub-stations here outlined no feeders will be necessary at any point, the conductor rails being sufficient to take care of the loads of ordinary service at a comparatively small loss.

THE SUB-STATIONS.

Each sub-station would consist of a small building containing the static transformers for reducing the 5,000-volt supply line three-phase current to a proper pressure for use in connection with the rotary converters, booster, battery of storage cells, and the necessary switching and regulating instruments for each section of the road. The equipments of these sub-stations would necessarily differ somewhat in capacity, but in the main they would be identical. The static transformers for the average station would have to be of about 400 kilowatt total capacity. It would not be advisable to put in two "rotaries" in each station, since the interconnection of the secondary system would permit trains to be operated over any section in the event of the temporary suspension of its sub-station. These machines are capable of standing considerable overloads, and are not liable to derangement, so the factor of safety is fairly large with only one in a sub-station. To the shaft of this rotary is mechanically coupled a booster of 40-kilowatt capacity, which is connected, as shown in the diagram (Fig. 5), with a storage battery of about 3,200 ampere-hours' capacity. This booster is wound with a shunt field energised by the storage battery and a series field in opposition, through which the whole discharge current flows. The effect of this, in proper balance, will be to aid the battery on discharge, and to continually

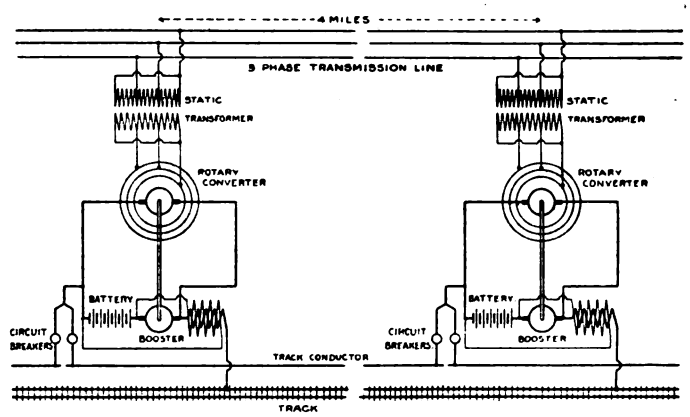

FIG. 5.—Sub-Station Equipment and Connections.

supply charging current to it when the demand from the trains on the section falls below the normal output of the rotary. By this arrangement the load upon the rotary, and consequently the demand of the sub-station upon the line, will be constant, working line, transformers, rotaries and the central station under almost ideal conditions for the highest efficiency. The field of the rotary can be compounded, if necessary, so that the wattless currents can be reduced to zero.

The sections of track assumed here are four miles long, the breaks being on the switchboards of the sub-stations, which are at that distance apart. Circuit-breakers are provided, as shown in the diagram, Fig. 5, and switches for handling the three-phase secondaries in the sub-station. A convenient arrangement of the buildings would place the static transformers in an upper room. Oil circulation, water-jackets or ventilation could be easily provided if necessary. These sub-stations could be conveniently combined with the block-system signal towers now used, and the same attendants could take care of both, except during the crowded hours. About 400 cells of battery should be provided at each station, mounted in paraffined wooden racks, and, of course, in a well-ventilated room, separated from that containing the rotary and booster.

THE TRANSMISSION LINE.

This line presents no features of difficulty. Structural iron poles 30ft. long, carrying cross arms and large porcelain insulators, will be required. The conductors are of bare copper wire or cable. The largest cross-section required at any point, for any one division of the railway assuming a maximum drop of 20 per cent., and an average drop of 10 per cent. is 1,350,000 circular mils total, or 450,000 circular mils in each of the three conductors. While most of the right of way on which this line runs is private, certain local conditions may require parts of it to be placed in conduit, but this offers no special difficulties. The line should be kept well away

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from the tracks, so that it would be out of danger of destruction by a derailed train, and also to avoid the consequences of mixing 5,000-volt current with a wreck in case of such a casualty.

The Power Station.

The requirements of the central station are, in a sense, unique. Operating at a steady load throughout the 24 hours of week days, it has an opportunity of shutting down for a few hours on Sundays for necessary overhauling. The total draught of power for the system is 225,000 kilowatt hours daily from the conductor rails. Adding the proper percentages for losses in conductors, batteries, rotaries and static transformers, this becomes 285,750 kilowatt-hours from the transmission line, or 315,000 from the central station, assuming an average loss of 10 per cent. on the transmission line. Under steady load conditions the station should, therefore, have an output of about 13,000 kilowatts continuously. This is based upon the assumption of three times as many trains as are now operated on all parts of the suburban system, providing seat accommodations for over twice as many passengers. As it is likely that the installation of the electric system will be progressive, it is advisable to provide at least two units for the generating plant. Since the adoption of electricity for the express service cannot be much longer delayed, a type of unit should be installed of such size that it will lend itself readily to this extension. These conditions seem to be met by two units, each consisting of a marine type quadruple expansion engine of about 12,000 H.P. direct-connected to two 5,000-volt three-phase generators of 4,000 kilowatts each. Engines of this size, working under practically similar load conditions, have been in use for some time in the better class of passenger steamers, and present no unusual or difficult features. Dynamos of the size suggested are of the same class as those in use at Niagara, and can be made of high economy and great simplicity of construction. By constructing the engines in the manner suggested in Fig. 6—dividing the second intermediate and low-pressure cylinders—a most perfect balance of cranks may be attained, and at the same time a divisible engine secured, which, in case of trouble with one of the generators, may be cut apart at the centre coupling, half of it then operating one generator as a triple-expansion engine. By this arrangement nothing short of a devastating catastrophe could interfere with the continuous operation of the power house. These engines could be reasonably expected to operate on 2lb. of coal per kilowatt-hour output. The frequency should be fairly low, about 16 to 20 cycles per second. While this will necessitate somewhat larger transformers than would be necessary with a higher frequency, it will greatly simplify the dynamos and rotaries.

A few suggestions as to the types of dynamos and rotaries may not be amiss. The inductor type of dynamo, having no moving wire or insulation, is certainly one of the most promising, and possesses many advantages worthy of consideration. In machines of this size, however, it is well to adhere to well-known types and follow accepted practice, so dynamos of the rotating field type are shown in the illustration. The difficulties of insulating the armature potential of 5,000 volts are practically removed when this is made stationary. The rotaries need not deviate from the accepted type in any respect, except that their commutators should be relatively large.

At the power station one or more exciter sets should be provided, of about 100 kilowatt capacity. These should give direct current at about 750 volts, so that, in case of failure, current could be taken from the track batteries for excitation. An additional generating set, consisting of a 1,200 H.P. engine, coupled to two direct-current railway generators of 500 kilowatts each, at 750 volts, and a 4,500 ampere-hour storage battery, completes the station outfit. These are used for the section of track between Broad-street station and the power house, where the trains are thickest, and also feed the radiating sections diverging at Powelton-avenue and South-street. The station is, of course, located at the foot of the hill on the west side of the river, and receives its coal on the second floor level.

Special Problems.

So far, the description of the system has dealt only with the features of those parts of the equipment presenting no special difficulties. There are certain troubles, however, the greater part of which are encountered in the elevated yards and approaches to the Broad-street station. The accompanying map of the track centres, Fig. 7, gives an excellent idea of the excessive complexity of the crossings, switches and spur tracks forming these approaches.

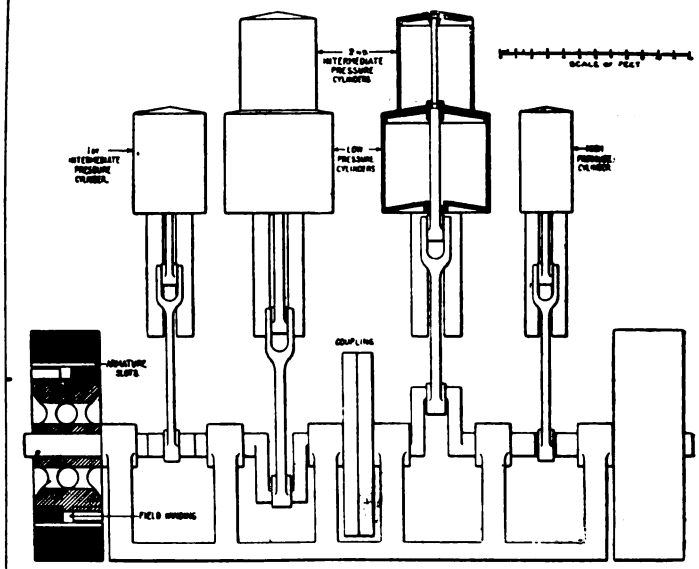

Fig. 6.—A Generating Set.

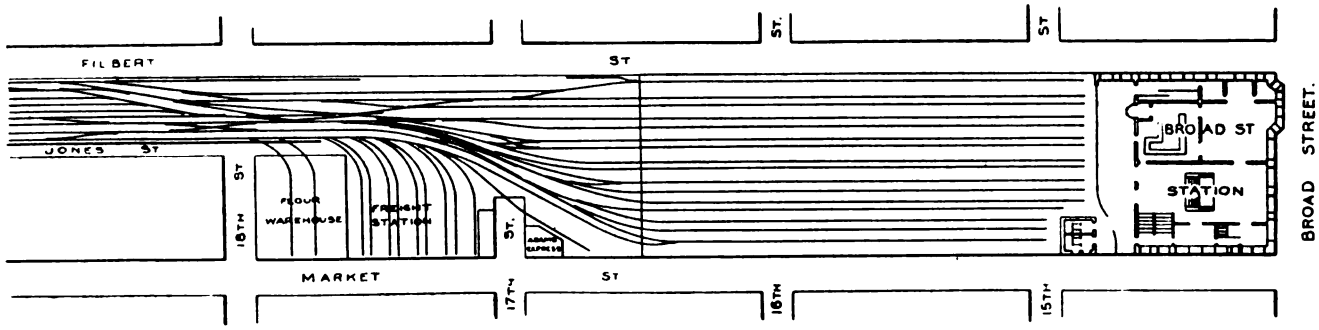

Fig. 7.—Map of Track Centres at Broad Street Station.

The difficulties of installing the conductor rail increase considerably in a place of this character, but they may be minimised by the simple expedient of using only the tracks in the northern side of the yard for the electric local service. This, however, does not afford a solution to the problem, because it is to be taken for granted that, in the course of time, all the tracks will be equipped with conductor rails. The discontinuity of these at switches and crossings will cause no real trouble, except possibly in shunting single motor cars with one contact brush. These might be caught between sections, but this seems little likely. The feature that is productive of the gravest difficulty is the danger of carrying 750-volt current around a yard full of labourers and switchmen. The simplest device here, as elsewhere, is generally the best, and flooring over the whole of the most complex portion of the yard above the conductor rails would be the means most likely to satisfy all the conditions. Grades present no features of difficulty whatever. Their effect is seen only in the arrangement of the sub-stations with reference to them. Curves will require a modification of the protective covering for the conductor rail, presenting no great difficulty of design. Bridges will require a modified form of supports for the conductor rail. These are practically all the modifications of the standard construction described above.

(To be concluded.)

Royal Society.—Among the Papers down for reading yesterday was one by Mr. T. Preston, "On the Modifications of the Spectra of Iron and other Substances Radiating in a Strong Magnetic Field."

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THE ELECTROLYTIC DECOMPOSITION OF THE CHLORIDES OF SODIUM AND MAGNESIUM.*

BY M. C. BEEBE.

The enormous quantities of bleaching powder which are consumed yearly in various industries and for various purposes has been the incentive for the numerous applications for patents on various forms of apparatus for decomposing sodium or magnesium chloride by electrolysis, their object being to produce a substitute for bleaching powder at a lessened cost. The matter has received much more attention abroad than in America.

It has long been known that by electrolysing a sodium chloride solution that the result was a liquid which possessed excellent bleaching properties. The primary elements liberated are sodium and chlorine, but these immediately recombine and form sodium hypochlorite (Na Cl O) unless special provision is made to prevent this. By placing the electrodes in separate compartments of the electrolytic cell, the products of electrolysis may be kept separate, and it is on special forms of diaphragms and partitions for this purpose that most of the patents have been granted.

As early as 1851 Charles Watt attempted to decompose sodium chloride on a commercial basis, using primary batteries as a source of power. Since the perfection of the dynamo the matter has received fresh impetus, and several plants are now operated on a commercial basis. In this article only the apparatus in which no attempt is made to keep the products separate will be considered. The solution formed owes its bleaching properties to compounds which are the result of secondary reactions in the cell. It is said that it possesses greater antiseptic powers than corrosive sublimate, and, as a bleach, has the advantage over other bleaching agents that it is slightly alkaline or neutral, and owes its bleaching action to a hypochlorite and not to a mixture containing an excess of a base, which is harmful to the articles to be bleached. The principal commercial apparatus for the production of electrolytic hypochlorite is one developed by Hermite, a Frenchman. His apparatus has been tried experimentally at Worthing, England, for the disinfection of the sewage of that town, and tests at this plant have shown it capable of doing much towards the solution of the sewage problem. It is also being used to some extent as a substitute for bleaching powder in the bleaching of paper pulp and textile fabrics. His apparatus consists of a galvanised iron tank, in which the decomposition takes place. The anodes are made by mounting platinum gauze in an ebonite frame, these anodes being fastened to a copper bar by a leaden lug. Between each pair of anodes is a zinc cathode. The cathodes are discs mounted on a revolving shaft, each being provided with a scraper which cleans it as it revolves. While running a white deposit adheres to the cathode, which, unless removed, increases the resistance of the cell greatly. This white deposit is probably hydrate of magnesium, formed according to the following equation :—

$$Mg\,Cl_2\,O_2 + 2\,H_2\,O = Mg\,H_2\,O_2 + 2\,H\,Cl\,O.$$

Hermite's process is a continuous one. The electrolyte enters the tank through a well-perforated pipe which runs along the bottom of the tank, and after passing up between the electrodes it overflows into a trough which surrounds the top of the tank. From here it is conducted away for use. After being used in bleaching vats it is returned to the electrolyser and regenerated. Sea-water is used for the electrolyte where available, but a solution containing 5 grammes $Mg\,Cl_2$ and 50 grammes Na Cl per litre is used where sea-water is not obtainable. The resistance of the electrolyser is about 0·00122 ohms. It is claimed that the sodium chloride is not decomposed during the process, but merely serves as a conductor. This seems rather improbable, since the E.M.F.s of polarisation of the two salts ($Mg\,Cl_2$ and Na Cl) are so nearly alike.

It has been shown by experiments at Worthing, England, that the electrolysed solution containing 0·25 gramme of available Cl per litre is an excellent deodoriser, but to effect sterilisation of sewage a solution containing at least 0·75 gramme Cl per litre is necessary. Dr. Ruffers found, further, that solutions containing 0·5 gramme per litre lost 90 per cent. of their strength in 24 hours; but stronger solutions were more stable; one containing 1·05 gramme per litre lost only 7 per cent. in 24 hours. The greatest loss seems to take place during the first 12 hours. As to the power required, it is said that a common size of Hermite's electrolyser requires 1,200 amperes at 5·5 or 6 volts. This electrolyser is capable of producing 2·2lb. (1,000 grammes) available Cl per hour. The theoretical amount liberated per ampere hour would be 1·32 gramme. Hermite himself says 10 H.P. acting for 24 hours will produce the equivalent of 100 kilogrammes of dry chloride of lime.

Mr. A. E. Woolf, of New York, has given the matter considerable attention, and has installed several experimental plants under the name of the Woolf system. The system used by him is very similar to Hermite's, and what is true of Hermite's solution is true of Mr. Woolf's. He uses tanks of about 500 gallons' capacity for his electrolysers, and his electrodes are of platinum, containing about 5 to 10 per cent. of iridium. The current density used is about one ampere per square inch of anode surface. He says regarding the power used that, in a practical operation, about 15 grains (0 97 gramme) of available chlorine are produced per ampere hour, the applied E.M.F. being about 6 volts.

It is customary to rate the bleaching power of a bleaching liquor by the number of grammes of available chlorine it contains per litre, and the value of electrolytic bleach has usually been estimated in the same way. It is claimed, however, by many who have made comparisons experimentally, that in the case of electrolytic bleach the arsenious acid test (which is the one generally used) shows nothing as to its real value as a bleach. Electrolytic bleach, they say, possesses greater power than ordinary bleaching powder of equal chlorometric strength, and this seems to be especially so in the case of electrolysed magnesium chloride. This is generally accounted for by the presence of some additional bleaching agent in the solution which is not taken account of by the arsenious acid test. It has been observed that in the electrolyses of the alkaline chlorides the volume of oxygen liberated is less than half that of the hydrogen. Some unknown oxygen-chlorine compounds may be formed which have bleaching properties. Others credit the bleaching action to hypochlorous acid, and not all agree as to whether the solution is acid, neutral or alkaline. Dr. Schoop's investigations recently made show that no free chlorine was ever formed during the electrolysis.

Messrs. Cross and Bevan, who have had considerable to do with the Hermite solution, made some comparative tests, and found that, in bleaching powder, instead of being a simple oxidation only, there was also a combination of chlorine with the fibre constituents. They carefully compared the hypochlorites of calcium, sodium and magnesium formed by chemical processes with those formed by electrolysis. They found that 26 per cent. of the calcium and sodium compounds was used up in the chlorination effect, and with magnesium hypochlorite 14 per cent. of the total amount was lost. With the electrolysed solutions there was no chlorination at all. In bleaching with the electrolysed solution there is a complete reversion to the chloride, and therefore its bleaching action is an oxidation pure and simple.

Electric bleaching was well known in Russia in 1883. Ltdoff and Tikcomroff, seeking to find the liquid of maximum bleaching power, electrolysed various solutions of chlorides. They gave the preference to chloride of potassium. Representing the bleaching power of electrolysed potassium chloride by 100, they found that of sodium to be 73, and that of calcium chloride 24. In the case of the electrolysed solution the chlorine is present in a weakly combined state, whereas with bleaching powder no action takes place until the chlorine is liberated by the addition of acid.

A series of comparative investigations by M. G. Saget into the action of Hermite's solution electrolysed sodium chloride (Gebauer and Knoeffler's solution) and ordinary bleaching powder upon cellulose are very interesting. Two series of experiments were made. In the first series the tissue was completely immersed in the liquid and exposed to the sun; under these conditions oxycellulose was not found with Gebauer's solution, provided the available chlorine was less than 0·25 gramme per litre, or with Hermite's solution if the chlorine did not exceed 0·2 gramme, but with ordinary bleaching powder as much as 0·54 gramme available chlorine might be present before the oxycellulose was formed. In the second series of experiments the tissue was partly immersed and placed in the shade, the liquid being drawn up into the fabric by capillarity. In this case chloride of lime was the most active, oxycellulose being distinctly formed even with less than 0·3 gramme available chlorine per litre, while the Gebauer and Hermite solutions formed none. As a bleaching agent he found Hermite's solution the most active, Gebauer's next, and chloride of lime least. Really very little has been done to determine the relative values of bleaching solutions formed in different ways. It is of prime importance because the cost of replacing the use of chloride of lime hinges directly upon this question.

As to exactly what takes place when a solution of a chloride is decomposed by electrolysis, as in the Hermite system, there is some difference of opinion. The following reactions probably take place simultaneously :—First : The electrolysis of Na Cl with formation of Na O H, H, and Cl. Second : Electrolysis of Na O H with formation of H and O. Third : Formation of Na Cl O, by the action of Cl on Na O H. Fourth : Formation of $Na\,Cl\,O_3$ by the oxidation of Na Cl O. Fifth : Electrolysis of Na Cl O with the formation of Na O H, H, H Cl O and O. Sixth : Electrolysis of $Na\,Cl\,O_3$ with formation of Na O H, H, H Cl O and O. Seventh : Reduction of the Na Cl O found at the cathode to Na Cl. Eighth : Reduction of the $Na\,Cl\,O_3$ found at the cathode to Na Cl. That the temperature of the electrolyte is an important factor in the amount of available chlorine produced there can be no doubt. At temperatures above about 20°C. the output of Cl per ampere is considerably smaller than

* Abstract of a thesis receiving special honours, submitted for the degree of B.S. in Electrical Engineering at the University of Wisconsin.

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at lower temperatures, other conditions being the same. It is generally believed that the decreased efficiency is due to the formation of chlorates in the bath instead of hypochlorites or that the hypochlorites are easily changed to chlorates at higher temperatures. It is important then to keep the temperature of the electrolyte low, either by artificial cooling or, better, by circulating the liquid.

Mr. Fitzgerald in a discussion of Mr. Swinburne's Paper entitled "Commercial Electrolysis," stated that he had devoted much time to the electrolysis of magnesium chloride, and had come to the conclusion that the selection of magnesium chloride by Hermite was an unfortunate one because of its strong tendency to form magnesium chlorate, even at ordinary temperatures.

The difficulty of obtaining a suitable anode for use in the electrolytic production of hypochlorite has been a serious one. A good anode should be a good conductor, cheap and not attacked by the products of the electrolysis. Platinum was finally adopted by Hermite after failing to find anything cheaper which would serve the purpose. It seems that it has served admirably, yet for the production of a cheap product some cheap anode is essential. Hermite at first used platinum foil, but found it poor mechanically. By using it in the form of a gauze he reduces the cost and obtains results, with the same weight of platinum, as good as when used in the form of a sheet. Carbon has been tried in a variety of forms, and the general experience has been that all forms of moulded carbon disintegrate rapidly. From the researches of Bartoli and Papasogli it is known that carbon is attacked when used as an anode in any solution which evolves oxygen at the anode. Retort carbon has been most generally used, since it is cheap and quite durable, especially when prepared by soaking in paraffin or tar, and heating very hot. The carbons are attacked and disintegrated much more rapidly in a dilute electrolyte than in a concentrated one. Hermite tried carbon in his electrolyser, but was forced to adopt platinum because it was the only substance he found which would not disintegrate in his weak electrolyte when used as an anode. Lithanode is a substance invented by Mr. Fitzgerald, and is made by mixing ammonium sulphate with litharge, and compressing into the desired form by great pressure. It is then oxidised to lead peroxide by immersing in a bleaching solution. Since it is incapable of further oxidation it is very durable. It is said that phosphide of chromium and also an alloy of iron and titanium are indestructible anodes.

The cathode is not nearly so troublesome as the anode, but for the sake of economy one should be used which does not give off hydrogen, not only because the hypochlorite would be reduced, but also because a considerable amount of power is wasted when hydrogen is given off. Mr. Fitzgerald gives the E.M.F. of polarisation as 2·3 volt when both hydrogen and chlorine are given off. When the hydrogen is absorbed it is 1·61 volt, and when both hydrogen and chlorine are absorbed in the electrolytic tank, 1·09 volt.

Since the cost of the power required for the production of hypochlorites by electrolysis is almost entirely the determining factor in the cost of the product, the writer performed some experimental work with the following objects in view:—First: To find the power required to produce hypochlorites by the electrolytic decomposition of magnesium and sodium chlorides. Second: To find the effect of different current-densities upon the amount produced and power required. Third: To find the effect of the density of the electrolyte upon the amount produced and the power required. Fourth: To find the effect of temperature upon the efficiency of the process. Fifth: To find how strong a solution could be obtained economically. The apparatus used for the purpose consisted of several glass tanks 6in. by 9in. by 8in. high. The electrodes were pressed carbon plates 6in. by 10in. by $\frac{3}{8}$in. thick, made by the Solar Carbon Company. To ensure good electrical connection with the carbon electrodes two holes were drilled in the end of each plate. The end of the plate was then copper-plated, and, after being well tinned, a leaden lug was cast around the top of the plate. The distance of the electrodes from each other was 1in. in every case. They were generally immersed in the electrolyte to a depth of 6in.

The method of getting at the results was to connect six tanks in series, all having different densities of solutions in them. The anode surface being the same in all the tanks, and the same current traversing each, enabled observations to be made by which the effect of a certain current-density upon the different densities and kinds of solutions could be determined. Several runs were made with the conditions similar, only using a different current value. From the data taken, the effect of different current densities upon a certain strength of solution are easily compared. During a run the following data were observed at regular intervals, *i.e.*, applied electromotive force, current, temperature, and the amount of available chlorine per litre. The test used to determine the amount of available chlorine contained per litre was the arsenious acid test generally employed for this purpose. This test takes account only of the chlorine existing in the solution in a free state or in a hypochlorite. In order to compare the results obtained, conveniently, curves were plotted from the data. These curves show the relation of the chlorine produced per ampere to the time the current was flowing, the chlorine per ampere being calculated from the chlorine per litre at any time by multiplying the amount of Cl per litre by the number of litres electrolysed and dividing by the current flowing. Typical curves are shown in

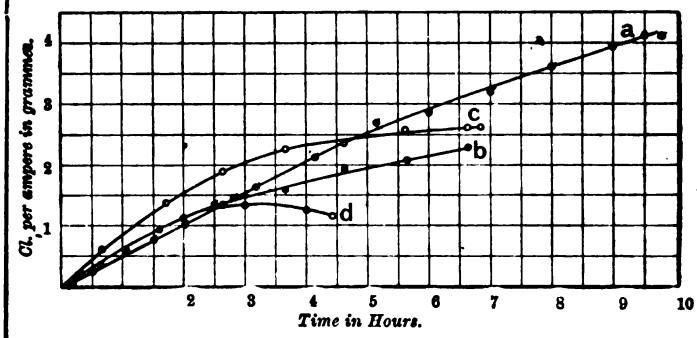

FIG. 1.

Figs. 1, 2, 3, 4, 5 and 6. Fig. 1 shows curves obtained by electrolysing a 13 per cent. solution of sodium chloride. In this run no attempt was made to keep the electrolyte at a low or constant temperature. A current-density of approximately 50 amperes per sq. ft. (*see* curve *c*) gives the best efficiency for over four hours, then, on account of the rise in temperature of the electrolyte the curve slopes off rapidly. Curve *a* was obtained from a current-density

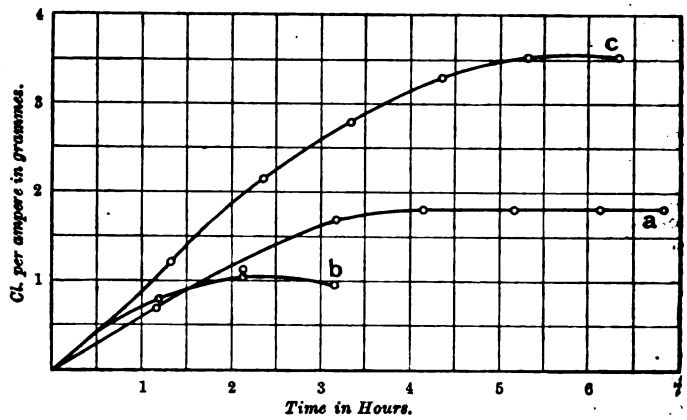

FIG. 2.

of 10 amperes per sq. ft. It is the lowest current used here, and undoubtedly the Cl. per ampere reaches a higher final value than any of the others in Fig. 1, because of the small C^2R loss and consequent small rise in temperature of the electrolyte. Fig. 2 shows similar curves obtained by electrolysing a mixture of sodium and magnesium chlorides. In this case the low current-density is

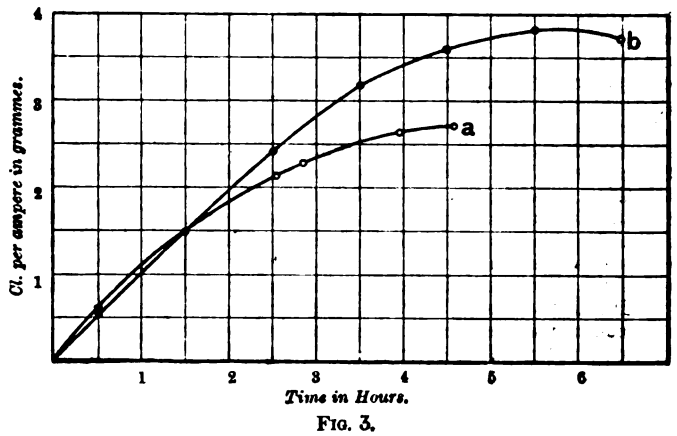

FIG. 3.

the most efficient, even at the start. This is true not only of this one test, but of several others using different proportions of magnesium and sodium chlorides.

Curves *a* and *b* (Fig. 3) were obtained from a 25 per cent. sodium chloride solution which is nearly saturated. The current-density for curve *a* was 24 amperes per sq. ft., and for curve *b* was about

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90 amperes per sq. ft. The temperature for curve *a* was kept constant at 11°C. Although *a* slopes off more rapidly than *b*, yet to obtain a certain strength of solution the high current-density is fully as efficient as the low one.

The curves (Fig. 4) were obtained by electrolysing 20 litres at a time, instead of four litres, as in the previous tests. To obtain curves *a* and *c* a 20 per cent. sodium chloride solution was used. With *a* a current-density of 60 amperes per sq. ft., and with *c* 30 amperes per sq. ft. was employed, while for curve (*b*) a 12 per cent. solution of sodium chloride was used and a current-

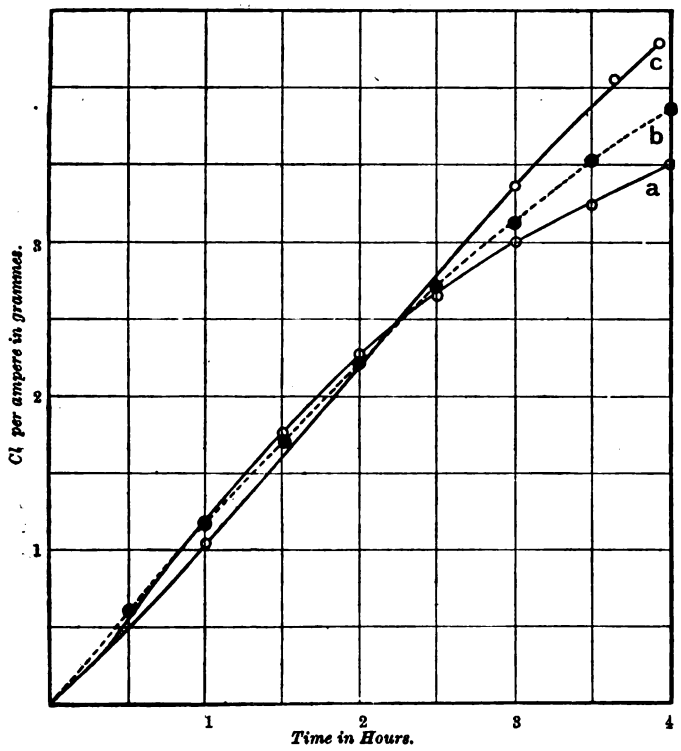

FIG. 4.

density of 30 amperes. These curves slope very little, and at first thought it would seem that better results are obtained by electrolysing a large quantity at one time. However, to obtain a certain strength of solution it is no more econimical to decompose a large quantity than a small one. Here, too, there is very little difference between the efficiency of high and low current-densities.

Curves (Fig. 5) were obtained by electrolysing mixtures of magnesium and sodium chlorides in approximately the proportions used by Hermite. However, they were obtained in a slightly different manner than the preceding ones. Four tanks containing

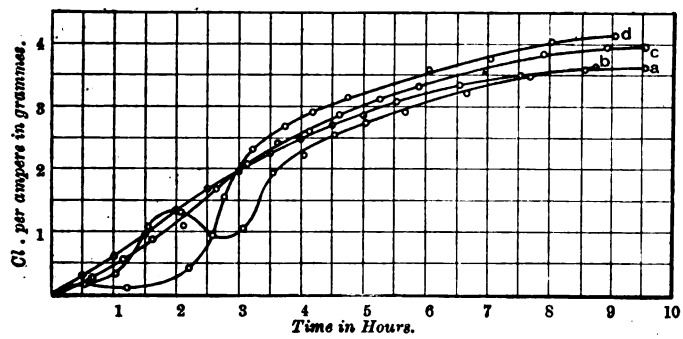

FIG. 5.

the same solution were connected in series, and a current of 9·9 amperes passed through them all. The current-density was varied by varying the amount of anode surface exposed, and in *a* it was 40 amperes per sq. ft., in *b* 60, in *c* 95 and in *d* 135. These curves obtained in this way indicate that the highest current density is the most efficient, which disagrees with the results obtained by Dr. Schoop in some recent investigations.

The power required for the electrolytic decomposition of the chlorides is made up of: (1) C^2R loss in conductors and electrodes. (2) C^2R loss in the electrolyte. (3) Energy necessary to decompose the electrolyte. The first of these is easily calculable and can be made of any value desired. The second may be easily calculated by knowing the specific conductivity of the electrolyte to be used. This loss may be made quite small by bringing the electrodes quite close together. The heating of the solution decreases the resistance and the consequent C^2R loss in the electrolyte, but, as explained before, it is very essential to keep the temperature of the electrolyte quite low. The power required for the decomposition may be calculated from thermo-chemical data. Oettel calculated it and found it to be 2·3 volts for all chlorides, and his results obtained experimentally were very near this value. It may be obtained experimentally by measuring the voltage of the cell immediately after breaking the circuit, by means of a high-resistance voltmeter, or more accurately by charging a condenser at the instant of breaking the current and then discharging through a ballistic galvanometer. The curves (Fig. 6) were obtained by this condenser method, and it is there shown that the E.M.F. of polarisation is entirely independent of the current-density. The curve of applied E.M.F. is a straight line of constant slope, as we should expect, knowing the counter E.M.F. of polarisation to be constant. The calculated E.M.F. and that obtained experimentally vary by at least 0·5 volt, depending upon the solutions used. It was also found to vary at least 0·2 volt, depending upon the time the current had been flowing.

Experiments in which zinc was used as a cathode showed that the polarisation E.M.F. was practically the same as when carbon was used. Dr. Schoop found in experimenting with a 3 per cent. Na Cl solution that the output of bleaching material decreased with increasing current-density. My results on a similar solution certainly seem to indicate rather the opposite.

My experimental work seems to justify the following conclusions. First, that the amount of available chlorine in the solution is not proportional to the power expended. Second, that the amount of available chlorine per ampere is largely dependent upon the temperature of the electrolyte. Third, that the amount produced is also dependent upon the amount of the products of decomposition already formed in the solution. Fourth, that at fairly high temperatures (50°C.) there may be an actual decrease in the amount of available chlorine per ampere-hour expended. Fifth, that the amount of available chlorine per ampere-hour is dependent largely upon the density of the electrolyte and that dense solutions pro-

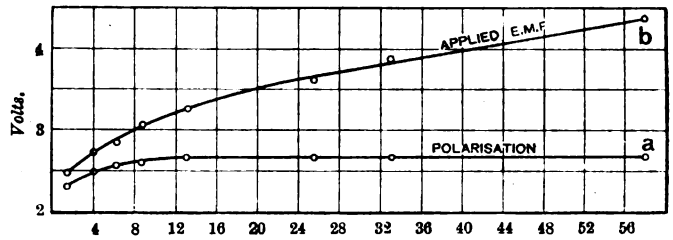

FIG. 6.

duce more chlorine per ampere than dilute ones; also that it is possible to obtain solutions having a higher value of available chlorine. Sixth, that the effect of the current-density upon the efficiency of the operation cannot be stated definitely, since in some cases a high current-density seemed to be more efficient than a low one, while in other cases the reverse held. Seventh, that if the temperature of the electrolyte be kept below 15°C. it is possible to reach a concentration of 9·7 grammes per litre at an efficiency of 0·9 gramme per ampere-hour, using Na Cl solution of a density 1·100. Using the Hermite solution, or one which had approximately the same proportions, using carbon electrodes, and at a low temperature it is practicable to obtain a concentration of 8·8 grammes of available chlorine per litre at an efficiency of 0·58 grammes per ampere-hour. Further, it is practical under the same conditions to obtain a concentration of 6·8 grammes per litre at an efficiency of 0·7 gramme per ampere-hour. Andreoli claims that the highest strength obtainable is 3 grammes per litre, using the Hermite solution. Eighth, that a dilute electrolyte disintegrates carbon anodes much more rapidly than concentrated ones. Ninth, that reversing the current frequently—as has been proposed, to lessen polarisation and resistance due to deposit upon the cathode — greatly reduces the efficiency of the process and is therefore useless, Tenth, that the polarisation for a given density of electrolyte and a given temperature remains constant, regardless of the current density. Time did not permit of making any quantitative determination of the disintegration of the anodes, but contrary to Hermite's statement, the anodes were eaten away most rapidly at the bottom and along the edges instead of at the water line.

The conditions for producing the electrolytic hypochlorite and the power required are fairly well known, but the cost of this bleaching agent cannot be fairly compared with others until reliable data are obtained in regard to its relative value as a bleaching and disinfecting agent.

The thesis is accompanied by a list of some of the more important articles on the subject.

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ELECTROLYTIC BLEACHING.

The direct production of a bleaching liquor by electrolytic means is so obvious and desirable a proceeding that the comparative failure of all attempts to attain it is proper subject for enquiry. We therefore welcome any serious effort to study the question, and in the present issue we give space to an abstract of a graduating thesis dealing with this matter, which has obtained a specially favourable reception at the University of Wisconsin. The author of this thesis, Mr. M. C. Beebe, has not sought to arrive at any process of industrial importance, but has endeavoured to ascertain under what conditions a bleaching solution can be economically prepared, thus contributing data whence it may be determined whether electrolytic bleaching can compete on equal terms, or with a balance in its favour, with existing chemical methods.

Before attempting to decide this highly debateable point a brief account of the scope of Mr. Beebe's Paper, and a short valuation of its merits may be usefully set down. Mr. Beebe appears to have taken the Hermite process as his guide in devising his experiments. He recounts the chief features of that process (which are well known to our readers and need not be recapitulated), and speaks of it with approval. He is evidently unaware that the balance of experience in this country is decidedly against the Hermite process, and he expounds again the venerable myth concerning the magical bleaching powers of electrolytic solutions, distinguishing them from the same liquids prepared by commonplace chemical means. This may be forgiven our author, who is clearly not a chemist, provided that he claim nothing more than a hypothetical validity for these quaint ideas and submit to necessary chastening for the prevention of erroneous doctrine. The

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more interesting part of the Paper, the description of its author's original experiments, deals with numerous tests made to discover the energy required to produce a given quantity of bleaching liquor of a particular strength, and the influence of alteration of working conditions, such as concentration and temperature of solution and current density, on the effective output. An adequate description of these experiments is given in the abstract already cited, and it is sufficient here to examine the conclusions arrived at. These are: "First, that the amount of available chlorine in the solution is not proportional to the power expended." Considering that in the preparation of a bleaching liquor of the Hermite class by the electrolysis of a solution of sodium chloride and magnesium chloride the products of electrolysis are allowed to intermix throughout the course of the electrolysis it is hardly surprising that the output of available chlorine is not proportional "to the power expended." Given that the primary products, caustic soda and chlorine, meet and form sodium hypochlorite, the continued existence of this secondary product is evidently dependent on its absence from the neighbourhood of the cathode, where it would speedily be reduced. The proportion coming into the neighbourhood of the cathode will increase as the electrolysis proceeds, and the concentration of the electrolyte in respect of sodium hypochlorite becomes greater. Thus there will be a limiting condition in which sodium hypochlorite is reduced to sodium chloride as fast as it is formed, and the composition of the liquid then becomes stationary. All energy impressed on the electrolyte after this equilibrium has been reached will reappear as heat, and will not contribute to the output of available chlorine. Thus Mr. Beebe's first conclusion is obvious on general principles and needs no experimental demonstration. The second conclusion is like unto it. It runs: "Second, that the amount of available chlorine per ampere is largely dependent upon the temperature of the electrolyte." Now, knowing that the reaction between an alkaline hydroxide and chlorine produces a hypochlorite or a chlorate, according to the temperature, and that the chlorine of the former solely is reckoned as available chlorine by the usual method of analysis, one is in a position to prophesy with a smaller risk than is commonly incurred by the seer that "the amount of available chlorine is largely dependent upon the temperature of the electrolyte." It is pleasing to have physical proof of the correctness of one's data and reasoning, but in this case the need for such corroboration is not imperative. With the knowledge implied by the statement of the principles which have guided us in our appreciation of Mr. Beebe's first and second conclusions, his third, fourth, fifth and sixth appear as particular cases of what has already been expressed generally. Those interested in tracing the relation are referred to the abstract. The seventh conclusion, viz., "that if the temperature of the electrolyte be kept below 15°C., it is possible to reach a concentration of 9·7 grammes (of available chlorine) per litre at an efficiency of 0·9 gramme per ampere hour, using NaCl solution of a density of 1·100," has no greater claim to individual existence than any of the foregoing, but may be re-stated because it affords figures which may be useful in the industrial preparation of a bleaching liquor should any be enterprising enough to attempt it anew. The observation that with the Hermite solution, *i.e.*, one containing 5 grammes of $MgCl_2$ and 50 grammes NaCl per litre, a concentration of 8·8 grammes of available chlorine at an efficiency of 0·58 gramme per ampere hour can be obtained, is interesting as showing how poor a result a much extolled method may give. When it is remembered that the theoretical output of available chlorine per ampere hour is 1·82 gramme, it is seen that the current efficiency of the Hermite process is 44 per cent.; the energy efficiency of course is much lower, being, when a pressure of 5·5 volts is used, about 18 per cent.—scarcely a satisfactory showing.

It would be ungracious to find much fault with Mr. Beebe's thesis. It is the work of a student completing his graduation course, and more than a little leniency is permissible, and indeed necessary, in judging such a production. We would go farther, and congratulate him on his industry, for the Paper displays that useful quality in high degree. We wish we could be equally effusive towards the professors presumably responsible for the initiation and guidance of the work. They have permitted a purely chemical subject to be handled without the needful knowledge of chemistry, and have admitted the outcome as a claim to a degree in the faculty of electrical engineering. To accept elementary chemistry of dubious quality as a qualification for an engineering degree indicates an inversion of ideas gratifying to the humorist but distressing to mere professional persons like ourselves, and nothing but our sense of obligation to our tutorial friends for the reopening of a difficult and weighty matter could prevent us from dealing faithfully with them, even to severity. Thus abstaining, let us consider the problem in a broader light. There are many uses for a bleaching liquor as distinct from bleaching powder, and its cheap production would be welcomed in many industries. The correct lines on which to work need nothing more recondite for their exposition than a sound knowledge of chemical and electrical principles, and these we may endeavour to indicate. The device of appropriate apparatus and special working details is a matter for the chemist or electrician consulted for the purpose of putting down of any particular plant, and does not fall within the province of a technical journal. Putting in this caveat, let us proceed with a discussion of those things which are fundamental. The direct preparation of a bleaching liquor by electrolysis of a chloride must be conducted so that the anode and cathode products intermix. Generally, this is accomplished by working without a diaphragm. In this case a host of difficulties, caused by the electrical resistance and the lack of permanency of most porous partitions, is avoided. On the other hand, for the reasons which we have given above, the free mingling of the products allows the reduction of the active chlorinated substanced, *e.g.*, a hypochlorite, whenever it comes into the neighbourhood of the cathode. This means waste of energy consumed in alternate oxidations and reductions, the nett effect of which is simply to heat the electrolyte. But, as we have already seen, a heated electrolyte connotes the formation of a chlorate instead of a hypochlorite, and thus the cost of indiscriminate commingling is enhanced. These drawbacks become more marked as the concentration of the electrolyte in respect of hypochlorite increases, for in a given time a larger number of molecules will be present in the neighbourhood of the cathode, and will then suffer reduction. Consequently electrolysis of a chloride for the direct production of bleaching liquor, if conducted without a diaphragm can only be used economically when the concentration of the hypochlorite is small, *i.e.*, weak liquors only can be produced. At a works where the bleach can be used and returned to the electrolysing tank this is of small importance, but where the liquor after use is so contaminated with organic matter as to be dismissed to the drain, the cost of replacing the original chloride is incurred. A more radical remedy is to perform the electrolysis in a cell with a porous partition, and allow the chlorine to act on the caustic soda (or other alkaline hydroxide) in a separate vessel. The practicability of this depends on the conductivity and chemical stability of the diaphragm.

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The next point is that the mingling of the anode and cathode products should be effected at a fairly low temperature, *e.g.*, 60°F. With a separate vessel for mixing this can be controlled, as in any other chemical process, by a common cooling arrangement, such as a water-coil or jacket. A similar method will suffice for the electrolytic tank itself, but it may need to be larger and require more careful watching because of the possibility of local rise of temperature, due to successive and useless oxidations and reductions brought about by the presence at the cathode of the chlorinated product of the anode to which we have already referred. With solutions of small concentration, such as are preferable for a cyclical bleaching process, the total quantity of energy in a given time uselessly appearing as heat is likely to be small, and it may well be that no cooling device is required. Spent liquor returning warm from its work would pass through a cooler before reaching its parent tank.

This is all plain enough. A more interesting point is the choice of a chloride to be decomposed, which will depend in some measure on the purpose to which the bleaching liquor is to be put. Sodium chloride will be the cheapest raw material in most places, and will yield an excellent bleaching agent in the shape of sodium hypochlorite, a substance which has been re-discovered several times within the last few years, and sold under many fancy names. Calcium chloride is a waste product, which is of low price near ammonia-soda works, and might well be used to give a substance substantially identical with ordinary bleach liquor. The favourite, however, is magnesium chloride, and the praises of the material prepared from it have been loud and indiscriminate, extending to the presumption that its electrolysis results in the formation of a substance unknown to chemists, and possessing bleaching properties of unequalled excellence. All this eulogy has arisen from ignorance of the elementary chemical fact that hypochlorous acid is an exceedingly weak acid, and that unless combined with a very vigorous base is readily set free. With lime or with soda its union is sufficiently strong to make a hypochlorite sensibly stable until acted on by some acid substance, which itself may be very weak—*e.g.*, carbonic acid. With magnesia, on the other hand, the combination is so loose that the salt magnesium hypochlorite is readily hydrolysed, splitting up, "even without the action" of carbonic acid, and yielding hypochlorous acid. This is the *vera causa* of the activity of electrolysed solutions of magnesium chloride, which in the light of these sober statements needs no far-fetched hypothesis for its explanation. Therefore, wherever the bleaching solution is to be used at once, and where an immediate action of the contained bleaching substance is desired, the product of the electrolysis of magnesium chloride is eminently suitable. Where a greater degree of stability is preferable, sodium chloride would be chosen. In either case the precaution of working with solutions of small concentration and maintaining the temperature of the liquid as low as is feasible would be observed.

Finally, one may consider the governing factors in the cost of electrolytic bleaching liquor. It follows from what has been said that a fair current efficiency—75 per cent., or better—would be attained by the use of cool solutions of low concentration. The energy efficiency, which is, after all, the true criterion of the technical merit of the process, will depend on the construction of the apparatus. In the hands of a qualified consultant it should be not smaller than half the current efficiency, but anything better than this is of the nature of a bonus. The permanency of the plant is at least as important as economy in the consumption of energy, and here experiment must be invoked and experience accumulated. The claim for special merit in the electrolytic bleaching liquor may be dismissed with the remark that if a very active product be required it can be obtained non-electrolytically by treating chloride of lime solution with carbonic acid. Thus the comparison is reduced to one of cost, and the prospects of electrolytic bleaching may be summed up as follows: Where the bleaching liquor can be circulated and regenerated, or prepared anew from a very cheap raw material, there is good hope of monetary advantage. This assumes proper knowledge and skill in the device and arrangement of plant. It is evident that a distant country having a local supply of cheap salt and fuel and a heavy freight to be paid on chloride of lime would be a suitable *venue* for trial on a manufacturing scale. Under less favourable auspices competition would be keener, quickly increasing to a point at which the manufacturer of bleach, who makes the preparation of chemicals his main business, and not a mere adjunct to a paper-mill, would soon be again on level terms with the electrolytic semi-amateur. Nevertheless, even here the electrolytic process has a reasonable chance of success, and may well be adopted if patented nostrums are disregarded and a trial is made in a manner consonant with sound science. We commend it to the enterprising.

REVIEWS.

Fortschritte der Elektrotechnik. Edited by KARL KAHLE. Eleventh year, Nos. 1 and 2. (Berlin: Julius Springer. 1897.)

This quarterly, which is a well-arranged catalogue of the principal articles on electrical subjects appearing in the technical journals of England, Germany, France, Austria and the United States, and includes short abstracts of the more important articles, made a good start eleven years ago, but it gradually developed such a serious time-lag as to render it practically useless. However, when the numbers for 1895 were appearing two years late, it was resolved to make a new start with 1897 while waiting for the completion of the parts relating to 1895 and 1896. We have before us the two numbers for the first two quarters of 1897 (we expect the third number shortly), and they deserve a few words of commendation. All the articles which can be considered as descriptive of electro-technical progress in any direction are mentioned by title, with reference to the volume and page of the journal in which they have appeared, and the number of illustrations in the article and its length in columns are also noted. Each item is numbered, and following the list are short abstracts of the more important ones, these abstracts bearing the same reference numbers as the titles. The subject-matter is divided into suitably-chosen sections and sub-sections, so that the list of articles is in no case unduly long, and the items are arranged in chronological order. We hope that this publication will maintain its present standard of excellence, and that it will become a really valuable adjunct to the technical library by appearing with still greater promptness.

Taschenbuch für Monteure Elektrischer Beleuchtungsanlagen. By S. FREIHERR V. GAISBERG. Fourteenth Edition, revised and enlarged. (Munich and Leipsic: R. Oldenbourg. 1897.)

A book which has run through 13 editions in 12 years, needs neither praise nor blame at the hands of the critic; but we are bound to say that the little work before us thoroughly deserves its popularity. Although of convenient size for the pocket ($6\frac{3}{4}$in. by $4\frac{1}{2}$in. by $\frac{3}{16}$in. thick), its 200 pages constitute a complete but very elementary treatise on practical electric-light engineering, and it should be of especial value not only to the German pupil and apprentice, but also to Englishmen who wish to become acquainted with German technical terms. It is clearly printed, and copiously illustrated with good diagrams, and, although couched in simple language, its descriptions and explanations are accurate and to the point; in

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fact, it forms more a pocket book-of-reference than one of those engineering pocket-books common in this country which contain useful tables and odd bits of valuable information arranged in a more or less disconnected and unsystematic way. If a number of tables were added to this book it would prove of still greater use to the workmen to whom it is dedicated, and the addition of an alphabetical index would also be an advantage. Owing, however, to the division of the matter into short, numbered sections, each with a side-heading which is duly set down in the contents, and the systematic disposal of the various subject-matter, the absence of an index entails no great inconvenience.

PROF. FLEMING'S LECTURES ON MAGNETISM AND DIAMAGNETISM.

The subjects of Prof. J. A. Fleming's forthcoming lectures at the Royal Institution are of such importance that a syllabus of the course, which is on "Recent Researches in Magnetism and Diamagnetism," will be of interest and utility to our readers. The lectures are to be delivered on the following days, at three o'clock:—

LECTURE I.—THURSDAY, MARCH 3, 1898.

Ferromagnetism.—The ferromagnetic group of bodies, Iron, Nickel, Cobalt, Magnetic, Pyrrhotite, and the Iron alloys—Their unique properties—Magnetic Flux and Gaussage—A bird's-eye view of electro-magnetic nomenclature—The abuse of the term *Force*—How Magnetic Flux is measured—Meaning of the term Circuital—Experiments to illustrate the nature of magnetic Retentivity, Coercivity, and Hysteresis—Their mechanical analogues—Magnetisation curves—Magnetic permeability—Process by which Magnetic Flux is established in Ferromagnetics—It begins at their surfaces and soaks inwards—Experiments to show this fact—Time taken to magnetise large masses of iron—The physical effects of Magnetic Flux in Ferromagnetics—Molecular disturbances produced by Flux changes—Effect of Flux in changing the dimensions of Ferromagnetics—Bidwell's experiments—Effect of magnetisation on the physical constants of iron—Effect on the electric and thermal conductivities—The effects of mechanical stress and vibration on the magnetic qualities of ferromagnetics—The Villari effect—Relation of torsion and magnetisation—Effect of magnetisation on the electrochemical properties of iron and on the passive state—The magneto-optic effects discovered by Kerr and Kundt.

LECTURE II.—THURSDAY, MARCH 10, 1898.

Paramagnetism.—Behaviour of iron, nickel and cobalt when placed in a non-uniform magnetic field—Tendency to move from weak to strong portions of the field—Faraday's classification of bodies into paramagnetic and diamagnetic—Similarity and difference between ferromagnetic and paramagnetic bodies—Magnetic attractions and repulsions—The Archimedean principle applied in magnetism—Faraday's experiments on the effects of the permeability of the surrounding medium in determining the motion of a substance when it is placed in a magnetic field—Experiments with magnetic solutions—Measurement of magnetic susceptibility—Magnetic ascent of paramagnetic liquids in tubes placed in a magnetic field—The so-called non-magnetic steels—The paramagnetic qualities of oxygen, gaseous and liquid—The measurement of the magnetic permeability of liquid oxygen—Absence of hysteresis in paramagnetic bodies—Mechanical model to illustrate the differences between ferromagnetic and paramagnetic bodies when subjected to magnetism.

LECTURE III.—THURSDAY, MARCH 17, 1898.

Diamagnetism.—The discovery of diamagnetic repulsion—Faraday's researches—Exhibition of the behaviour of bismuth in a non-uniform magnetic field—Diamagnetics tend to move in a non-uniform field from strong to weak places—Diamegnetic orientation of bismuth, antimony, phosphorus and iron in a non-uniform field—Diamagnetism of flames and certain gases—Faraday's experiments with heavy glass—Magneto-optical rotation of the plane of polarisation in diamagnetics—Increase of electrical resistance of bismuth when tranversely magnetised—Effects of low temperature on the above resistance change—The Hall effects in bismuth and other metals—Spurious diamagnetic phenomena—Electro-magnetic repulsions produced by alternating electro-magnets—Ampere's observations on electromagnetic repulsion—Effect of the circumjacent medium on the apparent diamagnetic property—The diamagnetic polarity controversy—The measurement of diagmagnetic susceptibility—Curie's observations—Lombardi's recent researches.

LECTURE IV.—THURSDAY, MARCH 24, 1898.

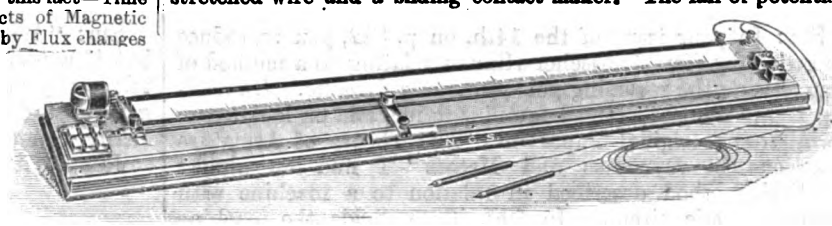
Thermomagnetism.—Experiments to show the effect of heat and cold upon magnets and magnetic permeability—The effect of increase of temperature upon the permeability of ferromagnetics—The magnetic critical temperature—The recalescence of iron—The three critical temperatures of iron—The effect of rise of temperature upon hysteresis and susceptibility—Magnetisation curves at different temperatures—Identity of the recalescence temperature with the magnetic critical temperature—The effect of very low temperatures on the magnetism of permanent magnets and on magnetic permeability of iron—Analogies between the magnetic effects due to strain and those due to temperature—The thermo-electric effects of magnetisation—Thermo-magnetic hysteresis—Peculiar properties of the nickel steels in this respect—The general effect of sufficient increase of temperature is to destroy ferromagnetic susceptibility and to reduce paramagnetic and diamagnetic susceptibility—Curie's law connecting susceptibility and absolute temperature.

LECTURE V.—THURSDAY, MARCH 31, 1898.

Magnetic Theories.—Ancient ideas—The beginnings of a scientific theory of magnetism—The celebrated letter of Peter Peregrinus—The contributions of Gilbert, Descartes, Æpinus, Coulomb and Poisson—The magnetic fluid theory—The methods of the French mathematical physicists at the beginning of the century—Discoveries of Ampere and Arago—The Ampere-Weber theory of magnetism—Weber's theory of diamagnetism—Faraday's views on magnetism—Maxwell's theory of molecular vortices—The hypothesis of molecular magnets oriented by an external field—The basis for that theory—Ewing's model magnet—Explanation of hysteresis and the finite limit to magnetisation on the above theory—Maxwell's electro-magnetic theory—The fundamental properties of the ether—Ether theories—Rowland's discovery of the magnetic field due to a rotating body carrying an electrostatic charge—Outlines of a dynamical theory of magnetism—Rotating electrons—Hypothetical structure of an iron molecule—Discussion of the probable molecular structure of a mass of iron—Bonded and free molecules—The explanation, on the above theory, of the effects of heat and strain—The magnetic difference between annealed and unannealed iron—The direction in which further advance in theory may be expected—Conclusion.

THE N.C.S. LOW-RESISTANCE MEASURER.

This is a very simple instrument designed specially for the measurement of very low resistances, such as dynamo and motor armatures. A thick platinoid wire 1 metre long and 0·1 ohm resistance, stretched in front of a box-wood scale, is connected in series with the resistance to be measured, and a current of about 10 amperes is passed through the circuit. Two leads ending in steel points are connected to one coil of a tiny pivot differential galvanometer on the board, the other coil being connected between the end of the stretched wire and a sliding contact-maker. The fall of potential



The N.C.S. Low-Resistance Measurer.

over the unknown resistance is thus balanced against the fall of potential over a portion of the stretched wire, and the resistance is read off directly in thousandths of an ohm. To give a larger range, a plug switch, seen on the left of the figure in front of the galvanometer, varies the resistance of one of the coils of the latter, so that the galvanometer is balanced when the currents through its coils are in the ratio of 2:1, 1:1, or 1:2, according to the position of the plug. Thus, if the plug is in the left-hand hole the scale reading in front of the slider at its balance position has to be multiplied by $\frac{1}{100}$th; if the plug is in its middle position the reading has to be multiplied by $\frac{10}{1000}$th; and if in its right-hand position, multiplying the reading by 0·002 gives the resistance in ohms.

In the case of armatures it is sometimes desirable to know approximately the relative resistances of the separate bars. If tested as above, however, the readings would be so small that the result would be of no practical use, and the following method may be resorted to. A shunt of any convenient size, say 6in. of No. 8 platinoid wire, is connected across the terminals of the stretched wire (the two heavy terminals seen on the right of the figure), a larger current is used and the testing is carried out as before. The results will, of course, only be comparative, but, if the shunt is firmly fixed, the readings will be sufficiently accurate for practical purposes.

The instrument, which is made by the Davies Motor Co., should prove valuable for workshop use by manufacturers of dynamos and motors.

The Royal Photographic Society.—The Royal Photographic Society is organising an international exhibition of photographic apparatus and photographs, which will be held at the Crystal Palace commencing April 27th. In addition to the usual displays of pictures, &c., there will be exhibits illustrating the scientific and commercial applications of photography, photo-mechanical processes, photographs in colours, and photographs by means of X-rays.

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CORRESPONDENCE.

DR. FLEMING'S FERROMAGNETIC HYPOTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I think that Mr. Hay's difficulty in reconciling statements in my Sheffield lecture arises from his having taken particular sentences away from their context. I was careful to point out that all we are able to do is to consider *averages* of molecular conditions, and it is so expressly stated in the paragraph below one which Mr. Hay quotes. If, as I have assumed, the molecules of solids are in rotation, their angular velocities are no doubt distributed according to some law similar to that governing the translational velocities of gas molecules. Hence, even if an increase in magnetic moment is experienced by some iron molecules on heating, yet if other faster rotating ones have already broken up into non-magnetic submolecules the average molecular moment may be diminished.

It is clearly stated in another place that the gradual loss of permeability is a statistical result. I think that no one reading the whole of the passages in question in connection with their context would find them "misleading." It is, of course, quite possible to take a couple of statements away from their setting and make them appear inconsistent; but we may generally assume that a reader will at least grant an author that "willing mind" which eminent Judges have asserted is to be brought to the perusal of even a patent specification.—Yours, &c., J. A. FLEMING.

SPARKLESS CONTINUOUS-CURRENT MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 14th, on p. 382, you reproduce an article by Herr J. Fischer Hinnen relating to a method of magnetising the reversing pole-pieces of a dynamo. On reading it the method seemed familiar to me, and on looking up Swinburne's original Paper on "The Theory of Armature Reactions in Dynamos and Motors" I find an almost identical method described in relation to a machine with single magnetic circuit. In fact, if we divide the machine illustrated in Fig. 3 along the line N S the arrangement corresponds with that described by Swinburne, except in one particular. In the Paper, Swinburne points out one disadvantage of his method (in which all the series-winding was put on one side of the reversing pole), viz., that the reversing coil is also a compensating coil, and the two effects may not be required in the same proportion. This is obviated by Herr Fischer Hinnen's method. But the objection to the method is this. The length of a turn on the magnet bar is necessarily much greater than the length of a turn on the reversing pole, indeed, is nearly as great as the length of an armature turn, and as the number of ampere turns required is the same as the number of ampere turns on the armature, as has been shown experimentally by Ravenshaw, the result is that the copper required for the reversing arrangement is nearly the same as the copper on the armature.

It is because the extra cost of these methods of enlarging the output of a dynamo equals the cost of enlarging the output by increasing the size of the machine that, so far, they have not come into extended use, notwithstanding their admitted advantages; but I have reason to know that data will shortly be forthcoming, showing in one such method a commercial saving which will have an important bearing on future constructions.—Yours, &c.,

LLEWELYN B. ATKINSON.

Western Mail Buildings, Cardiff, Jan. 17, 1898.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The article of Herr Fischer-Hinnen on "A New Method of Avoiding Sparking in Continuous-Current Machines" calls attention to the possibilities of the intermediate magnet system of avoiding sparking, but the method he describes is not new. It was described and patented 10 years ago by Mr. George Hookham and the writer (*see* specification, Hookham and Housman, No. 1,875, of 1888) and possibly by others. Herr Fischer-Hinnen's description of the method is not quite complete, as he does not state the most important condition that the unbalanced part of the winding on the two sides of the auxiliary pole *must consist of series turns, otherwise sparkless commutation will only be attained for one value of current in the armature.*

It will be readily seen that this involves a considerable over-compounding of the machine, which is not always desirable, so that in general it is better to wind the greater part of the series turns on the intermediate magnet itself, which allows the length of turn to be kept small. During the last ten years a considerable number of machines on this principle have been turned out by Messrs. Chamberlain and Hookham, of Birmingham, and when the number of series turns is properly adjusted they run absolutely without spark, when the current is varied from 0 to a large overload.

The only drawback is the extra cost of the copper in the series turns, though in many cases the advantage gained is well worth the cost.—Yours, &c. R. H. HOUSMAN.

Mason College, Birmingham, Jan. 14, 1898.

[Herr C. L. R. E. Menges also claims priority over Herr Fischer-Hinnen in the invention of the compensating windings referred to in the latter gentleman's article. Herr Menges, informs us that in his German patent, No. 84,465 of December 6, 1884, he describes not only the series winding distributed on the pole-pieces, but also the use of small auxiliary coils and the special arrangement of the windings on the limbs of the field-magnets.—ED. *E.*]

SPACE TELEGRAPHY (?)

TO THE EDITOR OF THE ELECTRICIAN.

SIR: "Wireless telegraphy" is not a bad technical term; but if a more scientific name be desirable would not Radio-telegraphy or Ray Telegraphy be preferable to "Space Telegraphy"? which Dr. Lodge employs in his interesting lectures. Perhaps someone will suggest a good term.—Yours, &c.,

Jan. 15, 1898. J. MUNRO.

ELECTRICAL FIRE RISKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I remind you that there are two sides to this question—that there are electrical installations *and* electrical installations?

How often does one find a first-class job left in charge of a man who has absolutely no knowledge of the subject other than that which he may have picked up during the erection of the plant? and many have not even this doubtful advantage.

Then again, these so-called electricians will take down lamps and put them on other circuits, without any regard to overloading. If fuses go, copper wires are substituted (unprotected patents of the electricians). I have even known cases where flexibles have been jointed on to flexibles and insulated (?) with rags.

An objectionable feature which is often met with is the wooden switchboard, with its faulty connections behind and automatic cut-outs with mercury break in front. Some of the large slate boards are very little better, for you are almost certain to find a wooden support within 2in. of a plug hole in the 'bus bar.

When electricians can put in installations that will not be tampered with and tinkered, fuse-boards that will only take the right fuse, switchboards that do not consist of inflammable materials, automatic cut-outs that cannot be propped up and rendered inoperative, then the time will have come for insurance companies to go into the question of rates.—Yours, &c., W. E. ASTLEY, Fire Inspector.

Castleton, Lancashire, Jan. 17, 1898.

BOOK RECEIVED.

"Practical Electricity and Magnetism," Vol. II. By John Henderson. (London: Longmans, Green & Co.) Price, 6s. 6d.

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MICA AND ITS USES.

The use of mica in the electrical industries during recent years has naturally resulted in vastly-increased consumption, and the trade in mica has consequently assumed considerable importance. On account of the abundant occurrence of the substance in excellent quality in Canada, the attention of capitalists has been attracted to the micaceous properties in the Dominion. Mica is used so largely by so many classes of our practical readers that some account of its electrical and other uses will be of interest. Canada has long been known to be rich in economic mica deposits, and in 1863 Sir William Logan, in his "Geology of Canada" (pp. 494-5 and 795), referred to the deposits of "muscovite," or "white mica," then known to exist on Yeo's Island, Cape Tourmente, and other sections of Quebec. Mention is also made of the phlogopites or "amber" mica at Grenville, Quebec, and in North and South Burgess, Ontario, "in all of which the mica is obtained in large sheets, which, being transparent and free from flaws, are wrought and employed for the same purpose as the 'muscovite' or potash varieties." An early producer was the Sydenham property, in the Kingston district, and the important deposit of "muscovite," particularly referred to by Dr. A. R. C. Selwyn, C.M.G., F.R.S., Director of the Geological Survey of Canada, in the report of the Royal Commission on the Mineral Resources of Ontario, has been opened up at Villeneuve, in Ottawa county, while at Templeton, about 16 miles from the city of Ottawa, several extensive deposits of first-class amber mica, notably on the Wallingford property, have been worked. Dr. Selwyn's opinion of the Villeneuve "muscovite" mica is fully confirmed by another well-known Canadian expert, Prof. F. Cirkel, who has also reported in high terms on the Wallingford and Lake Girard properties.

Mica is a crystalline mineral, which, in association with several other minerals—as pyroxene and felspar—forms the rocks we know as gneiss and granite, and is capable of being cleaved into elastic plates of extreme thinness. Both its colour and commercial value are greatly influenced by the mineralogical peculiarities of the rock in which it occurs or has been associated, and also by the manner in which it has been deposited after the decomposition of the rock in which it originally occurred. In consequence of the discovery of its great value as an insulator, and owing to the rapid strides in the development of electrical manufactures, the demand for mica both in America and Europe, and particularly in Great Britain, has rapidly and is constantly increasing, and now that the incandescent gaslight companies are largely using it for chimneys, instead of glass, it is conceivable that the supply may soon have to be considerably increased. Even now, as quickly as consignments reach London they are absorbed for use either in the United Kingdom or on the Continent.

The insulating power of mica is superior to that of any other substance applicable to armatures and commutators. An advantage peculiar to itself is its even laminated structure. The builders of armatures can split sheets into any desired and uniform thickness with great ease and accuracy. A valuable property of mica in connection with commutator insulation is its degree of hardness; it does not wear away too rapidly under the action of the brushes. Of all substances, mica is probably the best material for insulation in certain parts of armatures if it is desired to obtain not only efficient electric insulation but also durability under the influence of heat. The highest temperature to which an armature is subjected, even by short circuits or bad constructions, will have no injurious effects on mica, thick or thin. It may be held in a gas flame without burning or melting. It has been proved that a sheet of 4in. in thickness will stand the strain of a voltage of close upon 5,000 volts. Mica being infusible, tough, non-combustible, and, when split in sheets, transparent, has a multiplicity of industrial uses, including chimneys for lamps, sight doors or windows for stoves and furnaces, and similar purposes where its infusibility, toughness and transparency enable it to be advantageously substituted for glass. It is also used on board war vessels, in localities where glass would be broken by concussion due to the firing of heavy guns, and is made into reflectors, sea compasses, and inlaying for wood instead of enamel. Another use for mica is its application, when previously coloured or "metalised," to ornamental purposes. From its unalterable nature the material preserves gilding, silvering or colouring from deterioration; and owing to its diaphanousness, the articles so treated preserve their brilliancy.

The mineral is also somewhat extensively used in the manufacture of mica grease. As a lubricant for railroad purposes, bicycles, &c., its value lies in its absolute anti-friction, and it is claimed that with its use hot boxes or journals are impossible. A profitable employment of the immense quantities of scraps and fragments of waste mica is the substitution of mica for glass in spectacles worn by workmen (such as electric welders and stone and metal workers) to protect their eyes from sparks, chips, or splinters. These mica glasses are concave, in the shape of watch glasses, and are about $\frac{1}{16}$in. in thickness. The advantages gained by this utilisation are greater than would at first be imagined. Mica spectacles have the advantage over glass that they cannot be broken. Pounding with a sledge hammer merely flattens them, nor does a splash of molten metal coming into contact affect the mica eyeshade.

One of the most recent uses to which mica is commercially applied is in the manufacture of "micanite," by which large quantities of scrap or inferior qualities are utilised, and, by means of a patented process, small pieces of waste mica are built up into sheets 40in. square, and larger, if necessary. This product can be made in any desired form, and is also largely supplied to the electrical trade for insulating purposes. As a covering for boilers mica possesses various advantages over any other material. Many other ways of utilising mica might be given, but enough has been said to show that there is an ample market for a material with which the electrical industry is already very familiar.

LEGAL INTELLIGENCE.

South v. Lowenfeld

At Westminster City Court an action was heard, brought by Mr. Harry South, electrical engineer, to recover £18 in respect of electrical work done and materials supplied to the Prince of Wales's Theatre, London. The defence was that the goods were supplied during the time that the theatre was sublet without the defendants' authority. Plaintiff said the goods were supplied to the order of the defendant's electrical engineer, and were being used in the theatre at the present time. His Honour said he thought plaintiff had supplied the goods at his own risk, and gave judgment for defendant, with costs.

In the same Court the case **South v. Nathan** was taken. Mr. Ben Nathan was sued for £15 for electrical appliances supplied to his order. Plaintiff said defendant gave him an order for electrical fittings which were to be worn by a stage artiste, but upon being applied to for payment repudiated his personal liability, and referred him to the lady who wore the goods on the music-hall stage. The defendant said he merely introduced a customer to plaintiff, and never intended to make himself personally liable. His Honour said if that were so the defendant ought to have made it clear to the plaintiff at the time of the order. He had not done so, however, and therefore judgment would be for the amount of the claim, with costs.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Offic not later than first post Thursday morning. New Catalogues Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published at the end of this month.

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System o Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

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"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net, 2s. 9d. post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. WADE. *In the Press.*

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is in course of preparation, and that the work will be published shortly. Many new features of interest to the profession will be introduced, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, will be brought up to date and amplified where necessary. Subscription and advertisement orders, new names and addresses, and alterations to existing entries must be sent in immediately.

Tenders Invited.—The Stockport Corporation invite tenders for the supply, delivery and erection of the following plant at their electricity generating station in Millgate:—

(*b*) Two mild-steel Lancashire double-flued boilers, with brick settings, smoke flues, dampers, &c.

(*c*) Three sets of steam dynamos, with their foundations, beds, trenches, &c.; also a feed-water heater of 150 H.P. nominal, a 6-ton overhead traveller, two feed pumps, steam, exhaust, water pipes, &c.

(*d*) A storage battery of 136 cells, of 750 ampere-hours' capacity, with stands, switchboard, &c.

(*e*) Electrical instruments and other apparatus upon the general switchboard and elsewhere, electrical connections between machines, &c.

(*f*) Underground armoured cables, street boxes, &c.

Our advertisement columns contain some further particulars, and plans and specifications may be seen at the office of the consulting engineer (Mr. James N. Shoolbred, C.E.), 47, Victoria-street, Westminster, S.W., or at the Millgate Gasworks, Stockport. Tenders must be sent, addressed "Chairman of the Electric Lighting Committee, Gas Offices, Millgate," by noon of Thursday next, the 27th inst. Mr. Walter Hyde is town clerk.

Tenders Invited.—The County Borough of Brighton will receive tenders for the completion of the electric light wiring, &c., of the Town Hall. Drawings may be seen at the office of the borough engineer and surveyor (Mr. Francis J. C. May), Town Hall, Brighton, and specifications, &c., can be obtained from Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton, to whom tenders must be sent before 10 a.m. on Monday, the 31st inst. Some further particulars are given in an advertisement elsewhere.

——— The Country Borough of Brighton invite tenders for the supply and delivery of dynamos, motors, switchboards, and the necessary wiring at the municipal school of science and technology. Some further particulars will be found in an advertisement elsewhere, and tenders have to be sent in to Mr. Francis J. Tillstone, town clerk, the Town Hall, Brighton, by 10 o'clock of Monday, the 31st inst.

——— The Corporation of Rochdale require tenders for steam dynamos, balancer and boosters, &c. Specifications, conditions of contract, &c., can be obtained after Tuesday next at the offices of the engineers, Messrs. Lacey, Clirehugh and Sillar, 10, Delahay-street, Westminster, London, S.W. Tenders must be sent to Mr. James Leach, Town Clerk, Town Hall, Rochdale, not later than Saturday, Feb. 19. Some further particulars will be found in an advertisement elsewhere.

——— The Wimbledon Urban District Council invite tenders for the supply and erection of (*a*) water tube boilers, pumps, &c.; (*b*) condensing plant, steam pipes, &c.; (*c*) overhead crane; (*d*) high-speed steam engines and alternators; (*e*) switchboard; (*f*) underground mains, conduits, &c. Tenders to the clerk to the Council (Mr. W. H. Whitfield), Council's offices, Wimbledon, by 5 p.m. on Feb. 2.

——— The Corporation of Blackburn require tenders for a 500 kilowatt continuous-current steam dynamo and a 120 kilowatt steam alternator. Tenders to the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by Saturday, 22nd inst.

——— The Corporation of West Hartlepool invite tenders for work in connection with their electric lighting station including:—(1) boilers and mechanical stokers, (2) engines, dynamos, &c., (3) storage battery, (4) switchboard, (5) arc lamps. Tenders to Mr. Higson Simpson, Town Clerk's Office, West Hartlepool, by Monday next, Jan. 24.

——— Tenders are invited by the Corporation of Wolverhampton for motor vans. Those firms sending in tenders for electrical vehicles must submit details of a van which carries electrical energy for 12 hours continuous work. Tenders to Mr. J. W. Bradley, C.E., Town Hall, Wolverhampton, by 7th Feb.

——— The Baths Committee of the Borough of Ashton-under-Lyne require tenders for wiring the Corporation Baths. Tenders to the Borough Comptroller (Mr. J. Neal), Town Hall, Ashton-under-Lyne, by noon of Wednesday, Feb. 2.

——— The Tramways Committee of the Bradford Corporation invite tenders for the electrical equipment of about nine miles of street tramways. Tenders to the Town Clerk by Feb. 1.

——— The Shoreditch (London) Vestry require tenders for the erection of an underground transformer substation in Worship-street. Tenders to the Vestry Clerk, Town Hall, Old-street E.C., by noon of 31st inst.

——— – The tenders required for the supply and delivery of vulcanised rubber cables for the Bedford Corporation have to be sent in to the town clerk (Mr. T. S. Porter), Town Hall, Bedford, by *Monday next.*——The tenders invited by the Electricity Committee of the county borough of Newport (Mon.) for the supply and erection of mains, cables, transformers, switch gear and arc lamp-posts have to be sent in to the town clerk (Mr. A. Newman), Town Hall, Newport, by *Monday next.*——The tenders required by the Corporation of Walsall for the construction and erection of a 250-B.H.P. high-speed vertical compound engine and a 2,000-volt high-tension continuous-current dynamo, with spare armature, have to be sent in to the town clerk (Mr. John R. Cooper), Town Hall, Walsall, *to-morrow (Saturday).*——The tenders for the supply and erection of steam engines and dynamos for the Burnley Corporation have to be sent in to the Town Clerk's office, Burnley, by *Wednesday next.*

——— The Municipal Authorities of Tordesillas (Valladolid), Spain, invite tenders for the concession for the electric lighting of the town for 20 years. Tenders to El Secretario del Ayuntamiento de Tordesillas, by Feb. 8.

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Tenders Invited.—The Municipal Authorities of Saint Chamond (Loire) invite tenders until March 31 next for concession for street lighting by electricity or gas. Tenders to La Mairie.

——— Tenders are invited until Feb. 3 by the Prussian State Railway authorities at Breslau for the supply of a quantity of arc lamp carbons. Tenders to Die Königliche Eisenbahn Direction, Breslau.

Tenders Accepted.—The tender of Mr. H. M. Ashton has been accepted by the Southampton Town Council for the wiring of the electricity station at £387. 18s. 6d., subject to the fittings being approved by the engineer. Tenders were also submitted by Messrs. A. Ford-Lloyd and Co. (at £395), Messrs. Sanby and Co. (£415) and Mr. F. Shalders (£476).

Tenders Received.—The following tenders have been received by the Ipswich (Queensland) Municipal Council for the supply of plant and machinery for their proposed electricity supply works :—

SECTION A.—*Tubular Boilers.*	
Crompton and Co.	£1,020
Siemens Bros. and Co.	1,075
Babcock and Wilcox	1,650
SECTION B.—*Feed, Steam and Exhaust Pipes, Pumps and Heaters.*	
Crompton and Co.	856
Siemens Bros. and Co.	971
Babcock and Wilcox	1,050
SECTION C.—*Steam Alternators and Exciters.*	
Siemens Bros. and Co.	3,159
Brush Company	3,200
Babcock and Wilcox	3,550
SECTION D.—*Switchboard.*	
Babcock and Wilcox	£375
Electric Construction Co. ...	417
Siemens Bros. and Co.	518
SECTION E.—*High & Low Tension Mains, Junction Boxes, &c.*	
Siemens Bros. and Co.	6,894
Noyes Bros. (Agents for the Callender Company)	7,316
Brisbane Electric Supply Co.	10,068
SECTION F.—*Transformers.*	
Siemens, Bros. and Co.	725
Crompton and Co.	760
Nalder and Co.	785

The report of Mr. John Hesketh (the consulting engineer to the Council) on these tenders has been considered by the Council, but no tenders have been accepted, as the Council have not yet obtained the necessary borrowing powers.

Sales by Auction.—Elsewhere in an advertisement will be found some particulars relating to the sale by auction, in one lot, by Mr. Henry Sherley-Price (of the firm of Wheatley Kirk, Price and Goulty) at the Mart, Tokenhouse-yard, London, E.C., on *Thursday, Jan. 27, 1898, at 2 o'clock prompt*, of the well-known and old-established concern known as the Projectile Company (Limited), with extensive works at New-road, Battersea, London, together with the goodwill, fixed and loose plant and machinery, stock-in-trade, stores, &c. The firms from whom particulars and conditions of sale may now be obtained (gratis) will be found in the advertisement. The works buildings are very substantially built, and are admirably situated for railway connection.

Appointments.—Mr. W. T. Evans has been appointed Lecture Assistant in Physics at the City and Guilds Central Technical College, Exhibition-road, S.W.

——— Mr. Spencer, formerly Manager of the Wednesbury and Walsall Electric Tramway, has been appointed traffic manager of the Halifax tramways.

Appointment Vacants.—The Council of the County Borough of West Ham invite applications for the appointment of chief assistant in the Borough electrical engineer's department. Salary £130, rising by two annual increments of £10 to £150 per annum. Some further information is given in an advertisement elsewhere, and applications are to be sent in to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, London, E., by 4 p.m. on Wednesday, the 26th inst.

——— The Corporation of the borough of Southend invite applications for the position of electrical engineer. Commencing salary £200, rising by annual increments of £25 to £300. Some further particulars are given in our advertisement columns, and applications must be sent in by noon on Wednesday, Feb. 2, to the town clerk (Mr. William Gregson), Southend-on-Sea.

——— The Corporation of Barrow-in-Furness invite applications for the post of resident electrical engineer. Commencing salary £200 per annum. An advertisement elsewhere contains further particulars of the Council's requirements, and applications, addressed to the Chairman of the Electric Lighting Committee, must be delivered at the Town Hall, Barrow-in-Furness, on or before Tuesday, Feb. 8. Mr. C. F. Preston is town clerk.

Vacancies.—A working electrician to take charge of the machinery, &c., is required at the Devon and Exeter Hospital, Exeter. Applications to the secretary, Mr. Albert E. Boyce. See advertisement.

——— The Southampton Corporation require an assistant in the electrical engineer's department. Salary £1. 10s. Applications must be delivered at the office of the town clerk (Mr. George B. Nalder), Municipal Offices, Southampton, by Feb. 1st. See advertisement.

Business Notice.—Mr. W. G. Walker has been appointed consulting engineer to the Taylor Hydraulic Air Compressing Company of Montreal, Canada, and British Columbia. The Company will shortly commence operations in this country, with offices in London.

Personal.—Mr. Reginald P. Wilson. of 3, Princes-mansions, Victoria-street, London, S.W., has been appointed consulting engineer to the Dudley Corporation to report upon the present tram lines in the district, with a view to conversion for electric traction.

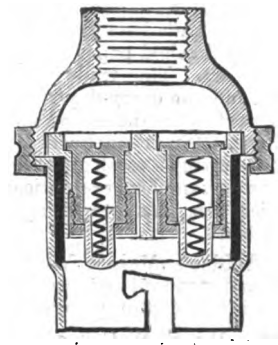
Liquidations.—A meeting of the Electrical Installation Company, Limited, will be held at 135, Victoria-street, London, S.W., on Feb. 18, to receive an account of the winding-up. Mr. J. G. O'Brien is liquidator.

——— Official notice is given that Mr. Samuel Wheeler has been appointed Official Receiver of the Ward Electrical Car Company, Limited. The first meeting of creditors will be held on the 26th inst., at 11 a.m., and the first meeting of contributories at 11.30 o'clock.

——— Claims against the Great Horseless Carriage Company, Limited, are to be sent, by March 1, to Messrs. Ward, Bowie and Co., 7, King-street, Cheapside, E.C.

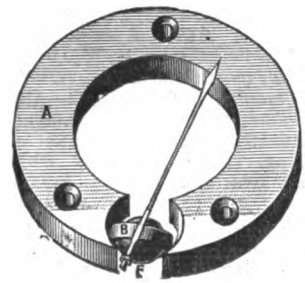
Bankruptcy.—The trustee in the failure of Thos. Fletcher, electrician, 188, Broadhurst-gardens, West Hampstead, London, N.W., late of 24, Clyde-road, Wallington, Surrey, has been released.

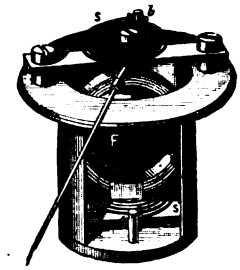
Ediswan "Anti-Shock" Lampholder.—The illustration below shows the Ediswan enamelled liner, or "Anti-Shock" lampholder, which consists of the Company's patent "S" insulator, the interior of which is surrounded by a patent enamelled liner preventing any



possible contact with the outer case by stray ends of wire. The Ediswan liner is fitted inside the brass case so that it does not interfere with the facility of wiring, &c., and the holder may be wired without removing the liner. The "S" holder, the licence for the manufacture of which reverts on the 27th inst. to the Edison and Swan Company, can be supplied with or without the enamelled liner.

"H.M.S." Instruments.—Messrs. H. M. Salmony & Co., of 118-120, Charing Cross-road, London, W.C., call attention to the merits of their "Dead-beat" type of direct current ammeters and voltmeters. The interior working parts of the voltmeter are shown in the accompanying illustrations. The movement in this instrument is due to the action of the current on a coil of well-insulated wire, suspended between two concentric rings of sheet





copper of very high conductivity. The whole of this is placed within the field of a very powerful circular magnet (A) of specially-hardened and well-aged magnet steel, which may be relied upon to remain practically constant for many years. This coil is connected in series with a much larger one of very high resistance, which is contained in the same case and which, with a 4in. voltmeter is claimed to have an average resistance of 20,000 ohms for every 100 volts. A ball (E) of the softest iron obtainable is inserted within the copper ring (B), which considerably increases the strength of the magnetic field. The needle acts in conjunction with the suspended coil (S), the axle working on jewelled pivots. The same instrument is made with six different windings, and the

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scale can be read either to 3, 30, 150, 300, or 600 volts. In the "Dead-beat" type of ammeter, by changing the shunts, the instrument reads over the whole scale up to 3,000 amperes. The two instruments can also be obtained in handy portable form, and makes a very compact testing set for reading over an enormous range. It is claimed that, owing to the exactness of the calibrations, this set may serve to determine unknown resistances of metals, &c., by placing them in series with the shunts. This type of testing set is in use in a number of central stations, and is guaranteed to be correct to ½ per cent. Messrs. Salmony and Co. also send out "Dead.beat" recording instruments, the sensitiveness of which may be varied in the same way as described for the ammeter and voltmeter. In the charging and discharging of accumulators the printing disc of the recording instrument may be in the centre of the paper cylinder, in which case the direction of the current is registered as well as the current itself. The popularity of this firm's special form of commercial testing set, "Station" type, is evidenced by the fact that, as we are informed, over 3,000 were sold in 1897.

Electric Bell and Telephone Lists.—The General Electric Company have just issued the 7th edition of their illustrated catalogue of telephones and telephone accessories, which is a publication well known in the trade, and contains particulars and illustrations of a large variety of apparatus for which this Company have a very extensive business. It is a noticeable point in all lists issued by the General Electric Company that they are arranged in a manner calculated to be of the utmost service to trade buyers of electrical apparatus and material, and the list under review, as well as the 12th edition of section L. catalogue of "Electric Bells and Accessories," which is also to hand, are striking examples of the skill of the catalogue compiler. There is something more required in the production of these trade lists than a mere grouping together of illustrations on highly-finished paper and printed in the highest style of the printer's art. The trade appreciate that class of publication doubtless, but the every-day trade buyer is more likely to place handy for easy reference the list which he regards as specially prepared for his benefit. We are inclined to think that he places the General Electric Company's catalogues very nearly at the top of the list. In the two examples here noticed the dealer in telephones, bells, batteries, &c., has everything required in every-day retail business to his hand.

Main Switchboard List.—Messrs. Veritys (Limited) forward a neatly printed and bound standard main switchboard list, into which a mass of information is crowded of general interest.

X-Ray Apparatus.—Mr. H. W. Cox, of Cursitor-street, London, W.C., is making a speciality of Röntgen X-ray apparatus, and has just issued a catalogue, which can be obtained by those requiring apparatus for this work and for wireless telegraphy experiments.

Soldering Compound.—Messrs. Beanland, Perkin and Co. desire us to notify that they are introducing a new soldering compound on the market, which is claimed to meet a long-felt want. It is stated to have met with considerable success in the United States.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 12 to Jan. 18, with the ports of destination :—

Aden—£47. *Argentina*—Buenos Ayres, £278 (including £203 telegraph material). *Australasia*—Auckland, £150; Brisbane, £61 (telegraph material); Melbourne, £87; Port Chalmers, £134; Sydney, £60; Wellington, £90 (telegraph material). *Belgium*—Antwerp, £237; Ostend, £78. *British Guiana*—Demerara, £21. *Ceylon*—Colombo, £44. *Chili*—Boca, £72 (telegraph poles). *Denmark*—Copenhagen, £60. *Egypt*—Alexandria, £40; Port Said, £8. *Germany*—Bremerhaven, £34; Hamburg, £35. *Greece*—Syra, £20 (telegraph material). *Holland*—Amsterdam, £200; Flushing, £160. *India*—Bombay, £21; Calcutta, £102; Madras, £29. *Italy*—Genoa, £60 (old telegraph wires). *Japan*—Yokohama, £107. *Natal*, £850 (including £421 telegraph material). *Persia*—Bushire, £120 (telegraph material). *Russia*—Odessa, £63. *Siam*—Bangkok, £150. *South Africa*—Cape Town, £125; Port Elizabeth, £45. *Spain*—Malaga, £494. *Straits Settlements*—Singapore, £24. *Sweden*—Gothenburg, £1,650; Stockholm, £126 (including £46 telegraph material). *Uruguay*—Monte Video, £69. Total, £5,951, against £6,290 in the corresponding week last year (Jan. 13 to Jan. 19).

Fire Risk Rules.—A copy of the new (1898) edition of the electrical installation rules of the Liverpool and London and Globe Insurance Company is to hand. These rules have been entirely revised and brought up-to-date, and differ in some essential particulars from the rules issued by other fire offices. The rules contain blanks for intending insurers, and a useful index. The new rules apply to installations where current is used at a pressure up to 250 volts, and, so far as we are able to judge from a brief review of the contents, have been compiled with a view to placing the smallest possible difficulty in the way of electric installation work. The rules are printed in handy pocket form.

Motor Starting Switch and Speed Regulators.—A pamphlet dealing with the uses and merits of the Cutler-Hammer motor starting switches and speed regulators which are placed upon the market by the Sturtevant Engineering Company, of 75, Queen Victoria-street, London, E.C. (who control this apparatus for Europe), has just been issued, and will be read with interest. These switches are designed to effectually shield the motor from harm when, from any cause whatever, the current is interrupted or the motor overloaded or subjected to an excessive supply of current. In the case of speed regulators the speed of the motor is regulated by the insertion of resistances into the armature circuit, the speed decreasing as the resistance is inserted. The pamphlet is called "Catalogue No. 14," and can be obtained from the Company free by post.

Calendars, etc.—A little late we have received from Messrs. Sampson and Co., belting manufacturers, of Stroud, Gloucestershire, a very serviceable desk blotting-pad, with moving date circles, showing month, day of the week, and day of the month. By means of a slip card for the year the pad becomes a prominent one, and, being strongly made, proves an excellent standing advertisement.

Messrs. Veritys (Limited) send a hanging tear-off pad. The tendency of these advertising sheets is undoubtedly in the direction of utility.

Aberdeen.—The borough electrical engineer (Mr. A. Blackman) and the gas engineer (Mr. Smith) have presented a report on the proposed extension of the electric light to the west end of the city, in which they recommend that the scheme, if adopted, should be proceeded with while the harbour mains and the mains to Bridge-street are being laid. As an alternative to the extension, a new electricity station could be erected in the west end at an estimated cost of £20,000. The Council are, however, recommended to carry out the lighting of the west end and the outlying portions of the town by means of high-tension continuous-current feeders, and that mains to supply 24,000 lamps should be laid to Queen's Cross at an estimated cost of £7,900. The Electric Lighting Committee have submitted the proposals to Prof. A. B. W. Kennedy for his consideration and report.

At the statutory annual meeting of the Harbour Board last week the Lord Provost announced that, amongst the new works and improvements to be carried out during the present year, an electric light installation would be put down for lighting the docks and harbour.

Ayr.—The burgh electrical engineer (Mr. A. J. Fuller) has presented a report on the tenders recently received for free-wiring schemes. Mr. Fuller states that, although he had received several inquiries, only one tender complied with their requirements, and before accepting this he suggested that application be made to the Secretary of State for Scotland for power to borrow money to enable the Corporation to carry out the work themselves. The Council have adopted this suggestion, and formal application will, therefore, be made for sanction to borrow £2,000 for wiring premises free of initial expense.

Bath.—The Urban Sanitary Authority have fixed the salary of the borough electrical engineer (Mr. G. F. Metzger) at £500 per annum. Mr. Metzger will also be allowed to have four apprentices, and to receive two-thirds of the premiums.

Mr. Metzger, in his report on the working of the electricity station during the past year, states that some trouble has been experienced owing to the heavy loads on the machinery. The lamp connections were then 11,700, and they had only a 10,000-light plant. On the strength of the promises that the new plant would be in working by October fresh lamp connections were made during the year, and these now amount to over 13,000. The various other difficulties with which the department have to contend are set out, and the report concludes as follows: "I am doing my best to keep things going, and often wonder that we are supplying to the present extent. We are working against overwhelming odds, and I have been compelled to request various customers to economise the light as much as possible, and we have even had to dispense with the light in the works. It will, indeed, be a relief when we are once again in smooth waters."

Bogota (Colombia).—In dealing with the subject of United States competition with Great Britain in Colombia, Mr. M. Villiers, British Consul-General, reports that amongst the articles which are supplied to Colombia by the United States are included electrical appliances and apparatus. The chief cause of the success of American competition is in the packing of the goods, the British merchant overlooking the fact that goods, if intended for the interior, must be packed for mule transport, and that varieties of mule packing have to be provided for to meet the conditions of the main roads (or want of roads), so that care has to be exercised in deciding the weight, size and shape of the packages. This question of packing is one which British merchants are advised to consider carefully, not only in its relation to Colombia but other foreign parts. The best method of packing where the consignment is a fairly large one

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would seem to be to divide the consignment into two equal-size shaped and weighted packages, so that the load can be equally divided on mule-back.

Boston.—The question of the erection of electricity supply works was introduced at the last meeting of the Town Council by Mr. John Beaulah, the Chairman of the Paving and Lighting Committee, who said that about 18 months ago they obtained an estimate from Mr. Adrian Collins, the consulting engineer for the docks lighting, and he put the initial cost of an installation at about £20,000. At that time the Committee were not in a position to go into the matter, but their hands had now been forced by the receipt of a communication from an electricity supply company. This offer, although it might appear to some to be generous, they could not entertain, as he considered that the Council should itself undertake the work. They contemplate applying for a Provisional Order next Session.

Cardiff.—The town's meeting held last week approved of the Corporation's Omnibus Bill, in which powers are sought for the construction of electric tramways in the town.

At the meeting of the Electric Lighting Committee on Tuesday, the borough electrical engineer (Mr. N. Appelbee) presented a report as to the progress of the electricity department. The increase in the lamp connections was hampered by the non-delivery of the additional plant for the station. In 1897 the department sold 324,461 units of current, against 308,430 units in 1896. Mr. Appelbee thought that the charge for current could be varied from 6d. per unit for the first two hours and 3½d. afterwards, to 7d. for the first hour and 3½d. afterwards, but no decision on this point was arrived at by the Committee.

Chester.—At the meeting of the Town Council on Wednesday Mr. B. C. Roberts, who presented the minutes of the Electric Lighting Committee, announced that during the past year the expenses of the electricity department had been about £2,400, and the receipts £4,985. The interest upon the capital borrowed was £1,269; the sinking fund instalment was £732, which would leave a net balance of about £565. They had not had what they might call an average working year, because they started in quite a small way. They were informed by the electrical engineer (Mr. F. Thursfield) that they might look forward to a gross income next year of quite £8,000, so that they should be in a very excellent position indeed. The net balance they had realised of £565 they had dealt with by giving an extra discount to their customers, which would absorb about £421, and leave a balance of £141 to be carried to next account. They had given notice to Messrs. Parker that the Corporation intended taking over the works in March. The price of electric current would most probably be reduced from 6d. to 5d. per unit. The Council have ordered a further sum of £5,000 to be placed to the credit of the Committee.

Colombo (Ceylon).—The Municipal Council have decided to light the portion of the city outside the Fort by incandescent electric lamps, and a contract for the supply of current for five years has been entered into with Messrs. Boustead Bros. 548 gas lamps of 12 c.p. each are to be substituted by the same number of incandescent electric lamps of 60 c.p. each. The cost of the installation of the generating plant, the adoption of the present lamp posts for the electric light, and the supply of the necessary lamps, mains, overhead wires, &c., has been fixed at £10,000, the annual cost of each lamp being 54·74 rupees. Provision is made for the purchase of the plant by the Council at the expiry of the agreement.

Douglas (Isle of Man).—The Isle of Man Tramways and Electric Power Company have offered to supply electric current for lighting the promenade for a term of three years at 3½d. per unit, the necessary lamps, cables, &c., being provided and maintained by the Council. The Company, however, declined to tender for the maintenance of the lamps and cables. Terms have also been obtained from the gas company, and a committee has been appointed to consider and report upon the two offers, with authority to employ an electrical expert if necessary.

Ealing.—The proposals of the London United Tramways Company to construct electric tramways in this district is, judging from the correspondence in the local Press, arousing considerable interest. Although the District Council have already resolved to oppose the scheme, the Company's proposals are viewed with favour by a considerable section of the community. A conference is to take place this week between the Council and Mr. J. C. Robinson (the Managing Director of the Company), and should the decision be adverse to the tramway project the ratepayers can console themselves with the fact that they have a light railway scheme to fall back upon.

Electric Mail Vans.—It is stated that the Postmaster-General and the executive of the Post Office are very satisfied with the working of the motor vans which have been running between London and Reigate in the postal service, and have decided to introduce small electric mail vans to expedite the London suburban delivery of letters.

Electric Power in South Staffs.—A meeting of the South Staffordshire Iron and Coal Masters' Association was held yesterday (Thursday) afternoon, at the Queen's Hotel, Birmingham, for the purpose of meeting representatives from the Midland Electric Corporation for Power Distribution (Limited), in order to consider and discuss the scheme of the latter Company for the supply of electrical energy for power and manufacturing purposes throughout South Staffordshire. The meeting has been convened by Sir Benjamin Hingley, Bart., and Mr. J. B. Cochrane, Chairman of the South Staffordshire Trades Association.

Finchley (Middlesex).—The District Council have received a proposal from an electricity supply company to erect electricity supply works for lighting East Finchley. The matter is being considered by a committee.

Fish Oil as an Insulating Material.—The American Fisheries Company (Limited) has been formed with a capital of $10,000,000, with the object of working a patent for extracting oil, &c., from waste fish. One of the uses to which the manufactured product is to be put is that of providing insulating material for cables, telegraph wires, &c., and is stated to have a greater resistance than any known substance at present employed by electricians for that purpose.

Folkestone.—As previously announced, the Folkestone Electricity Supply Company have purchased a site for their electricity generating station near Shorncliffe station. The Company has already entered into agreements for supplying current to the Pavilion and West Cliff Hotels, and arrangements have been made for the wiring of consumers' premises, on the hire-purchase system if desired. The price charged under the hiring agreement will vary from 2s. to 2s. 6d. per lamp per annum, the payment ceasing at the end of 14 years, when the installation becomes the property of the consumer.

Govan.—The Corporation have appointed Mr. William Arnot, late city electrical engineer at Glasgow, to prepare a report upon the electric lighting question.

Guatemala Customs' Dues.—All sizes of cables and iron or steel wire are now admitted free in Guatemala. The following duties per kilo are leviable upon the gross weight: on electrical apparatus (chemicals not included) and lightning rods $0·02; galvanised or copper wire $0·01½.

Hanley.—The Town Council have reduced the price of electric current for motive power purposes from 3d. to 2½d. per unit.

Horsham.—This not particularly up-to-date Sussex town has appointed a committee to consider the electric lighting question. Mr. Harrington, a member of the Town Council, thinks Horsham should have been provided with the electric light some time ago, and at the meeting of the Council at which the committee was appointed, put some figures before the members which impressed even the most sceptical as to the reasonable probability of success of a public and private electric supply undertaking—if in the hands of the Council. He estimated that about £10,000 would cover the initial expenses, and, while this may be somewhat under the mark, it is certainly time Horsham took the matter in hand and emulated Sussex towns like Eastbourne, Brighton, &c.

Hotel Lighting.—It is proposed, if found practicable, to utilise the Falls of the River Devon at Rumbling Bridge, N.B., to generate electric current for lighting the hotel, grounds, conservatory, stables, and outhouses of the Rumbling Bridge Hotel.

Hyde Park (London).—A writer in *Truth* points out that Parliament, in the estimates for 1897, provided for the electric lighting of the band stand in Hyde Park, at a cost of £250, and for the electric lighting of the footpath between the Marble Arch and Albert Gate at a cost of £900. The order of Parliament, it is pointed out, has so far been disobeyed, the objectionable gas lighting being continued.

Huddersfield.—Highly satisfactory reports from the borough electrical engineer (Mr. A. B. Mountain) were submitted at Wednesday's meeting of the Town Council. There are 598 customers, against 385 in the corresponding period of 1897, being an increase of 213, or 55 per cent. The equivalent number of 8-c.p. lamps connected was 41,702, against 28,983, an increase of 11,719, or 43 per cent. The units of energy metered in 1897 were 456,255, against 317,648 in 1896, an increase of 138,607, equal to 43 per cent. Tenders for work in connection with the proposed extension of the electric lighting premises were recommended for acceptance by the Electric Lighting Committee, the total cost being about £6,000. In moving the adoption of the various reports the Chairman of the Committee (Ald. Calvert), said that the extension of the works had become absolutely necessary in order to cope with the steadily increasing demand for current. The reports were adopted.

Infirmary Lighting.—The new Infirmary of the Bethnal Green (London) Guardians is to be lighted throughout electrically. The report of the architect of the building stated that by the adoption of the electric light there would be a saving of about £240 per annum. At the last meeting of the Guardians the proposal to employ electric lighting was agreed to, after one member (Mr. Walklate) had comfortably announced that "electricity was still in its infancy."

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Jersey.—The St. Helier's (Jersey) parish assembly have decided to petition the States of the Island in favour of a bill empowering the municipality to borrow a sum not exceeding £30,000, for the erection of electricity supply works.

Kirkcaldy.—A conference took place on Tuesday between the the Tramways and Town Council Committees and Prof. A. B. W. Kennedy on the proposed electric lighting and traction scheme for this town, and after full discussion Prof. Kennedy recommended the Committees to proceed with the combined scheme. The tramways will be equipped for the overhead trolley system.

Liverpool.—A conference took place on Tursday last at the Municipal Offices between the Tramways and Lighting Committees with reference to the question of the supply of electric current for traction purposes, Dr. John Hopkinson, the consulting engineer to the Tramways Committee, being in attendance. Mr. A. Bromley Holmes, the city electrical engineer, submitted proposals of a scheme for extending the electricity supply undertaking, with a view not only to meet the demand for current for tramway purposes, but also for extended street lighting and general purposes. The scheme provided for the erection of a large new generating station on a site near the Leeds and Liverpool Canal, at an estimated capital expenditure of £150,000. After considerable discussion, Dr. John Hopkinson was instructed to prepare a full report on the entire project.

Marylebone (London).—The Vestry have decided to enter into negotiations with Lord Portman for the purchase of land in the vicinity of the stoneyard, for the purpose of the erection of an electricity supply station.

Melton Mowbray.—The Urban District Council have approved the draft Provisional Order of the Melton Mowbray Electric Lighting Company.

Morecambe.—The District Council have resolved to ask Mr. F. Thursfield, borough electrical engineer at Chester, to act as arbitrator in the matter of the dispute between the Council and the Morecambe Electric Light and Power Company as to the terms of the purchase of the electric light undertaking by the Council, and in case of Mr. Thursfield's refusal to request Mr. W. R. Wright, of Burnley, to act as arbitrator.

Municipalities and the Telephone.—A half-hearted resolution that the monopoly of the National Telephone Company should be abolished, and that the telephone service should be in the hands of the Corporation, was discussed at the last meeting of the Southport Corporation, and for once in a way was sensibly discussed. Mr. Alderman Unwin, who brought forward the resolution, had very little to say on the subject, and the seconder of the resolution had less. Councillor Austin, describing the resolution as "somewhat milk-and-watery," gave it as his opinion that, whether the telephones were in the hands of the municipalities or a private company, it must be a monopoly, which we presume is the view held by most people whose opinion is worth anything. Councillor Austin very properly urged that reason and civility need not necessarily be absent even in the case of a monopoly, and he counselled the telephone company to so regulate its charges that they were neither excessive nor unjust. Councillor Travis expressed the opinion that the National Telephone Company not only had a monopoly, but was able able to charge what it liked, which is somewhat different to the general run of monopolies—in this country at any rate. A railway company is a monopoly, but its charges are regulated somewhat by Parliament. What he complained of was that they had originally a company which provided a service at £5 per instrument. When that company was bought up the purchasing company nearly doubled the rates. This, in his view, was a real grievance. The Council approved the motion. ——At the next meeting of the Bedford Town Council, Councillor Royle will propose that a committee be appointed to consider the desirability of applying to the Postmaster-General for a licence to construct and work a municipal telephone service for the borough.

National Fire Brigades' Union.—This Union, with headquarters at Trinity Chambers, Guildford, are circulating suggestions as to the amendment of the law relating to fire brigades, retained and voluntary. Attention is called to the fact that the French Chamber of Deputies has recently passed a Fire Brigade Bill, which will doubtless become law. This imposes a tax upon insurance companies. It is not unfairly pointed out that this is a peculiar way of obtaining funds for improving the fire brigade service, as the insurance companies will, of course, recoup themselves by raising their rates, and the expense will thus be thrown upon the insurers, and the owners of property who do not insure will obtain all benefits free gratis and for nothing. The Union invites the assistance and sympathy of the public.

Newport (Mon.).—We regret to notice that the Town Council have not adopted the recommendation of the Electric Lighting Committee to increase the salaries of the borough electrical engineer (Mr. C. D. Copland) and his assistant (Mr. H. M. Taylor) by £50 each per annum. The proposal led to a lengthy discussion, but eventually it was decided to grant an increase of £25 to Mr. Copland and £20 to Mr. Taylor.

Partick (N.B.).—The Council have declined to entertain proposals from the Municipal Electric Supply Company for the erection of electricity supply works in this town.

"Pocket Book of Electrical Rules and Tables."—Prof. A. Jamieson desires us to notify that the 13th edition of this well-known publication is in hand, and he would be pleased to receive hints for improvement in the new edition.

Private Bill Legislation.—The Great Northern and City Railway Company, who obtained powers in 1892 to construct an underground electric railway from Canonbury to the City, have deposited a Bill for powers to extend their line to Finsbury Park Station, and also to effect a diversion for a short distance of the Canonbury branch of that Company near Drayton Park. The generating station is to be erected at Drayton Park. Sanction to the creation of £400,000 additional share and loan capital, and power to cancel the existing agreement with the Great Northern Company, and to enter into and carry into effect a new agreement are also sought.

Amongst the Bills which have been certified as complying with the standing orders, and are therefore ready to be introduced into either House, are the Chelsea Electricity Supply and the Metropolitan Electric Supply Companies' Bills.

The Bill for power to construct an underground electric railway from Charing Cross, *via* Knightsbridge, to Paddington, at an estimated cost of £1,225,734, has been dropped.

Queensland.—*Daily Tenders and Contracts* announces that the Queensland Government are making enquiries as to the practicability of employing electric traction on the suburban railway line at Adelaide.

Sevenoaks (Kent).—Mr. H. E. McKrell has notified the District Council of his intention to apply for a Provisional Order to light the district electrically. The matter has been referred to the Lighting Committee.

Southampton.—The output of the Electricity Department for the month of November was 24,240 units, an increase of 8,970 units over the corresponding period of 1896. Owing to the general increase in the output, it has become necessary to run the works continuously throughout the 24 hours, and the Council have decided to appoint a third assistant.

Southport.—The Tramways Committee of the Corporation presented their report at the last meeting. Councillor Travis detailed the route which the proposed new tramways to be constructed in this district are to take, and the order in which the Committee proposed to take the various routes. It appeared from the report that in August, 1901, the Council comes into possession of the lines now owned by the Southport and Birkdale Tramways Company, and the possession of these lines will considerably facilitate the scheme of the Tramways Committee. The Committee expressed their preference for a circular route. As to the mode of traction to be employed, lengthy consideration was given to this important point. The report contained a very exhaustive review of different systems, including horse, gas traction, underground cables, and the overhead electric system, and Councillor Travis announced, amid applause, that of all the different modes the electric overhead trolley system had found most favour, and it was this system the Committee recommended the Corporation to adopt. As to the question whether the Corporation should work these lines themselves or should lease them, Councillor Travis himself preferred the former course, but in asking the Council to adopt the Committee's report all that was asked was that power might be reserved for Corporation working. In this connection reference was made to the practice adopted by the Corporations of Glasgow, Leeds and other towns. The Tramways Committee did not propose, in the event of it being decided that the Corporation should work the lines to themselves generate the current, but recommended its purchase from the Electricity Committee, the price per unit to be decided later. The report concludes in a most sanguine estimate of the value of the extension of tramway facilities to the inhabitants, and of the prospect of its being a profitable undertaking to the Corporation. With regard to the latter point statistics have been presented by the electrical engineer (Mr. Charles D. Taite) and the borough surveyor, and it was estimated that the routes Nos. 1 and 2 which would be first of all taken in hand would cost about £27,000, while lines Nos. 3, 4, 5 and 6, to be taken later, would cost about £20,000. The Committee estimated the cost of running per car mile at 5d., or, with interest and sinking fund allowance, a total of 8d. This was set against the average receipts of the cars in a portion of the district already provided with tramways, which was equal to 11d. per car mile. At present only 10 miles of streets containing tramways existed in the district, and this would be, even with the additional lines now proposed to be constructed, very far below the mileage of Continental towns on

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the same scale as Southport. The report was briefly discussed and ultimately unanimously adopted.

St. Luke's (London).—A discussion on the best means of improving the street lighting took place at a meeting of the Vestry last week. Mr. Pond, who initiated the discussion, thought the Vestry should consider the advisability of lighting some of the principal streets electrically. Eventually the matter was referred to the Works Committee.

Swansea.—The Streets Committee have received an offer from the Harbour Trust to supply electric current for lighting the town side of the north dock, the terms being that the Council should bear the cost of extending the mains and of maintenance, and in return the Trust would supply current free of charge. A sub-Committee has been appointed to consider the matter.

Taunton.—At the last meeting of the Town Council the Mayor, in proposing the adoption of the Electric Lighting Committee's report, stated that the Committee were carefully considering the question of supplying current for power and heating. He was glad to state that the prejudice in the town against the electric light was gradually disappearing, as was evidenced by the large number of unsolicited applications for supply. The Committee would shortly bring before the Conncil a project for considerable extensions, especially in the northern part of the town.

Telegraphs and Telephones in British Guiana.—The length of telegraph and telephone lines throughout the colony of British Guiana is 462 miles. There are 17 cables, with an aggregate length of 84½ miles. The public telephone service in Georgetown has 457 renters, the charges being £5 for business premises and £2. 10s. for private houses. New Amsterdam also has a small telephone service. For the financial year 1896-7 the total gross revenue from the telegraph and telephone services was £4,476, and the cost of maintenance, exclusive of salaries, was £791.

Telegraphic Difficulties on the Gold Coast.—Telegraphic communication with Kumasi was completed in March, 1897, and is a permanent line constructed by the Colonial Telegraph Department. There has been a steady increase both in the number of messages sent, and the total amount received from both inland and other telegrams. Unfortunately, interruptions are frequent and are attributable to many causes. The Kumasi land lines pass through dense forests, and are injured and broken by the falling trees and branches. The coast line is affected by the action of the sea spray, causing a corrosion of the copper conductor which gives way under the first strain of a stiff breeze or tornado. Considerable lengths of wire have been stolen from time to time, copper wire being valued by the natives for making armlets. In 1896 240 yards of wire was so stolen.

The Strike.—As anticipated in our last issue, the quiet return of many of the men in the engineering trade to their old employment has led to the collapse of the strike. Formal notice of the withdrawal of the 48-hour demand was made to the Employers' Federation on Saturday last, and while this intimation was received by the men in some districts with apparent surprise and indignation, no such surprise was evinced by the leaders of the movement in the principal centres of strike activity. The end has been in sight for some time, and it was only the large subscriptions received—it may be from tainted sources—that kept the movement alive. We do not, however, lose sight of the fact that the men have twice supported their leaders' action by ballot, but it is undoubtedly true that the men, in so acting, were unaware of the serious strain which the strike movement has had upon the resources of their union. The Federation, in acknowledging the receipt of the notification of the withdrawal of the 48 hours demand, took occasion to inform the A.S.E. officials that the Federated employers were only prepared to open their works to the members of the allied unions on an official confirmation of the acceptance of the "conditions of management" which were mutually agreed to at the Westminster conference, and on the understanding that any resumption of work by members of the unions would be simultaneous throughout the country. This is the position of affairs at the moment of going to press, and it is anticipated that an official answer will be received by the Employers' Federation this day (Friday).

In our view, apart from the fact that the strike has collapsed, the most serious news of the week in connection with the dispute is the publication by the Employers' Federation of a charge against the Amalgamated Society of Engineers that it favours the policy of restricting output, and interferes in an arbitrary and irritating manner not only with the workmen members of the society, but with those who are appointed foremen of works. This question of the restriction of output is by far the most important with which the Employers' Federation has to deal, and we take occasion to express the opinion that the Federation have here hit upon the most serious weakness in trade union working, and one which calls for the attention not only of employers in the engineering trade, but in all trades where the men are members of a trades union. Complaints are made by employers in other trades that this restriction of output is an actual "instruction" from the trades union leaders, and, taken in conjunction with the notoriously false plea upon which the 48 hour week was agitated for (that the men require more time for recreation), it exposes a state of things which we think calls for the earnest consideration of employers generally. In many trades it is extremely difficult to gauge at a glance the value of work done by men in a specific time, even apart from the fact that no two men work alike as to output, and therefore if an "instruction" has been issued that it is the duty of a trades unionist to only produce a minimum result for a maximum wage, this will at once account for the diminished profits of which such general complaint is made. Below we give some striking instances of this restriction of output as issued by the Employers' Federation, and it will be seen that the figures show a very serious state of affairs. It may be mentioned that the non-unionists particularised in the list are men who, it is claimed by the Amalgamated Society, were non-efficients :—

	A.S.E. Men.	Non-Unionists.	Hours saved.
1st Case	24 hours	16 hours	8
2nd „	29½ „	17½ „	12
3rd „	37 „	22½ „	14½
4th „	39 „	28 „	11
5th „	56 „	22½ „	33½
6th „	24 „	17 „	7
7th „	23¼ „	19 „	4¼

We have not space at command to include the complete figures and particulars issued by the Federation, but except in the matter of actual names and dates, these figures are circumstantial to a degree.

Withington.—The District Council have appointed a Committee to arrange terms with the Manchester Corporation for the supply of electric current in the district for public and private lighting.

Workhouse Lighting.—In our issue of Jan. 7 we announced that the Ipswich Guardians had decided to light the new workhouse electrically. It appears, however, that in 1896 the Guardians passed a resolution against the adoption of the electric light, and a special meeting was held last Friday to rescind this resolution and to re-affirm the decision to introduce the electric light.

Wrexham.—Some time ago the District Council applied to the Local Government Board for sanction to borrow £8,000 for the purchase of a site for an electricity station, baths, &c., but after inquiry the Board have declined to grant the loan.

Electro-Harmonic Society.—A smoking concert will be given in the St. James's Hall Restaurant, Regent's-street, London, on Friday evening next, the 25th inst., at eight o'clock, when a more than usually attractive programme will be submitted.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

The fifty-first half-yearly ordinary general meeting of this Company was held yesterday (Thursday) at Winchester House, Old Broad-street, under the presidency of the Marquis of Tweeddale.

The SECRETARY (Mr. George Draper) having read the notice convening the meeting,

The CHAIRMAN proposed the adoption of the report and accounts. He stated that the gross revenue for the half-year ended September 30th last had been £443,727, being an increase of £8,262 compared with that of the corresponding period of 1896. There was a decrease in the Cape and the Australian traffic, but this was more than balanced by the temporary increase in the Indian and other classes of traffic. The latter increase was due to the military operations on the Indian frontier, the considerable part being Press traffic, which, as they were aware, was carried at very low rates. The commercial traffic with India showed, he was sorry to say, a tendency to decrease, but he thought that they might now look forward to better times in India. The expenses for the half-year had been £109.243, or an increase over those of the September half of 1896 of £6,867. The actual increase was due to their staff having been increased, and the effect of this was seen under the head of salaries and wages. Year by year they found that they had more work to do in order to earn approximately the same amount of money. Experience taught them that a reduction of tariff did not always develop their traffic, or, at any rate, not to an extent sufficient to cover the increased expenditure entailed in the working of it. Their policy, however, would always be to lower the rates whenever there was a reasonable likelihood of creating an increase of traffic. They must adopt the latest approved patterns in every form of apparatus incidental to their work. It was their constant endeavour to secure greater accuracy and speed, because the better they could do their work the more work they would have to do. All this, however, meant greatly increased expenses, but so long as they could continue to improve their earning powers without increasing their capital expenditure, the stronger would be their position. He need hardly reiterate the assurance that the most rigid economy, consistent with thorough efficiency, was practised by the management; but the gradual increase in the working expenses was a

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factor which would have to be reckoned with in the future. It was the inevitable result of the development of their business and of giving effect to the sound principle of sharing their prosperity with the telegraphing public. The expenses attending repairs and renewals of cables had been £31,637, or an increase of £9,516. Notwithstanding this increase, these expenses were really low, the average having been for some years past between £40,000 and £50,000 for the six months. The Vigo-Gibraltar cable, to which he referred at their last meeting, was successfully laid by their own steamers, and was charged against the general reserve fund, which remained at about the same figure as last half year—£790,000. The maintenance ships' reserve fund was to replace the vessels as they wore out and became obsolete, and they could not replace their five ships for less than £200,000 or £250,000, whereas the fund for this purpose amounted to only £142,000. They had decided to build a new vessel, which would be larger, faster and a greater carrier than any they had at present. The marine insurance fund was a separate fund, and was for providing against loss occurring to their ships, stores and spare cable. From time to time a desire had been expressed for an increase in the dividend on the ordinary shares. This was a question which for several years had exercised the minds of the Directors, who had been loyally supported by the shareholders in their policy of building up their reserves. If they had paid larger dividends in the past they would have exposed themselves to further demands for tariff reductions, and they would have also invited competition at a time when they would not have been able to meet it. He believed that if the current half-year continued as it had begun they would be able to recommend an increase of a further ½ per cent. in the bonus, making the total distribution for the year up to 7 per cent. They at the same time contemplated making a certain reduction in their tariff rates. He afterwards referred to the bonus paid to the staff in celebration of the twenty-fifth anniversary of the Company and also in connection with Her Majesty's Diamond Jubilee, and remarked that it was hardly necessary to tell them that the bonus had been highly appreciated, while in his opinion it had been very well merited.

The VICE-CHAIRMAN and MANAGING DIRECTOR (Mr. J. Denison Pender) seconded the motion, which was carried unanimously.

Resolutions were afterwards passed re-electing the retiring Directors and auditors.

An extraordinary general meeting was held subsequently, to consider the Company's Bill in Parliament.

The SOLICITOR read the heads of the Bill, and

The CHAIRMAN afterwards proposed the following resolution:—

"*That this meeting having considered the Bill proposed to be introduced into Parliament in the ensuing session, intituled 'A Bill for the conversion of the existing Preference shares of the Eastern Telegraph Company (Limited), and for other purposes,' hereby approve the same, subject to such additions, alterations and variations as Parliament may think fit to make therein; and as the Directors shall approve.*"

He stated that the conversion of the Preference shares into Preference stock had been proposed owing to several reasons. The Preference shares were offered to the shareholders, and afterwards to the public in February, 1876, to provide capital for duplicating the cables between Suez and Bombay. The price of their Ordinary £10 fully-paid share in that year ranged between £5 and £7 (compared with £18 that day), and it was with considerable difficulty that they were able to place the Preference shares. As time went on their credit—thanks to the policy of paying moderate but substantial dividends and bringing up their reserves—slowly but surely improved. In these altered circumstances they considered it most desirable to rearrange their issues, and in doing so eliminate the Six per Cent. Preference, which was not only misleading as an indication of the financial status of the Company, but it also operated as a bar to obtaining additional capital on the most advantageous terms. He had no doubt that the proposal would be unanimously accepted. The exact effect of the conversion would be as follows: A present holder of 100 Six per Cent. Preference shares (nominal £1,000) derived an income therefrom, less tax, of £58 per annum. If he converted them, as was now proposed, into Three and a-Half per Cent. Preference stock, at the rate of £18. 10s. for every £10 fully-paid share, he would receive £1,850 of the new stock, bringing him in an income, less tax, of £62. 11s. 10d. The proposed alteration was calculated to benefit all classes of proprietors and the Company generally.

The VICE-CHAIRMAN and Managing Director seconded the resolution, which was carried unanimously.

On the motion of Mr. PARRITT, a cordial vote of thanks was afterwards passed to the Chairman, Directors and staff.

The CHAIRMAN briefly acknowledged the vote, and the proceedings then terminated.

[*We shall publish a full report of this meeting in our next issue.*]

Direct United States Cable Company (Limited).

The report of the Directors of this Company for the six months to Dec. 31st last, to be presented at the general meeting to be held on Tuesday next, the 25th inst., states that the half-year's revenue, after deducting out-payments, amounted to £50,098. 2s. 8d., compared with £47,601. 2s. 1d. for the corresponding period of 1896, an increase of £2,497. 0s. 7d. The working and other expenses for the same period, including income tax, but exclusive of cost of renewal and repairs of cable, amounted to £19,722. 13s. 10d., leaving a balance of £30,375. 8s. 10d., as profit, making, with £3,927. 13s. 4d. brought forward, a total of 2s. 2d. For the corresponding period of 1896, the working nd other payments amounted to £19,815. 13s. 6d. Interim 3s. per share for the quarter ended Sept. 30, 1897 (paid Oct. 26, 3s. per share for the quarter ended Dec. 31, 1897 (payable ther amounting to £18,213, have been declared, and after setting aside £12,000 to reserve, the balance of £4,090. 2s. 2d. on revenue account has been carried forward.

The Reserve Fund account has been debited with £8,325. 0s. 11d. cost of cable renewal and repairs, and with £2,000 written off the Ballinskelligs buildings account, and, after being credited with interest on the investments and sum transferred from revenue account, the balance of the Reserve Fund now amounts to £345,767. 17s. 9d.

Yorkshire House-to-House Electricity Company (Limited).

The report of the Directors of this Company for the year to Dec. 31st last just issued states that the profit for the year, after transferring £2,300 to depreciation fund account, is £10,703. 1s. 11d., to which is added £392. 12s. 2d. brought forward, making a total of £11,095. 14s. 1d., which the Directors propose to appropriate as follows: To reserve, £3,000; interim dividend at the rate of 5 per cent. per annum on the amount called and paid up on the Ordinary shares for the half-year ended June 30, 1897, £2,624. 8s. 1d.; dividend on the amount called and paid up on the same shares, which, with the interim dividend, equals a dividend at the rate of 6 per cent. per annum for the year, £4,142. 3s. 7d.; balance forward, £1,329. 2s. 5d.

The Company's works and plant have been maintained in a thoroughly efficient state of repair. The number of lamps connected was equivalent to 49,150 35-watt lamps, against 39,396 in 1896. 18,948 Ordinary shares were, Feb. 2, offered at par to the then existing members of the Company, and on 18,626 shares were applied for and allotted. The Directors have carefully considered the suggestion for extinguishing the Founders' shares, but have come to the conclusion that it is not yet practicable to effect such an operation.

The Company's new buildings are practically completed, and contracts have been made during the year for additional engines and alternators of a total capacity of 1,500 I.H.P. (or 900 kilowatts). The greater portion of this plant is expected to be ready for use in a few weeks, and the remainder during the coming summer. A large expenditure has been incurred in the provision of improved means of distributing electrical energy in the central parts of the City. The mains have been considerably extended in the direction of Kirkstall, and an extension will shortly be made in Meadow Road. A reduction in the charge for electrical energy has been made, which came into effect on the 1st inst., the maximum price being reduced from 6d. to 5d. per unit. The charge previously made for connecting premises has been abolished, except in cases where the wires have to be carried exceptional distances, and the minimum charge of 13s. 4d. per quarter for current (authorised by the Company's Provisional Order) is not now enforced. These modifications will represent a future total concession of several thousand pounds per annum, but the Directors look forward to a compensating additional consumption.

The Leeds Corporation have in contemplation the purchase of the Company's undertaking.

City and South London Railway Company.

The report of the Directors of this Company for the half-year ended Dec. 31st last, to be submitted to the proprietors on Friday, the 28th inst., states that the receipts from all sources have amounted to £26,528. 10s., and the cost of working £15,035. 3s. 7d., leaving a profit of £11,493. 6s. 5d. Inclusive of the balance brought forward, the net revenue shows a total of £12,567. 3s. 1d. After making provision for the Debenture and Debenture stock interest, a balance remains available for dividend of £9,156, 2s. out of which sum the Directors recommend the full dividend of 5 per cent. per annum on the Preference shares, and a dividend at the rate of 1¾ per cent. per annum on the Consolidated Ordinary stock, carrying forward £1,510. 14s.

The number of passengers (exclusive of season ticket holders) carried during the half-year was 3,337,861, and the receipts £25,472. 12s. 10d., against 3,437,810 and £25,403. 3s. 6d. respectively in the June (1897) period, and 3,368,480 and £25,456. 6s. 9d. on the December, 1896, half-year. In comparison with the half-year to December 31, 1896, the traffic receipts show only a small increase, but the receipts of the former period were exceptionally increased by the Australian cricket matches at the Oval, and by a continuance of much colder and more unsettled weather than has been experienced in the past six months.

Very satisfactory progress has been made with the extension of the line to Finsbury-pavement, but the works necessary for upholding the fabric of the church of St. Mary Woolnoth have caused considerable delay at that point. The difficulties have, however, been nearly overcome, and more rapid progress there will now be possible.

To meet the increasing demands on the generating depôt at Stockwell, it has been decided to enlarge the premises, and the Directors are making arrangements for acquiring the adjoining property.

Considerable progress has been made in the acquisition of the sites for the stations on the Clapham extension, and it is hoped that it will be possible very shortly to let the contract for the completion of that portion of the line.

In order to utilise the portion of the present line between the Borough station and King William-street, which will be thrown out of use by the construction of the new extension, arrangements have been made with a new company (the City and Brixton Railway) to continue this part of the line from the Borough, *viâ* St. George's-circus and Kennington-road, to Brixton-hill, and it is proposed that the new line when completed should be leased to and worked by the City and South London Company in conjunction with its present system upon terms which are now in negotiation, and which, when settled, will be submitted for the approval of the proprietors at a special meeting to be convened for that purpose.

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Provisional arrangements have been made for the construction of a subway to connect the platforms of this Company's station at Lombard-street with those of the Bank station of the Central London Railway, at the joint cost of the two companies. This will greatly facilitate the interchange of traffic between the two undertakings.

A Bill has been deposited, the principal purpose of which is to obtain an extension of time for the construction of the line to the "Angel" at Islington, authorised by the Act of 1893, and to authorise a short additional siding at Clapham Junction, rendered necessary in connection with the station there. This Bill will also be submitted for their approval to the proprietors at the special meeting.

The Five per Cent. Terminable Debenture Bonds have been reduced during the last half-year by £10,500, leaving only £17,800 now outstanding.

The locomotive, generating, hydraulic and condensing plant continue in good working order, and have been well maintained. The rolling stock is also in good working condition, and has been increased by eight additional coaches recently delivered.

NEW COMPANIES, STATUTORY RETURNS, &c.

MOTOR MANUFACTURING COMPANY (LIMITED).—This Company was registered on Jan. 12, with a capital of £300,000, in £1 shares, to manufacture, sell, let on hire or otherwise deal with motors of every description, cycles, vehicles, &c., and to carry on the business of electricians, mechanical engineers, &c.

RAILWAYS' ELECTRIC SUPPLY SYNDICATE (LIMITED).—The statutory return to Oct. 15 has been filed. 7,000 shares have been taken up out of a capital of £10,000 in £1 shares, and all have been issued as fully paid.

RAND CENTRAL ELECTRIC WORKS (LIMITED).—The annual return to Dec. 28 has been filed. The whole nominal capital of £300,000 in £1 shares has been taken up, and 25,000 shares are considered as paid. £275,000 has been received on the others.

SALISBURY ELECTRIC LIGHT AND SUPPLY COMPANY (LIMITED).—The annual return to Jan. 5 has been filed. The capital is £20,000 in £1 shares, of which 1,307 have been taken up, and the full amount called.

SILICON ELECTRIC LAMP SYNDICATE (LIMITED).—This Company has never gone to allotment, and the signatories have requested that it be struck off the register.

SINGLE WIRE MULTIPLE TELEPHONE SIGNAL COMPANY (LIMITED).—The annual return to Dec. 24 has been filed. The capital is £5,000 in £10 shares, and 374 shares have been taken up, and paid for in full.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26½d. per oz. (Jan. 20). Consols (2¾ per cent.) 112¾—112⅞ for money, 112¾—113 for account; 2½ per cent. 105⅞—106¼ (Jan. 20.) Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Days, Jan. 25 and Feb. 8; Ticket Days, Jan. 26 and Feb. 9; Pay Days, Jan. 27 and Feb. 10; Mining Share Carry-over Days, Jan. 24 and Feb. 7.

BLACKPOOL AND FLEETWOOD TRAMROAD COMPANY (LIMITED).—At an extraordinary meeting of the shareholders of this Company, on Wednesday, at Manchester, the Directors were authorised to proceed with their Bill for powers to construct tramways in Blackpool. It is proposed to construct a double line from Regent-terrace along the Carriage Drive authorised by the Blackpool Improvement Act (1893); a single line from Queen-square to the Carriage Drive, and a single line from Dickson-road to Queen-street. The Company propose to take powers to raise £75,000 additional capital. The Chairman announced that the line to Fleetwood would probably be open for traffic by May 1st.

CENTRAL LONDON RAILWAY COMPANY.—The fifth ordinary general meeting of the shareholders of this Company will be held on Wednesday, Feb. 2, at 2 p.m.

DUBLIN SOUTHERN DISTRICT TRAMWAYS COMPANY (LIMITED).—At a meeting of this Company, to be held on Feb. 8, the Company's Parliamentary Bill, dealing with the proposed increase in the speed of the electric service, will be discussed.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The interest on this Company's Four per Cent. Mortgage Debenture Stock for the half year to 31st inst. will be paid by warrant on Feb. 1, the stock register being closed from the 27th to the 31st inst., inclusive.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—The transfer books of the Ordinary shares of this Company are closed from the 18th to the 31st inst., inclusive, for the payment of the second half of the dividend at the rate of 6 per cent. per annum, declared on July 22 last.

GLOBE TELEGRAPH AND TRUST COMPANY (LIMITED).—The financial papers announce that an interim dividend of 1s. 9d. per share has been declared by the Directors of this Company.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY (LIMITED).—Official notice is given in our advertisement columns that a petition has been presented to the Chancery Division of the High Court of Justice for confirming the special resolution passed on the 17th ult. (and confirmed on the 28th ult.) reducing the capital by cancelling the whole of the Founders' shares. The reduction will be from £200,000 (divided into 40,000 shares of £5 each, of which 27,900 are Ordinary, 12,000 Preference, and 100 Founders' shares), to £199,500 (divided into 39,900 shares of £5 each, of which 27,900 are Ordinary and 12,000 Preference shares). The petition will be heard before Mr. Justice Romer, on Feb. 5. Messrs. Neve and Beck, 21, Lime-street, E.C., are solicitors for the Company.

MUNICIPAL ISSUE.—The Liverpool Corporation are inviting applications for £1,500,000 £2½ per Cent. Stock, redeemable at par, at the option of the Corporation, on and after Jan. 1, 1923. Tenders must be delivered at the Chief Cashier's Office, Bank of England, before 2 p.m. to-day. The issue will be devoted to the purchase of the tramways, the extension of the electricity supply undertaking, and other works of improvement in the city.

OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY (LIMITED).—Letters of allotment in the recent issue of this Company have been posted.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—The Directors of this Company recommend a dividend for the half year to Dec. 31 last of 11s. per share on the Ordinary shares, making, with the interim dividend, 14½ per cent. for the year 1897.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a settling day in, and to grant a quotation to the further issue of 10,000 Ordinary shares of the County of London and Brush Provincial Electric Lighting Company (Limited), 12,000 shares of the Direct West India Cable Company (Limited), and 285,157 Vendors' £1 shares (fully paid) of the Cape Electric Tramways Company (Limited). Application has also been made to the Committee to allow the further issue of 5,072 Ordinary shares (Nos. 14,929 to 20,000 inclusive) of the Barcelona Tramways Company (Limited), £120,000 Four and a-Half per Cent. Registered Debentures of the Direct West India Cable Company (Limited), and 5,000 shares (Nos. 1 to 5,000) and £103,500 Four and a-Half per Cent. First Mortgage Debentures of the Halifax and Bermudas Cable Company, to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Jan. 14 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,240. The numbers are published of the 180 £100 debentures of 1880 (Series "A" and "B") of this Company which were drawn on the 17th inst. for payment at par on or after Feb. 2.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half month ended Jan. 15 is £1,997, against £2,379 in the corresponding period of 1897.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—The Directors of this Corporation will recommend to the shareholders at the general meeting to be held on Wednesday, Feb. 16, the payment of a dividend of 8 per cent. for the past half-year, making, with the interim dividend already paid, 12 per cent. for the year 1897. The dividend is payable on March 1. We understand that the recent issue of £200,000 Three and a-Half per Cent. First Mortgage Debentures of the Company was largely over-subscribed.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Jan. 15	3,459	+435	...	...	...
Bristol Trams & Carriage	„ 14	2,365	+451	2	4,828	+ 902
City & South London Ry.	„ 16	1,085	...	3	3,259	- 14
Dover Tramways	„ 15	108	...	19	2,157	...
Dublin United (Southern)	...	...	...	...	...	...
Liverpool Overhead Rly.	„ 16	1,361	+ 83	3	4,156	+ 239
Sheffield Tramways	„ 16	961	+161	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Jan. 12.	Price Wednesday, Jan. 19.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 15. Highest	Lowest.
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	8/0	Central London Ordinary	9¾ 10¼	9¾ 10¼	2 13 6	June and December	9⅛	9⅛
143,106	10	1/9¾	Do. (£6 paid)	5¼ 5⅝	5¼ 6	3 0 0	„ „	5¼	.
£880,000	Stock	2½	City and South London Railway Con. Ordy.	69 71	69 71	2 14 10	January and July	70	69½
8,419	£10	.	Do. 5% Perpetual Preference	15½ 16	15½ 16	3 2 6	„ „	15¾	...
£135,701	Stock	4¾	Do. 4½ Perpetual Debenture	138 140	138 140	3 17 2	May and November	..	...
54,080	10	2/6¾	Waterloo and City Ordinary	12½ 13	12½ 13	3 6 1	June and December	12⅝	12 5/16
87,880	10	8½	Liverpool Overhead Railway Ordinary	11 7/16 11 9/16	11⅝ 11¾	3 12 2	February & August	...	...
10,000	10	5½	Do. 5% Preference	16 16⅜	16 16½	3 0 7	„ „	...	...
125,000	Stock	4½	Do. 4½ Debenture xd	108 110	108 110	3 11 5	January and July	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Jan. 12.		Price Wednesday, Jan. 19.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 15.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£923,960	Stock	14/0	Anglo-American	62	64	61	63	4 12 0	Feb., May, Aug., Nov.	..	..
£3,058,020	Stock	28/0	Do. Preferred	111½	112½	111	112	5 3 7	" "	111½	111
£3,038,020	Stock	5/0	Do. Deferred	14	14½	13½	13¾	..	" "	14½	13½
£ 37,400	£100	4%	*African Direct Telegraph (Red)	101	104	100	104	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	6	7	6	7	..	" "	..	..
130,000	10	3/0	Brazilian Submarine	16½	16¾	16½	16¾	4 3 6	Mar., June, Oct., Dec.	16¾	16½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	112	116	4 6 2	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	182	187	185	190	4 4 8	Jan., Apr., July, Oct.	190	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105	107	105	107	3 14 9	" "	106½	105¾
16,000	10	8/0	Cuba Submarine	8½	9½	8	9	8 17 10	February and August	9	..
6,000	10	10%	Do. Preference 10 per Cent.	18½	19½	18	19	5 5 3	" "	..	..
12,981	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	102%	105%	103%	106%	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877 xd	10½	11	10½	10¾	5 16 3	Jan., Apr., July, Oct.	10¾	10½
400,000	£10	2/6	Eastern xd	17¼	17¾	17⅝	18¼	3 11 3	" "	18	17½
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference xd	18	19	18½	19½	3 4 1	" "	18⅝	18½
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	130	133	131	134	2 19 11	May and November	132¾	131½
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	102	105	102	105	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension xd	18½	19	18¾	19¼	3 13 8	Jan., Apr., July, Oct.	19¼	18½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	132	135	132	136	2 19 9	February & August	132½	132
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99	103	99	103	4 17 3	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99	103	99	103	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103	106	104	107	3 16 2	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108%	111%	108%	111%	3 12 1	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	11½	12½	11½	12½	3 15 6	Jan., Apr., July, Oct.	12 1/16	11⅝
180,042	10	6%	Do. 6 per Cent. Preference	17⅝	18½	17⅝	18¼	3 5 9	" "	18¼	17⅝
150,000	10	5/0	Great Northern of Copenhagen	25½	27½	27	28	3 11 5	January, April, July	26⅝	26½
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	101	104	101	104	4 17 7	March & September	..	..
17,000	25	12/6	Indo-European	52	55	52	55	4 10 11	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	107	110	108	111	5 10 1	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105	108	105	108	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	7½	8½	7½	8½	4 14 1	April and October	8⅞	8½
3,381	£100 Cert.	6%	Submarine Cables Trust	136	141	136	141	4 5 1	" "	142½	..
15,609	10	6/0	West African Telegraph	4	5	4	5	5 0 0	.. ..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 14 4	March & September	..	..
30,000	10	..	West Coast of America	¾	1½	¾	1½	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	107	105	107	3 14 9	June and December	..	..
88,321	10	1/0	West India and Panama	⅝	⅝	⅝	⅝	..	May and November	½	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7¼	7⅝	7	7¼	8 0 0	" "	7⅝	7 1/16
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	9¾	10½	9¾	10¼	2 18 5	May and November	10½	9¾
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7¼	7¾	7½	8	3 15 2	" "	7 1/16	..
33,129	7½	1/6	Do. Deferred Ordinary	2¾	3¼	2¾	3¼	..	" "	..	..
£382,220	..	4%	Do. 4 per Cent. Debenture Stock	104	107	104	107	3 14 1	June and December	..	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	..	..
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3	3½	3	3½	5 14 4	August	..	..
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16	1/16	1/16	1/16	..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	..	..
484,597	5	3/0	National	6½	6¾	6⅝	6¾	4 7 3	February & August	6 1/32	6½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 10 7	" "	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14	16	14	16	3 15 0	" "	15 1/32	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6	6½	6	6½	3 16 11	" "	6½	..
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	102	107	102	107	3 5 0	June and December	106	..
171,504	1	0/4	Oriental	1/16	1/16	1/16	1/16	4 2 4	April and October	..	..
58,000	5	5/0	United River Plate	8¾	4½	4	4½	5 11 1	July	..	..
£146,733	Stock	6%	* Do. 5 per Cent. Debenture Stock (red.)	100	105	101	106	4 14 6	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.								
£150,000	5	4½%	Birmingham Electric Supply (fully paid)		10¾		10¾		March	..	..
£50,000	5	..	Do. (New Issue) £3. 10s. paid		..		..		..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	26	27	27	28	2 10 0	February & August	27	26⅝
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17	18	17	18	3 6 8	January and July	17⅝	..
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	..	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12½	13½	12⅛	13½	2 8 2	February & August	13 5/16	13½
20,000	5	2/3	Do. 4½ per Cent. Preference	6½	6¾	6⅛	6¾	3 6 8	" "	..	..
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)						January and July	..	..
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	10½	11	10½	11	3 8 2	March	10⅞	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	112	114	112	114	3 14 7	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	13½	14	13½	14½	..	..	14½	13½
20,000	£10	6/0	Do. 6% Cumulative Preference	15½	16	15½	16	3 15 0	March & September	..	..
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9	10	9	10	..	..	..	..
10,000	£5	7%	Do. 7 per Cent. Preference	11	11½	11	11½	3 0 11	March & September	11½	11½
111,000	£5	..	London Electric Supply Ordinary	2⅞	3¼	3	3¼	..	..	..	..
48,050	£5	..	Do. Preference	6⅜	6⅝	6⅜	6⅝	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	18½	19½	18	19	2 17 11	April and October	18 1/16	18⅜
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	18	19	18	19	..	" "	18⅜	18¼
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	..	..
6,452	10	8/0	Notting Hill Electric Ordinary	17½	18½	17½	18½	2 3 3	March	..	..
275,000	1	..	Rand Electric	1 1/16	1 1/8	1 1/16	1 1/8	..	..	..	..
£125,000	Stock	5%	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90	95	90	95	5 5 3	..	..	..
150,000	$100	82	Royal Electric Company of Montreal Shares	145	147	145	147	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 4 1	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	17	18	17	18	3 3 11	February & August	17⅛	17⅛
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	10⅜	10¼
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	101	104	101	104	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	15½	16½	16	17	2 18 10	March & September	16½	15½
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	1/6	Brush Electrical Engineering	1⅞	2⅛	1⅞	2⅛			2	1⅝
90,000	2	2/0	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	..	..	2⅛	..
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109	113	109	113	4 0 9	February & August	110½	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	100	103	102	105	4 6 2	June and December	102½	102
10,000	£10	..	British Aluminium Ordinary							..	..
20,000	10	..	Do. 7% Cumulative Preference							..	..
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7½	8½	7½	8½	5 17 8	June and December	..	..
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	107	112	107	112	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1	1½			..	..
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½			..	..
£2,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	86	91	86	91	5 6 5	January and July	..	..
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3	5 10 0	February & August	2 1/16	..
17,139	5	2/9½	Do. (£5 paid)	4½	5½	4½	5½	5 0 0	" "	..	..
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	100	102	100	102	3 17 8	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅜	2⅝	2⅜	2⅝	3 13 4	February & August	2 1/16	2 1/16
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3⅝	3½	3⅝	4 3 4	August	..	..
91,196	1	10/0	Elmore's Patent Copper Depositing	½	⅝	½	⅝	..	..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	20½	21½	21	22	4 10 11	February & August	..	..
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 12 0	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 10	" "	..	..
80,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	23½	24½	23½	24½	4 1 8	" "	..	..
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	103	107	3 14 9	March & September	..	..
£7,350	12	12/0	Telegraph Construction and Maintenance	36	39	38	41	4 7 10	March and July	39½	39
£100,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	101	104	102	105	4 15 3	January and July	103⅜	..
£22,500	£5	3/6	Willans and Robinson Ordinary	7¾	8½	7¾	8½	4 4 10	April and October	7 1/16	7
£22,500	£5	3/0	Do. 6% Cumulative Preference	6¾	7½	6¾	7½	4 2 0	" "	..	..
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	105	107	105	107	3 19 6	May and November	106½	..

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NOTES.

To-day expires an important patent granted in 1884 to Carl Dornfeld, of Cologne, for improvements in holders of incandescent lamps. This patent covered the use of spring plungers, and the specification described a form of bayonet socket-holder which is the progenitor of the one so common to-day. It is alluded to as follows in the claim of the patent: "In holders for incandescent lamps the arrangement of spring pins, with guides, which effect both the electrical contact with the lamp and, by means of their vertical pressure against the lamp-head, the secure fastening of the lamp in the holder . . . ." It is noteworthy that this pattern of holder has held its own in this country against the "Acorn" or "Edison" type, although, after the expiry of the Edison master lamp-holder patent in 1894, the latter type could be manufactured free of licence, and, in consequence, at considerably less cost. It will be remembered that this Edison patent was an extremely broad one, taken out before the days of commercial electric lighting, and claiming not only the combination of a separate removable lamp with a suitable lampholder, but also the use of an incandescent conductor formed of a single carbonised fibre in an electric lamp, and the use of contact pieces at the base of the lamp.

England is, we believe, the only country in which the bayonet-socket is used almost exclusively. Both in America and in Germany the "Acorn" pattern is favoured; in the former country probably because it was invented by Edison, in the latter undoubtedly because it is cheaper. The normal pattern of "Acorn" socket is large and unsightly compared with the bayonet type, but there appears to be no reason why it could not have been reduced in size, for both mechanically and electrically it is as good as its rival. Perhaps, after all, it has been partly a question of fashion, and no doubt, also, lamp manufacturers have discouraged the introduction of a new form of lamp top.

As is well known, the Dornfeld patent was acquired by the Edison and Swan United Electric Light Company, who did not, however, reserve to themselves the sole right to manufacture under it, but licensed 17 other firms. By the terms of this licence a fairly high minimum selling price was fixed per lampholder, and this caused much grumbling on the part of contractors. Even now it has been agreed between the Edison and Swan Company and the majority of their former licensees that a minimum price be fixed for this necessary article so as to avoid too close competition and cutting prices. It is doubtful, however, whether this will have the desired effect, as no limiting trade-discount has been agreed on. When the lamp patents expired, the market was immediately flooded with a number of cheap foreign-made lamps, and we may expect a similar result now in the case of lamp holders. We have little doubt, however, that the British public will try this second-class article—as they have done before—form a true estimate of its value, and finally, as in the previous instance, find it more economical to return to the higher-priced variety.

A correspondent asks us whether the regulation of the Board of Trade, which provides that "no metal forming part of the electric circuit shall be exposed so that it can be touched" applies to the carbon-holders of arc lamps. It is difficult to say whether the clause referred to was designed to include the carbon-holders of arc lamps, but it is certain that not only do these holders, but in many cases also the frame and casing of the lamp, form part of the circuit, or are electrically connected to the circuit. Lamps for public lighting are usually constructed with the frame and casing properly insulated, as, indeed, all arc lamps should be; but lamps supplied to private consumers are commonly defective in this respect. Undoubtedly the Board of Trade regulation could be rigidly enforced in respect of the casing and framework, but where the lamp is provided with a globe that, with the corona, completely envelops the carbons, it is probable that the holders are not, technically speaking, "exposed."

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It should be a matter for encouragement to those who have at heart the interests of electric traction on common roads that so soon after the commencement of practical work the London Electrical Cab Company is able to contemplate an immediate and considerable extension of its operations. In the prospectus recently issued in connection with the issue of the balance of 86,388 shares at a premium of 12½ per cent., it is stated that "it is with the object of still further increasing the number of the Company's vehicles that this issue is made," the balance in hand of half the working capital being required to meet the contracts now being carried out for the building of new cabs. Doubtless these new vehicles, which will treble the number of electric cabs now on the London streets, will embody improvements in detail suggested by practical experience with the first batch; for, though the electric cab as at present constructed is vastly more comfortable, quieter and more rapid than a horse cab, it cannot escape the engineering eye and ear that certain minor improvements are possible, such, for example as reducing the wheeze noticeable in the gearing after it has become somewhat worn.

Prof. Short, of Cleveland, has patented an apparatus for the direct production of electrical energy from coke. It consists of a gas retort through which coal is thrust by a reciprocating rod, being destructively distilled during its passage, and when converted into coke, falling into an electrolyte fed with oxygen. Here it is opposed to an electrode of lead or lead oxide and is consumed with the production of current. The advantages claimed are that the heat necessary to carbonise the coal not only produces gas, which is drawn off and utilised in the ordinary way, but suffices to bring the coke itself to a temperature suitable for its electrolytic oxidation. An economy of heat would certainly result from using coke red-hot as it is drawn from the retorts, but the saving is not very large, and whether it is worth while to encumber a generator with a gas plant for the sake of this saving is far from certain. But all this is of exceedingly minor importance compared with the fundamental question of the nature and efficiency of the generator. Of what does the electrolyte consist? Can it act for an indefinite time, being fed with coke and oxygen, or has it to be renewed? What becomes of the ash of the coke? What fraction of the energy of the coke is converted into electrical energy? Indeed, is there the smallest prospect of making the apparatus work? Is it in any way better than the dozen other carbon cells which have entertained the *cognoscenti*? Plentiful and accurate details must be forthcoming before the present device can be viewed in any less sceptical spirit than that which has been found satisfactorily serviceable in assigning their value to many similar inventions equally freely acclaimed at their introduction, and now possessing an interest mainly historical.

While it is an undoubted fact that there is an abundance of waste water-power in such far-away parts as Iceland and the dark continent, English electrical engineers can more suitably find a considerable amount of water-power nearer home on which to exert some of *their* waste energy. In Spain there is already a demand for electric light, not only in the larger cities, but also in the towns of medium and small size, and a number of these have already erected water-power central stations to meet their requirements. The greater part of the machinery and plant for these stations has, however, to be imported from abroad, although the stations themselves have in most cases been erected by Spanish firms. From a conversation we recently had with a Spanish engineer, it has appeared to us that there should be a good opening for English capital and English engineers to establish works in the Iberian peninsula for the manufacture of electrical apparatus and machinery. Material manufactured in the country by, say, a branch of an English firm of good standing would practically command the market there, for, apart from any national prejudice in favour of machinery produced by Spanish labour, the cost of production would be low, as power would be inexpensive and freight would be saved. At present English plant has to compete in Spain with that of German, American, Swiss, and even French manufacture. Now that water-power is being utilised for manufacturing purposes in nearly every part of the globe, whether it is in close proximity to the markets for the manufactured goods or not, English engineers and capitalists will do well to take the initiative and establish works in Spain before the best sites have been occupied by foreign competitors. In the circumstances, successful competition will, no doubt, be established ere long on these lines, and there is nothing unpatriotic in hoping that, if English-made wares are to any extent to be beaten out of the Spanish markets, it should rather be by our own countrymen and our own capital than by the competition of foreigners.

A correspondent has sent us the socket of a combined wall plug and single-pole fuse in which a dangerous arc had occurred, caused by a short-circuit in the flexible wire. It appears that the fuse-wire in the plug-socket had melted, and that the fused metal had bridged two of the terminals *viâ* the head of a holding-down screw, with the result that one of the tubular brass sockets was almost entirely melted away, and even the surface of the porcelain base bears signs of melting The blowing of the circuit-fuse prevented the arc from spreading further. Our correspondent expresses the opinion that it would be safer if the fuse-connections were omitted in such fittings, and we cordially agree with him, but it is only fair to point out that the socket in question is one of the worst designed ones it has been our fate to come across. Just as contractors disregard the regulations of the Phœnix Office to the effect that "No wall sockets with flexible conductors will be allowed in any place or in any risk unless by permission," so probably they would fail to observe a rule specifying that every wall socket should be protected by an independent fuse; but rather than have the fuse within the socket it would be safer to omit it altogether.

It is stated that the Treasury will bear the expense of casting an equestrian statue, upon which Mr. Watts has been working for some years, and that the statue will be placed in Hyde Park. The subject is announced by the newspapers to be "Energy or Force," but which of these it will be is

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not clear. Surely this should be settled early between one or the other, as "the dimensions" are affected. In an age of science and materialism, like the present, a statue to either Energy or Force would not be inappropriate.

New French Trunk Telephone Line.—It has been definitely decided that Nice and Paris shall be connected by telephone, and the work will be commenced forthwith.

Royal Society.—Among the Papers down for reading yesterday were two by E. Wilson: "The Kelvin Quadrant Electrometer as a Wattmeter and Voltmeter" and "The Magnetic Properties of Almost Pure Iron."

Post Office Electrical Delivery Vans.—On Monday last a service of electrical Post Office delivery vans, provided by the London Electrical Cab Company, was put into operation for the conveyance of mails between the General Post Office and the West Central, Western, and Paddington district offices.

Physical Society.—We regret to announce that Mr. Thomas H. Blakesley has resigned his seat at the Council Board of the Physical Society. He is, therefore, no longer honorary secretary of that Society. The Physical Society thereby loses one of its most energetic and useful officers, whose loss is to be deplored.

The Webb Testimonial.—We are asked to state that the presentation dinner to Mr. and Mrs. Webb has been postponed to Monday, February 21st, owing to the rooms of the Hôtel Métropole being required on the 14th (the date originally fixed) for a dinner at which the Prince of Wales is to be present. Early application for tickets should be made to Mr. Henry Edmunds.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Bundaberg—New Caledonia ...	Nov. 4, 1897 ...	Jan. 20, 1898.
Ceara—Maranham	Dec. 23, 1897 ...	—
Teneriffe—St. Louis (Senegal)...	Dec. 24, 1897 ...	Jan. 23, 1898.
Curaçao—La Guayra...	Jan. 5, 1898 ...	—
Para—Caminha.....	Jan. 13, 1898 ...	—
Para—Maranham	Jan. 22, 1898 ...	—

The University of London.—In a letter to *The Times* of yesterday, Prof. S. P. Thompson alleges that "the opposition to the scheme of reconstitution" of the University of London "has come chiefly from members of the legal profession," while in the faculties of science and medicine the majorities were in favour of the scheme. Analysis of the votes into faculties shows a majority in favour in every faculty except that of Laws.

Municipal Lighting in the Province of Quebec.—The town of Magog, Quebec, is one of the first of Eastern Canadian townships to adopt the electric light, and to operate its own plant. The power at the station is obtained from the Magog river. The water-wheel plant is of the Crocker type, and the generating and electrical plant was made by the Canadian General Electric Company.

The Laxey and Ramsey Electric Railway.—We understand that in connection with the extension of the Douglas and Laxey Railway to Ramsey it is intended to employ a storage battery of considerable dimensions, and the order for the same has been placed with the Chloride Electrical Storage Syndicate (Limited), whose batteries, it will be remembered, are already in use in connection with the Douglas and Laxey section, as also on the Snaefell mountain line.

A Veteran Telegrapher in Canada.—From the *Canadian Electrical News* we learn that a complimentary banquet was accorded Mr. H. P. Dwight by his friends, at the Toronto Club, on December 22nd last. The dinner was in honour and congratulation of the completion in August last of the fiftieth year of Mr. Dwight's connection with the Great North-Western Telegraph Company, of which corporation he is president and general manager. Such a record fully entitles Mr. Dwight to the reference made to him by our contemporary as being the *doyen* of the telegraph service of Canada.

Gas-Driven Plant for a Heavy Electric Railway.—A standard gauge electric railway is being built from the town of Trossingen in Germany to the railway station bearing that name, a distance of 2·8 miles, with no gradient exceeding 3 per cent. According to the *Elektrotechnische Zeitschrift* the power house will contain two Körting gas engines, each of 100 H.P., two 75 H.P. dynamos, and a battery of 300 cells, for the railway service, and two more dynamos and a battery of 124 cells, for the supply of light and power in the Trossingen district. There will be two motor cars, each equipped with two 40 H.P. motors. It is expected that the railway will be opened in September.

Annual Report of the Metropolitan Fire Brigade.—In the annual report of the chief officer of the Metropolitan Fire Brigade, issued on Tuesday, it is stated that there are 114 telephone lines between fire-stations, 592 fire-alarm call points, 16 telephone lines to police-stations, 89 telephone lines to public and other buildings, 9 bell-ringing fire alarms to public and other buildings, and 1 speaking tube to a public building. 19 cases are detailed in which offenders have been punished during the year for giving malicious false alarms. In one case the offender was fined £20, in another case £10, and in two cases £5. While in some cases the offenders were sentenced to imprisonment for varying terms, in others the magistrates appear to have taken singularly lenient views of the offence and inflicted half-crown fines!

Telegraph Facilities in Mexico.—A despatch from the City of Mexico states that the Mexican Telegraph and Cable Company and the Western Union Telegraph Company have secured a concession from the Mexican Government to connect their wires in the United States with the Federal lines at Nogales, Juarez and Laredo. Through despatches can thus be sent by Government wires to the United States and to all points abroad. The Western Union Company, it is stated, will pay 15 per cent. of its receipts to the Government for the franchise, and the Cable Company will also pay the same percentage. The Government agrees to send all its foreign despatches by these two lines. The contract is looked upon as one of the most far-reaching of its kind ever entered into, and will, it is thought, drive the Postal Telegraph Company out of the country. It is stated that the Postal Company will defend its position in the courts, and make a strong legal fight against the prohibitory clause in the contract of its competitor. It is claimed by the opposing interests that the Mexican Central and Mexican National Railways violated their concessions in making the arrangement with the Postal Telegraph Company for an exchange of business.

Combined Microphone and Phonograph.—Writing in the *Revue Générale des Sciences* for December 30, 1897, Dr. Louis Olivier describes, says *Nature*, the latest combination of the principles of the microphone and phonograph under the name of "microphonograph," the invention of M. F. Dussaud, of Geneva, and subsequently developed by M. George F. Jaubert and M. Berthon. A demonstration of the properties of this apparatus was given a short time ago at the house of M. and Mdme. Eugène Pereire. From certain physiological facts, Dr. Laborde showed the possibility of rendering sounds audible to deaf mutes by this instrument, and his view received practical confirmation at the hands of Dr. Gellé, who experimented with signal success on a number of subjects to whom a sensation of sound was thus conveyed for the first time. It is suggested that the microphonograph may become an important factor in the education of deaf and dumb subjects Finally, M. Berthon and M. Jaubert have employed the new apparatus in connection with the telephone and the kinematograph, the latter combination rendering it possible to reproduce scenes with all the attendant sounds of conversation and so forth. With this apparatus it is proposed to arrange life-like reproductions of a number of naval scenes at the Exhibition of 1900, under the auspices of the Compagnie Générale Transatlantique.

Motor Vans for Postal Despatches.—The motor van which has been conveying mails between London and Redhill since Dec. 16, as previously announced by us, is driven by steam. In another note we announce the running of some electrical postal delivery vans. Particulars of the Redhill service, notwithstanding its non-electrical nature, will interest those of our readers who are watching the development of motor

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traffic. The van, which was built by Messrs. Julius Harvey and Co., is slightly smaller than the ordinary two-horse mail van, and weighs, with its engine and boiler, about a ton and a-half. The engines are placed underneath the van, and are entirely housed and run in oil. The steering gear is extremely simple; and, as the engines are fed automatically, the driver has merely to keep an occasional eye on his gauges. Thus it is not necessary for an expert engineer to be employed as driver. The engines are capable of developing 20 H.P., but this extreme is only used for the purpose of travelling up steep hills. The ordinary power employed is only half the maximum; and with that it is possible to attain a speed greatly in excess of the regulation 10 miles an hour. The road to Redhill, though it is far from level, does not present any difficulties. The van is timed to leave Mount Pleasant Post Office at 10:30 p.m. every day, and to arrive at Redhill at 1:42 a.m., returning to Mount Pleasant at 4:45 p.m. The record run on December 30th brought the van back by 3:45 p.m., and it is usual for the van to arrive from 15 to 30 minutes ahead of time.

Wireless Telegraphy, by Tesla.—It appears that Mr. Nikola Tesla is working at wireless telegraphy, but if we may judge from the statements he is reported to have made to an interviewer recently, he is some distance yet from a practical solution of the problem. The following is an extract:—

"The machines which I have completed will carry messages though the earth for a distance of 20 miles or so. I have sent and received signals with them, and I feel confident that I am not mistaken in saying that the problem upon which I have spent many days and nights is solved. Of course, it is possible that I am mistaken. I have made mistakes before, but not many. I shall at once make machines which I expect will enable me to telegraph to any part of the earth as readily as I can within a limited distance by means of the ones I have.

"If I have a machine which will throw a stone from here to there," continued Mr. Tesla, pointing from the floor at his feet to the door of his laboratory, "then I do not need to doubt that I can make one which will throw the stone 50 miles, if I can control the necessary power.

"Suppose the whole earth," he said, "to be like a hollow rubber ball filled with water, and at one place I have a tube attached to this, with a plunger in the tube. If I press upon the plunger the water in the tube will be driven into the rubber ball, and as the water is practically incompressible, every part of the surface of the ball will be expanded. If I withdraw the plunger the water follows it, and every part of the ball will contract. Now, if I pierce the surface of the ball several times, and set tubes and plungers at each place, the plungers in these will vibrate up and down in answer to every movement which I may produce in the plunger of the first tube. If I were to produce an explosion in the centre of the body of water in the ball, this would set up a series of vibrations in the whole body. If I could then set the plunger in one of the tubes to vibrating in consonance with the vibrations of the water, in a little while, and with the use of a very little energy, I could burst the whole thing asunder."

Obituary.—We regret to announce the death, on Monday last, of Major ALEXANDER WOOD. Major Wood was born off Cape Horn, on June 1, 1843, his parents being at the time on a voyage from Australia to England. His early years were spent in Australia, where he was educated. At the age of 16 he was gazetted to a British regiment, and shortly afterwards joined the Bombay Staff Corps, and, with the 2nd Belboch Regiment, served with Chinese Gordon in the Taeping rising, and afterwards went with his regiment to Japan, the first occasion of the landing of British-Indian troops in that country. After several years' service in India, Major Wood returned to England, and retired from the service in 1872, and in that year became secretary to the Great Western Telegraph Company, Limited, found to connect England with the Azores, Bermuda, and New York. Major Wood visited the latter country in order to arrange for landing-rights, &c., and, on his return, found a newly-formed company (the Western and Brazilian Telegraph Company, Limited) had acquired the interest of the Brazilian Coast Cable concession. Major Wood shortly afterwards visited South America to arrange for the transfer of the concession to the new company, of which he now became manager. At the time of his death Major Wood was Managing Director of the Western Brazilian Company, of the Platino-Brazilian Company, and of the Amazon Company, and a Director of the Pacific and European Company. Always very popular, he was presented some years ago with a handsome testimonial in recognition of the friendly feeling entertained for him by his colleagues and the staffs of the companies with which he was associated. He died after a long illness, and leaves a widow and four children to mourn his loss, which will be shared by a large circle of friends in the telegraph world, with which he has been intimately connected from the early days. He was buried yesterday in the quiet little churchyard at Erith, where the remains of his mother are also interred.

Electric Delivery Waggons in Chicago.—Two electric delivery waggons, the property of a firm of silk merchants, have been running during the past five months in Chicago. The *Electrical Engineer* of New York gives the following particulars of their construction: The weight of each waggon is 1,700lb., of which 572lb. is in the batteries. The odometer shows that each waggon has run an average of 37 miles each working day, or a total of 4,810 miles. Much of this has been made over exceedingly rough streets. Each waggon has one 3½ H.P. motor, dust- and water-proof. These are geared to the two rear hubs, and a differential gear and hollow armature shaft provide for the difference in rotation of the rear wheels in turning corners. The armature rotates at about 1,200 revolutions per minute when the carriage is at full speed on a level. The maximum speed is 12 miles an hour. The wheels are 34in. in diameter, both front and rear, and have been equipped with 3in. pneumatic single-tube tyres of very heavy design. These, however, are being changed to cushion tyres 2½in. in diameter, as it is found that the pneumatic tyre gives out quickly in rough delivery work. The batteries are the Crowdus type. Forty-four cells are used, each cell taking up 4¼in. by 9in. by 5¼in. of space. They are, of course, completely enclosed, with but a small vent for the escape of gases. The controller employed groups the batteries in three combinations to give three different speeds. On the first point four groups, 11 cells in series in each group, are put in multiple; on the second point two groups of 22 in series are put in multiple; on the third point all 44 cells are put in series to give full speed. The current required to maintain full speed on a level runs very close to 15 amperes, and, strange to say, this does not vary more than an ampere or two between granite block and smooth asphalt or macadam. The worst power consumer is a broken cedar block pavement full of holes, where the current sometimes runs as high as 20 amperes. The initial starting current is about 25 amperes. The batteries are charged at night off the regular 110-volt current from the Edison mains. The charging current is started at 7 to 8 amperes, the 44 cells being, of course, in series, and toward the end of the charge reduced to 4 or 5 amperes. The makers of the cells contract to maintain the batteries at $50 per year for a waggon of this kind.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, JANUARY 28th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting at 25, Great George-street, Westminster. Paper to be read: "Condensing Apparatus," by H. Williams.

SATURDAY, January 29th.

INSTITUTION OF JUNIOR ENGINEERS.

7 p.m. Anniversary Dinner at the Westminster Palace Hotel. The President, Mr. John A. F. Aspinall, in the chair.

WEDNESDAY, February 2nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street, S.W. Paper to be read: "Comparison of Gas and Electricity as used in Tramway Work on the Continent," by O. M. C. Heyl.

FRIDAY, February 4th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Paper to be read: "Electro-Magnetic Brakes and their Capabilities," by L. H. Walter.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on "Some New Studies in Cathode and Röntgen Radiations," by A. A. C. Swinton.

SATURDAY, February 5th.

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' visit to Messrs. Siemens' Works, Woolwich. Train from Fenchurch-street at 10.5 a.m. Applications to join the party should be made at once to the Students' Hon. Secretary (Mr. S. Grant, 28, St. Mary Abbott's-terrace, W.), as the number will have to be limited.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Magnetic Images.—The elegant conception of magnetic images applied by S. P. Thompson to the self-induction of a circuit, as modified by an iron plate in its neighbourhood, has been extended by H. Jaeger to the case of a constant current traversing a conductor in the neighbourhood of such a plate. He explored the field of a straight wire by means of a small test coil, and repeated the measurements with the same wire laid on a thick and broad iron plate. He found that the field was doubled at all points distant from the wire, just as if instead of an iron plate there had been another wire carrying the same current in the place of the geometrical image of the first wire in the plate. To obtain good results the earth's force had to be got rid of by placing the axis of the test coil parallel to the line of dip. An extremely sensitive galvanometer was employed. The experiments were repeated with a coil of iron carrying a current in the neighbourhood of the plate. The field as modified by the plate was precisely identical with the field produced by the original coil and its geometrical image in the plate. This was proved by taking a similar coil of equal dimensions, and mounting it in the position of the image. The field was then the same as when the plate was used.

[Jaeger, *Wied. Ann.*, No. 13, 1897.]

Heating Effect of Röntgen Rays.—Röntgen himself, in his first communication concerning X-rays, said: "That these rays can also exert a heating action I have not yet experimentally proved; but we may well assume this property to exist, since their capability of transformation is proved by the fluorescence phenomena, and it is certain that not all the incident X-rays leave the body again as such." The heating effect there foreshadowed has been definitely proved to exist by E. Dorn, who also determined its amount. He measured the heating effect produced on sheets of platinum or palladium contained in a glass vessel with an aluminium window. The vessel communicated with a Toepler pressure gauge, and the heating was measured by the expansion of the gas. A very definite expansion was obtained, but that does not in itself prove a heating effect of the Röntgen rays. The expansion might have been due to dissociation of the gas. But a simple calculation proved that the fraction of gas actually dissociated by the quantity of electricity at work could not surpass 5×10^{-12}, and would, therefore be quite inappreciable. That the heating was not due to induced currents was shown by the fact that a glass plate reduced it to ¼, owing to absorption of the rays. The quantity of heat generated, as estimated by artificially heating the sheets with currents and comparing the expansion of the air was 1·68 mgr-calories per second, with a sparking distance in the coil of 8·3 cm. This amounted to 0·18 mgr-calories for a single discharge, an amount very small in comparison with the effect of the cathode rays.

[Dorn, *Wied. Ann.*, No. 63, 1897.]

An Electroscopic Wave Detector.—Since the advent of the coherer as a detector of electromagnetic waves, all other detectors have been put into the background. But that other forms are also capable of great sensitiveness has been shown by A. Toepler, with his modified electroscopic arrangement. It is not impossible that along this line much progress is yet to be made. In Toepler's apparatus two upright metallic cylinders stand in a box with glass and ebonite walls. One of them is connected with one of the rods of a rectilinear resonator, the other, which is thicker, is put to earth. Any wave incident upon the resonator which produces sparks, however minute, between its terminals, sets in violent motion a fine aluminium wire suspended between the two cylinders, which conveys the discharge from one to the other. The aluminium wire is attached to a steel needle, which is just held suspended by its point by a permanent magnet. Another magnet with opposed poles may be moved along the first one, so as to weaken the grip on the needle until is is only just held suspended, thus giving the system the greatest possible freedom of motion. Should the needle fall off it is caught by means of cross pieces in a wire loop, and can be re-attached by a lever from the outside. An image of the vibrating wire is thrown on a screen. Secondary sparks only 0·002mm. in length produce very perceptible motion. With an influence machine and condenser giving 5·1cm. sparks in petroleum, and a primary spark of 1·75mm., secondary sparks were thus indicated at a distance of 21 metres across several intervening rooms with cases of apparatus.

[Toepler, *Wied. Ann.* No. 13, 1897.]

Counter E.M.F. of Aluminium.—The fact that an electrolytic cell with one electrode of aluminium and one of a neutral substance such as carbon resists the passage of a current in the direction aluminium-carbon by a counter E.M.F. of 22 volts, while it allows a free passage (except for H polarisation) in the opposite direction, has been utilised for converting an alternating into a continuous current, a process known as electro-chemical rectification. V. von Lang has examined an aluminium arc with a view of finding some connection between its counter E.M.F. and the above phenomenon. An arc with two aluminium electrodes shows a counter E.M.F. of 18·8 volts, a number which is very near the above number 22, as given by Graetz, especially if allowance is made for hydrogen polarisation in the latter. This is the result as calculated by Ayrton's formula. The simpler formula

$$V = a + \frac{\delta L}{A}$$

where L is the length of arc, A the current, V the difference of potential between the two electrodes, and a the counter E.M.F. sought, gives the value 24·9, which differs on the opposite side. An interesting variation of the experiment was the substitution of carbon for one or both of the electrodes. It turned out that the counter E.M.F. from carbon to aluminium was the same as between two carbon points, but that the counter E.M.F. from aluminium to carbon was considerably less. This is just the opposite case to the electrolytic cell. It follows that an aluminium-carbon arc can also be used as a rectifier, but experiments showed that only about 6 per cent. of the alternating current could be thus converted.

[V. Lang, *Wied. Ann.*, No. 13, 1897.]

Current-Intensity of Lighting.—In the course of some investigations of the magnetic properties of basalt, F. Pockels hit upon an explanation of Folgheraiter's *punti distinti*—outcrops of formations magnetised in directions not in accordance with ordinary terrestrial magnetism—which led him to an approximate determination of the current-intensity of a lightning flash. These local magnetisations are probably due to discharges of atmospheric electricity, and if it is assumed that the discharge passed along the surface of the rock, some estimate of the current-strength of the discharge may be made from the magnetic moment of rods cut from the rock along its magnetic axis. Pockels did that, and found the intensity of magnetisation to be 0·4 per cc. After demagnetisation the same permanent intensity could be imparted to a specimen by a field of 290 units. The specimen having been 2cm. below the surface, a current strength of 2,900 amperes was required at least to produce this effect. But the magnetisation having been found very fairly uniform, the discharge probably passed at a greater distance, and was larger. In another case the distance could be better estimated. Three pieces of basalt were cut from the neighbourhood of trees damaged by the lightning. The intensities derived were 6,400, 6,600, and 10,800 amperes respectively. It is interesting to note in this connection that the specimens of basalt, containing larger nuclei of magnetite, are more easily saturated than those containing very finely-divided ones.

[Pockels, *Wied. Ann.*, No. 63, 1897.]

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STORAGE BATTERIES.*

BY E. J. WADE.

(*Continued from page 351.*)

Usher in 1892 described various arrangements for protecting and separating electrodes by means of plates of porous earthenware or kiln-dried wood. His supports were of the type shown in cross-section in Fig. 50, the wide grooves being filled with active material (in the form of consolidated tablets) and the narrow ones being left free for the electrolyte to circulate through. In 1893 Roe and Lutso also proposed to use porous wood diaphragms for separation and protection, but in this instance the active material was filled into the wood separator,

FIG. 50.

which was grooved to receive it, and flat metal plates were placed against it on either side. Fig. 51 shows the form of separator employed, which is very similar in design to the metallic support of Usher's electrode just described, and also has narrow grooves to hold the free electrolyte; in fact, the two arrangements are the converse of each other, the one consisting of a grooved support and flat separator, the other a flat support and grooved separator.

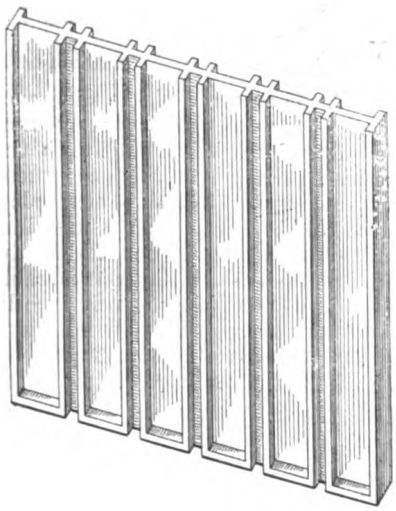

FIG. 51.

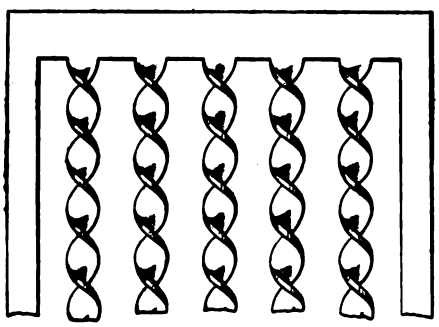

FIG. 52.

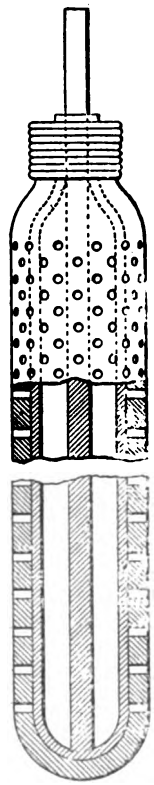

FIG. 53.

In another arrangement, proposed by Usher about the same time, flat porous separators were again used, but in connection with supports of the type shown in Fig. 52 the active material being packed in between the two.

It will be observed that in all these arrangements the electrodes are only separated from each other by the porous plates which have to contain the whole, or nearly the whole, of the useful electrolyte, and a similar plan was proposed by Menges in 1895, but recognising what an extremely limited amount of acid was thus allowed for, he left hollow channels and ways through the interior of his electrodes so that a further supply could be kept up from the back.

A rather curious method of protection was described in a patent of the Hess Storage Battery Company in 1894. A central cake of active material was held between two metallic grids, whose cells were filled with quartz sand fixed with some binding material. The faces of the grids were covered with some insulating compound to protect them from electrolytic action.

In 1895, Faure after an interval of 14 years again patented a protected form of electrode, this time in conjunction with King. The novelty in this instance did not lie in the arrangement of parts, which was of a very ordinary nature, but in the materials employed. The deterioration and ultimate destruction to which many of the substances usually employed for protective coverings are liable, is due not so much to the acid solution in which they are immersed as to the strong oxidising action of the lead peroxide with which they come in contact, and Faure proposed to use a compound protection consisting of an inner layer of silicated asbestos and an outer covering of perforated celluloid or the like. The former material is prepared by treating asbestos cloth with sodium silicate, and, while itself unaffected by the peroxide, prevents the celluloid which might be acted upon from touching it.

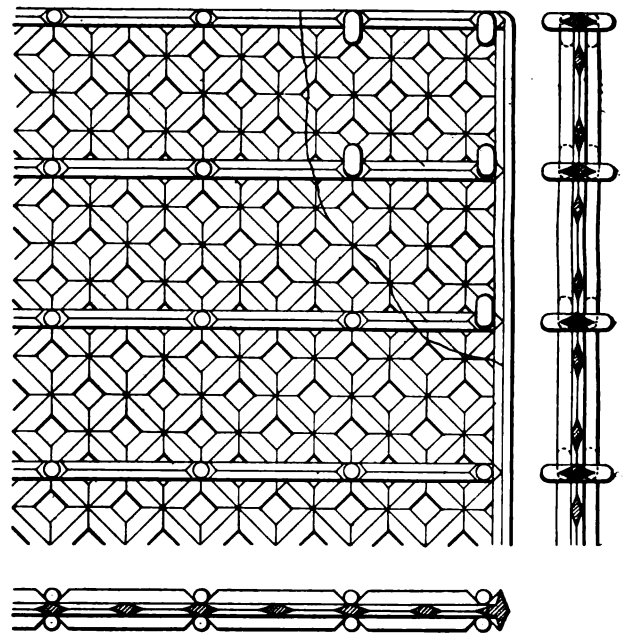

FIG. 54.

Fig. 53 shows, partly in cross-section and partly in side elevation, the design of electrode illustrated in the patent. The active material is supported on either side of a central flat conducting plate by sheets of the protection—first the porous asbestos fabric, and then the perforated celluloid—bent round the bottom and drawn in and tied at the top.

Later in the year King patented an electrode to which this compound protection or any other could be applied in flat sheets. The support was of the sunk grid type; a shallow grid with raised ridges on either side, which formed a boundary frame and also subdivided it into compartments.

Fig. 54 is a side view and two cross-sections at right angles to each other of a portion of such a support. Pins project from the cross ribs at intervals, and may be bent over, as shown in the right-hand corner of the side view, to hold the protective sheets in position, or else they may be used as guides for grooved separator strips, which are wedged in between the plates and serve the same purpose.

Still later in the year, in another patent, King proposed to use protected electrodes, in which holes or cells are left open at intervals in between the pasted portions, so as to maintain a better supply of acid underneath the protective sheets, and

* From a forthcoming book to be published by *The Electrician* Printing and Publishing Company (Limited). All rights reserved.

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prevent the sulphation of the active material that otherwise is liable to take place.

Fig. 55 gives a side view and cross-section of a support designed on this principle. The round holes *aa* passing right through the electrode from side to side remain unpasted, and serve as reservoirs for the electrolyte. Notches *d* are cut in their edges to facilitate the diffusion of the acid into the adjacent active material. The portions to be pasted are not open right through, but divided up by a central web or back plate *b*, which converts them into a series of pockets or recesses on either side of the plate.

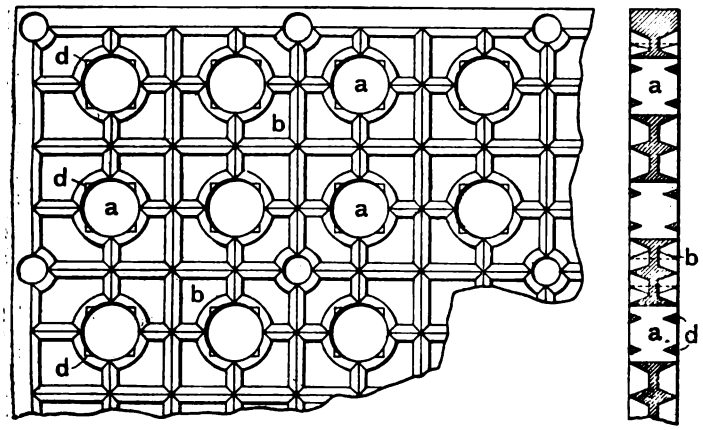

FIG. 55.

This series of patents contains some of those which form the basis of the "Faure-King" cell recently put upon the market by the Electrical Power Storage Company.

Envelope and Tubular Protection.

For envelope protection, as distinguished from sheet protection, the tubular or cylindrical form of electrode appears to have been most generally employed.

In 1890, Woodward proposed to construct electrodes of tubes of perforated india-rubber or other suitable insulating material, containing a central conducting core and active material packed round it. The use of a lead tube underneath the

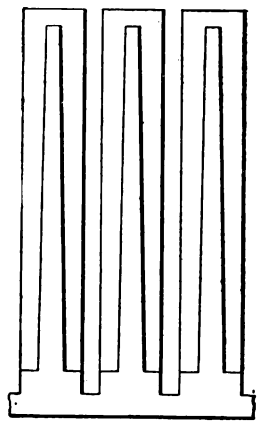

FIG. 56.

insulating tube and correspondingly perforated was also mentioned. In the same year Tommasi and Theryc patented a very similar form of electrode. In both these instances each tube constituted a complete electrode, and the positives and negatives could be grouped and arranged in relation to each other in any desired manner.

The more usual procedure, however, with tubular electrodes is to connect a number of them of the same polarity in a row to a main bar, thereby constituting one larger electrode of an approximately rectangular shape. Currie patented an electrode of this nature in 1891, in which tubes of woven asbestos formed the protective covering. The raw active material was lead chloride cast into each tube round a central brass core in the shape of a tapering rod. The core having been withdrawn, molten lead was run in to form the conducting support. Fig. 56 shows part of an electrode composed of a number of tubes standing up side by side from a main bar underneath, but they could also be suspended from a bar at the top. In a later modification, the asbestos sheaths were drawn direct on to the lead rods whose surfaces were then converted into lead chloride in an electrolytic bath.

In 1892, Rosenthal and Doubleday described a protected electrode consisting of a perforated corrugated sheet lead support pasted with active material and contained in an ebonite case with perforated sides. In the same year Theryc and Oblasser patented a form of electrode in which a grid support surrounded with active material was enclosed in a perforated celluloid envelope.

Tubular or Rod Electrodes.

Besides the protected tubular electrodes, various unprotected electrodes of a somewhat similar type have been proposed from

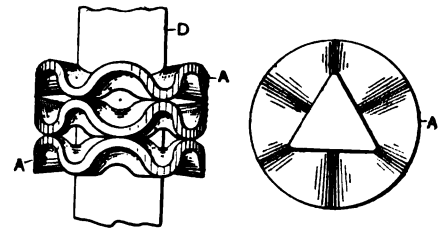

FIG. 57.

time to time. In 1883, Knowles described some electrodes built up of washers or discs of lead and of lead oxides correspondingly shaped, piled alternately upon each other and clamped together by a lead bolt passing through the central hole. A modification of this construction was to leave the central hole open so as to form hollow electrodes, and to pass two clamping bolts through the holes on either side. According to another modification, a deeply-grooved lead rod constituted the core and support, the oxides being filled into the grooves. Lee, in 1892, also proposed to use grooved rods, with the object of exposing a series of thin laminæ of metal to the action of the electrolyte, and a spiral grooving was mentioned

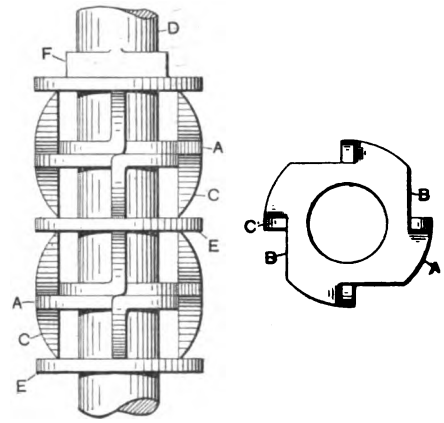

FIG. 58.

as being convenient for this purpose. When the grooves were pasted the laminæ could be bent upwards to form inclined shelves and give a better support to the active material. He further suggested strengthening the rods with central cores of enamelled iron.

In 1895, Barber-Starkey patented a variety of rod electrodes, in which washers of various descriptions are strung upon a central conducting core and the active material filled in the interstices between them. Fig. 57 shows a plan of a radially corrugated washer, and a view of several of them in position on a rod, which is of a triangular cross-section to prevent their shifting round. Fig. 58 shows a circular washer slit at intervals near the circumference, and the ears thus formed turned up at right angles to form spacing pieces.

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According to the method of mounting illustrated, these washers are put back to back in pairs with plain ones in between. The principle of the construction shown in Fig. 59 is somewhat different to the other two, although the result arrived at is practically the same. The central rod is slotted, and into the slot is inserted the back edge of a strip of lead cut with projecting teeth somewhat like a comb. The teeth are twisted on themselves at right angles and then bent close round the rod.

Figs. 60 and 61 illustrate the construction of some of the rod supports patented by Vaughan-Sherrin in 1896. Those shown in Fig. 60 have a central core, either solid or hollow, of non-conducting material. Round this core some lead wires are wrapped spirally in the one case, and in the other, several crimped strips of lead are attached at intervals by ties of wire

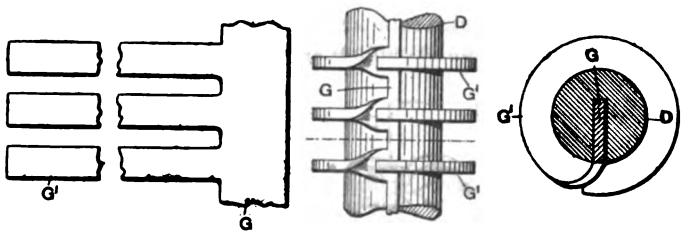

Fig. 59.

to provide the metallic conductors. Upon these again is wound an open spiral of non-conducting strip, and the active material is filled in flush with its outer edge. In the supports shown in Fig. 61 the non-conducting core is dispensed with, and the outer ebonite strip wound direct upon a metallic core such as two L-shaped strips set back to back, or a single strip with four arms, twisted spirally on itself.

In the same year, Brophy and Andrews also proposed to construct rod electrodes of metallic cores of various cross-sections surrounded with active material, which may be mechanically applied under pressure to the core as it passes through a die of suitable size.

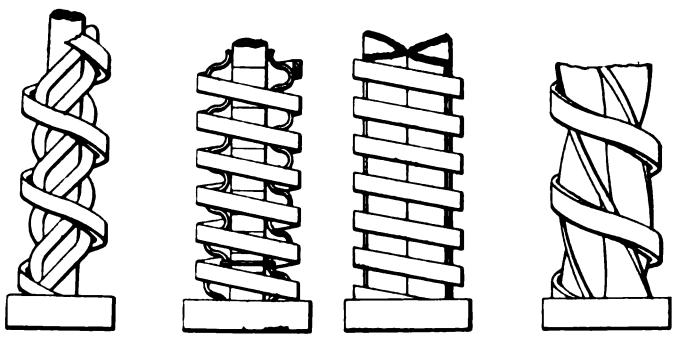

Fig. 60.

Fig. 61.

Also, in 1896, Woodward again patented a form of tubular electrode. Lead washers are passed over a central conducting core, and are spaced apart by layers of active material in the form of small balls packed between them. The whole is contained in a tube of perforated lead or of insulating material, but the latter is not recommended. Unlike most electrodes of this type, it does not appear to be intended for mounting in rows on a main bar, but to be used as a central electrode surrounded by a number of smaller ones of opposite polarity.

(To be continued.)

Electric Railways in Saxony.—The Saxon Minister of the Interior has refused his consent to a project for an electric railway on the route Pillnitz-Pirna-Bartei in the so-called "Saxon Switzerland." He states that mountain railways cannot be deemed a necessity in the district, as the points from which fine views are obtained are not at particularly great elevations, and can easily be reached by post and by carriage, and that regard must be had for æsthetic considerations.

THE IMPERIAL OR BOARD OF TRADE STANDARD WIRE GAUGE TABLE.

BY H. G. CHEESMAN.

In the early 'eighties the Boston *Journal of Chemistry* called the epoch the "Wire Age," from the fact that such a multitude of wires were to be found in the world for telegraphic, telephonic and electric lighting purposes. The question of a standard wire gauge was at that time being discussed in England, and quite a battle was being waged against the different gauges then in use,* as is shown by the following:—"An order was received by cable from New York for metal No. 36 wire gauge; the receivers gave out the order accordingly. The manufacturers discovering that the order was from America, rightly concluded that Stubs' gauge was intended. Had the order been executed in No 36 Birmingham wire-gauge the metal would have been useless for the purpose intended; No. 36 on Stubs' gauge is No. 44 on the Birmingham wire gauge, and the difference in price on this order £26 per ton."†

In publishing several useful tables and data for the guidance of those interested in electrical work, Mr. W. F. Dennis, to make his tables clear, had to compare the Birmingham, Paris, Westphalian pin and the Westphalian common gauges.

It was not until the year 1883 that any definite gauge was settled on, when by an Order-in-Council, made at Osborne, a standard wire-gauge was legalised. The ironmasters of Wolverhampton and neighbourhood expressed great dissatisfaction with the new gauge, and went so far as to recommend the trade to ignore it, as their transactions would be prejudiced in some instances to the extent of 10s. to 12s. per ton. Notwithstanding this obstruction the Imperial or Board of Trade Standard Wire Gauge has gradually crept into use, and at the present time it is generally accepted in Great Britain as the only reliable one.

Previous to standardising the wire-gauge, a few tables on the properties of copper had been computed to the various gauges, the best of which being those by Sprague‡ and Glover. Others were either incomplete or inaccurate; one by Hall, calculated in 1863§, first published in Culley's "Practical Telegraphy," and copied in many other text-books on electricity, was admitted by Mr. Hall to be faulty.

No table having been calculated to the standard gauge, the writer was led to work out one for his own use, which was afterwards published as a Supplement to *The Electrician* (Vol. XIII., Aug. 16, 1884), and subsequently reprinted in "*The Electrician* Electrical Trades' Directory and Handbook."

This table was found so valuable that permission has been given for its being copied in many makers' lists, and it is now in everyday use in most of the electrical workshops, not only in Great Britain but also on the Continent.

The newly-defined ohm, 10^9 C.G.S. units—represented by a column of pure mercury 106·3cm. in height, and 1 sq. mm. section; at the temperature of freezing ice, and legalised by an Order-in-Council made in 1894—has necessitated that the table should be revised, and part of it, viz., that treating on resistances, has been brought up to date. Constants for using the table in the metric measures have been added, rendering it still more valuable on the Continent, where it has been so well received. The new ohm is 1·36 per cent. lower, but it is easily converted into B.A. units by simply multiplying by 1·01351.

The standard of resistance to which the table has been calculated is the one originated by the late Dr. Matthiessen when experimenting on wires for defining the original B.A. unit; and considering the facilities, the means at his disposal, and the very careful manner in which he conducted his investigations, there is no reason for doubting the accuracy of his standard. Though in some few instances copper has been found from 4 to 6 per cent. better conductivity than the Matthiessen standard,

* "Birmingham Wire-gauge," *Journal* of the Society of Telegraph Engineers, Vol. VII.

† Report on the Birmingham wire-gauge, *idem*, Vol. VIII.

‡ "Electricity: its Theory, Sources and Applications," by Sprague.

§ *Journal* of the Society of Telegraph Engineers, Vol. VII.

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yet it is very generally received as accurate. In the "Reports of Electrical Standards" is found an account of Dr. Matthiessen's experiments, and on page 227 of the reports the resistance of 1ft. of annealed copper wire, weighing 1 grain, at 0° C. is 0·2064 B.A. unit, from which all the calculations of resistances in the Supplement Sheet Table, which is published with this issue of *The Electrician*, are based.

MR. J. W. SWAN'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.

(Concluded from page 417.)

Electrolytic Alkali Production.

I now come to perhaps the most important of all the applications of electro-chemistry at present engaging the attention of chemical and electrical engineers, namely, its application to the alkali manufacture. The manufacture of alkali has undergone a revolutionary change during the last 25 years; the Le Blanc process, which produces carbonate of soda and hydrochloric acid, having been largely superseded by the ammonia-soda process of Hemming and Solvay—a process identified in this country, in its most highly developed form, with the names of Brunner and Mond. The ammonia-soda process yields no hydrochloric acid, and, therefore, does not lend itself as easily to the production of chlorine for the purpose of making bleaching powder as does the process of Le Blanc. Devices to meet the want of hydrochloric acid in the ammonia-soda process have been many; most of these have been based on ordinary chemical reactions, but some have been electrolytic. I have already mentioned one of these—the chloride of zinc process of Hoepfner. But there are schemes afoot for the production of alkali and chloride by the electrolysis of alkaline chlorides which aim at the accomplishment of another revolution in this great industry. There are now several processes in commercial operation for the production of caustic alkali, and chlorine from brine. In the process of Holland and Richardson brine is electrolysed in a tank divided into anode and cathode compartments by impermeable partitions reaching nearly down to the bottom of the tank. The anode compartment is enclosed, and provided with a flue for conducting the chlorine to bleaching powder chambers. Carbon anodes and iron cathodes are used. During electrolysis the caustic alkali formed at the cathode dissolves, sinks down to the bottom of the tank, and is drawn off; this alkaline solution is subsequently evaporated and fused. A somewhat similar process has been introduced by Messrs. Hargreaves and Bird for the manufacture of bleaching powder and alkaline carbonates.

In the process of Hulin—in which brine is electrolysed for the production of soda and chlorine—the anode and cathode are both of carbon, but the carbon cathode is in the form of a thin porous partition. The peculiarity of the process is the percolation through the cathode partition of the stratum of the electrolyte in contact with it. This portion of the electrolyte is most strongly charged with alkali, and is forced slowly through the diaphragm by slight pressure on the surface of the bath, caused by restraining the escape of chlorine.

In the processes described, considerable loss and many disadvantages arise from imperfect separation of the products of the electrolytic action at the anode and cathode. There have been a number of inventions with a view to avoid this defect. The apparatus of Castner and Kellner is one that grapples with the difficulty in a most ingenious and effective manner and it is especially entitled to notice because it is already in extensive commercial use. 10,000 tons of caustic soda and over 20,000 tons of bleaching powder will be produced by it this year. The elementary apparatus consists of a shallow rectangular slate trough, divided into three compartments by two partitions. These cross the trough from side to side, but do not quite reach the bottom, which is grooved to form a shallow gutter under each partition. The partitions dip into the gutters sufficiently deeply to ensure complete isolation of the three compartments when the gutters are filled to the level of the bottom of the trough with mercury. During operation the mercury not only fills the gutters, but extends in a thin stratum over the bottom of the trough. The trough is so mounted that a slow and extremely slight oscillatory movement is given to it. This results, when one end is tilted up, in the stratum of mercury on the bottom running out of the upper end compartment into the middle compartment. The alternate rise and fall of the ends of the trough is so small that the movement is almost imperceptible, but it is sufficient to cause the mercury in the compartment at the raised end to run into the middle compartment, and that from the middle compartment into the lower end compartment; that is to say, there is an alternate flow of mercury from end to end, which alternately leaves the raised end compartments denuded of mercury, but the floor of the middle compartment and of one of the end compartments are always covered with mercury. The grooves into which the partitions dip always contain mercury, and completely prevent the mixing of the electrolyte in the three compartments. The two end compartments contain brine and carbon anodes, and the centre compartment an iron cathode and water. The anode compartments are covered with glass, and provided with pipes for the conveyance away of chlorine to bleaching powder chambers. During the working of the process sodium is deposited upon mercury, with which it instantly amalgamates; the tank is then tilted until the mercury in an anode compartment runs into the cathode compartment, where the sodium is oxidised and dissolved by the water. The current generated by the oxidation and solution of the sodium helps to reduce the power required for electrolysis; for it will be seen that the sheet of mercury lying on the floor of the trough and divided by the partition is always negative in the end compartments and positive in the middle compartment relatively to the opposed electrodes. The chlorine evolved at the anodes is, so far, entirely used for the manufacture of bleaching powder. The caustic soda produced by this process is of great purity.

Closely resembling the Castner-Kellner apparatus is that lately invented by Rhodin, in which the mercury-sealed anode compartments are capable of being rotated, and the construction is such that external heating may be applied, a higher current-density employed, and such temperature conditions maintained as are necessary for obtaining the best result. Electrolytic chlorine is also extensively applied to the production of chlorate of potash. The manufacture of chlorate of potash by electrolysis is performed in a tank divided by a porous partition with very thin iridio-platinum anodes and iron cathodes, The electrolyte in the anode compartment is usually a solution of chloride of potassium maintained at a temperature of 45°C. to 50°C. The solution from the cathode compartment containing caustic potash is continuously supplied to the anode compartment, where the potash absorbs the chlorine, with the production of hypochlorite, which is almost immediately decomposed, with the formation of chloride and chlorate of potassium. The chlorate is removed from the electrolyte in crystals. The yield of chlorate of potash is about 1lb. per 5 E.H.P. hours—nearly 45 per cent. of the theoretical amount. In Switzerland and in Sweden chlorate of potash is now largely produced electrolytically by water power. I am informed on very good authority that preparations are in progress for a large increase of production, and that there is no question as to the electrolytic method entirely superseding the purely chemical method.

Electro-thermal Processes.

The electro-chemical processes I have so far described or referred to are all of them of the electrolytic kind. There are other electro-chemical processes which are not electrolytic, but which are important, and deserve mention. I refer, in the first place, to a group of processes and effects which depend on the principle of dissociation and combination at extremely high temperatures, and which involve the employment of the electric furnace, first suggested and applied experimentally by Sir William Siemens. In this class is included the electro-thermal manufacture of phosphorus; also that most useful and interesting polishing and cutting material next in hard-

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ness to the diamond, carborundum—the invention of Mr. Acheson, to whom I am indebted for these most beautiful specimens lying on the table. Mr. Acheson has developed the size of the electric furnace to enormous proportions, and made it yield results of great industrial value. Amongst these I must mention incidentally—for it is not a chemical, but a physical action—the complete transformation of amorphous carbon into graphitic carbon. It is not new to produce this transformation on a small scale, but to completely convert large masses of carbon into graphite is both new and of great importance. It is well known that blocks of carbon as ordinarily manufactured, when used as anodes in an electrolytic cell rapidly disintegrate; and until now this has been a serious difficulty in the construction of electrolytic apparatus like that of Castner-Kellner. This difficulty is completely met by the use of graphite anodes. into which ordinary amorphous carbon anodes are now being transformed by the electric furnace. Some idea of the scale of these electric-furnace operations may be formed when it is realised that 1,000 E.H.P. for 36 hours is expended in one heating. To the same class of electro-thermal products belong carbide of calcium and a great number of analogous products, first obtained by M. Moissan by means of the electric furnace, employed with the most admirable skill, guided by thorough scientific knowledge, and the exercise of that kind of imagination which apprehends and realises far-off possibilities. I am informed by Mr. Worth, of the Acetylene Company—to whom I am indebted for the specimen of carbide of calcium on the table—that carbide of calcium is now being manufactured at the rate of probably 20,000 tons per annum. Considering the value of this substance as a means of easily generating the highly illuminating gas, acetylene, and other products, there appears to be great probability of this manufacture becoming much larger.

Ozone Manufacture.

I must not omit to mention a quite different order of electro-chemical effects in which alternating or intermittent currents of high tension are employed to induce the formation of ozone, By means of ozone secondary chemical effects of great value are obtained; among these I may mention the manufacture of vanillin and heliotropine, now established manufactures. Ozone has also been applied to wax-bleaching, and to the thickening and bleaching of oils, and to a number of other important uses. Here is a model of an ozone-generating apparatus, kindly lent by Mr. Andreoli, to whom I am also indebted for the specimens showing the effect of ozone on wax and oil. There are also on the table specimens of vanillin and heliotropine, perhaps at present the most important of the ozone products. For these, and for much information on the subject, I am obliged to Mr. Salamon.

Prospects of the Electro-Chemical Industry.

Although I have but touched the fringe of this matter, I will not weary you with further examples of the value and extent of the applications of electricity to chemical manufactures. I have shown that already there is a large amount of valuable electro-chemical work being done, and that there is a limitless prospect of expansion. Looking at the immediate future, many interesting questions present themselves which must be considered, even though we may not be able to completely answer them. Amongst these are the questions: To what extent, and in what cases, are electro-chemical methods likely to supplant old-established chemical methods? And it is not too soon to ask: Where, and by what means, will the new electrolytic manufactures be ultimately carried on? Will the introduction of electro-chemical methods of manufacture uproot the old manufactures from their ancient habitat? Already there are ominous signs. The aluminium manufacture, the carborundum manufacture, and the calcium carbide manufacture are entirely located where there is cheap water power. But these are all *new* industries, and of the kind in which the power element of cost is large, and the value of the product is also large. In these respects they differ widely from such industries as the alkali and the bleaching powder manufactures and from electrolytic copper refining. In these manufactures, carried on in the electrolytic manner, the cost of power is comparatively very small and nearness to the market, cost of the carriage of raw material and of product, are even more important factors. Consistently with this we find that caustic soda and bleaching powder are being electrolytically produced on a large scale in Lancashire by means of *steam* power.

It remains to be seen how far, in the long run, the most economically produced steam power, as the basis of electrolytic manufacture, can hold its own against water power. It seems to me probable that in a number of instances steam power *can* hold its own. There is no uniformity in the cost either of water power or of steam power. In one place water power will be less costly, and in another place steam power.

Speaking generally, electro-chemical manufactures demand *cheap* electricity; not all of them with equal imperativeness demand the *cheapest*, but some of them absolutely depend on electric energy developed at its cheapest rate. It is perhaps not entirely superfluous to ask the question whether there is any ground of hope that electric energy may be economically generated by other means than by the transformation of the energy of motive power. It would be rash to say that it is not possible, but it is certain that there is no better way at present discernible.

Any hope once entertained of the possibly economical direct conversion of *heat* energy into electric energy was crushed by the result of the investigation Lord Rayleigh communicated to the British Association meeting of 1885. The projects for obtaining voltaic effects by means of carbon as the positive element in a cell have never approached within measurable distance of practicability, and the prospect of their ever coming within that range is all but hopeless. It is quite hopeless so long as the general lines of voltaic cell construction are followed, and so long as it is contemplated to employ the positive carbon in the expensive manufactured forms in which hitherto it has been proposed to use it in carbon-consuming cells. It seems to me that if ever the voltaic cell is brought into serious competition with the dynamo its form and character must be such that there will be no occasion for renewal either of the electrodes or the electrolyte, but that it must in these respects approximate, in the conditions of its working, to the gas battery. But when it is remembered how small a steam or water engine and dynamo will develop a hundred or a thousand electrical horse-power, and what a small amount of attendance such apparatus requires; and when this is compared and contrasted with the much greater amount of labour involved in the maintenance of any equivalent voltaic combination of the ordinary type, it will at once be seen that, to supersede the dynamo, something radically different from and superior to even the most perfect voltaic combination now known would be necessary. Any such development as this is at the present moment entirely out of sight; meanwhile, in contemplating the prospective changes which electrolytic processes of manufacture must bring about, we have to count upon the dynamo and motive power as the agency by means of which, in the immediate future, such manufacture will be carried out.

The conditions under which steam power is used in electro-chemical manufacture are extremely favourable to economy, where, as would generally be the case, coal is cheap, the unit of power large, and the power is used *continuously* and *uniformly*. It seems to me that there is still plenty of room for the steam engine in connection with electro-chemistry, and that, though there are certain electro-chemical industries which can be most economically carried on by means of cheap and not too distant water power, there are other industries—and these may grow to be very large—which may with great advantage be carried on in the "Black Country," or wherever coal is cheap and the market and the raw material are near at hand. In the time that has passed Britain has enjoyed in chemical manufactures a great advantage in the possession of an abundance of coal. We are about, in some measure, to lose the benefit of this advantage through the innovations of electro-chemistry. Whether we profit or lose by the change largely depends on our readiness or unreadiness to adapt ourselves to the new order of things. Whatever happens nothing can be more certain than this—that the electrical

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engineer who adds to the ordinary knowledge of his profession a competent knowledge of the principles of electro-chemical practice in manufacturing operations, is thereby making broader and surer his path to success.

ADDENDUM.—*Ratio or cost of power to production in electrolytic manufactures.*

—	E.H.P. hours consumed in the production of 1lb.	Cost of power to produce 1lb. with 1 E.H.P. at £5 and £10 a year.	
		At £5. d.	At £10. d.
Aluminium	14·0	1·75	3·5
Nickel	1·0	0·13	0·26
Sodium	3·33	0·41	0·82
Caustic soda + 2½lb. bleaching powder	2·7	0·33	0·66
Chlorate of potash	5·0	0·62	1·24
Zinc extraction	1·0	0·13	0·26
Copper „	0 5	0·065	0·13
Copper refining	0·25	0·032	0·064

MECHANICAL FEATURES OF ELECTRIC TRACTION.*

BY PHILIP DAWSON.

Introductory.—Previous to discussing certain special mechanical features which enter into the design and construction of an electric traction system, a few figures may be quoted for showing the importance of the subject in general. Table I. shows the mileage of tramways in America for the six years 1890-5. It is seen that rope traction continued to extend up to 1894; since that time its importance has diminished. In San Francisco, Los Angeles, Minneapolis, Denver, St. Louis, Pittsburg, Philadelphia, Baltimore, and other American cities, electric traction has been substituted in place of ropes. Table II. gives the electric tramway mileage in Europe at the end of last year, 1896. It will be seen that Great Britain is yet much behind Germany. This is especially remarkable, because the regulations of German local authorities are generally much the more severe. Electric trolley roads are now to be found in the oldest and handsomest of German cities. Table III. shows the great financial importance of tramways as compared with railways in America. The passenger traffic on the tramways is six times greater than that on the railways; and the ratio of working expenses to receipts is lower for the tramways than for the railways. The gross earnings of the tramways in the United States are approximately 50 per cent. of the passenger earnings of the railways, and 15 per cent. of the total earnings of the railways, whereas the tramway mileage is only about 6 per cent. of the railway mileage. A highly important fact is that tramway receipts are found to be practically independent of good or bad trade, and not to depend on the prosperity of the country. Tables IV., V. and VI. have been compiled from the official reports of the Massachusetts Board of Railroad Commissioners. Massachusetts more closely resembles England in the habits of the people and in local conditions than any other State of the Union. Table VI. shows the rapid increase of passenger traffic and mileage. Table IV. shows the difference in cost of completely equipping tramways in small and large towns, varying from £7,000 to £20,000 per mile of single line. Table V. shows that as passenger carriers tramways play a much more important part than railways. It is demonstrated, not only in America but also in England and on the Continent, that wherever an electric tramway runs parallel to a railway the former will secure practically all local traffic. It has been frequently urged

Table I.—*Mileage of Tramways in America and Number of Cars during six years*, 1890-95.

Mileage.	1890. Miles.	1891. Miles.	1892. Miles.	1893. Miles.	1894. Miles.	1895. Miles.
Electric	2,523	4,061	5,939	7,466	9,008	12,583
Horse	5,400	5,302	4,460	3,497	2,243	1,232
Rope	510	594	646	657	662	599
Steam	604	642	620	566	614	519
Total miles	9,037	10,599	11,665	12,186	12,527	14,933
Number of Cars.	Cars.	Cars.	Cars.	Cars.	Cars.	Cars.
Electric	5,592	8,892	13,415	18,233	24,849	36,121
Horse	21,970	21,798	19,315	16,845	11,507	5,420
Rope	3,795	4,372	3,971	4,805	4,673	4,871
Steam	751	815	698	616	639	2,957
Total cars	32,108	35,877	37,399	40,499	41,668	49,369

* Paper read before the Institution of Mechanical Engineers.

Table II.—*Mileage of Electric Tramways in Europe, and number of Cars and Horse-power at end of* 1896.

Country.	Miles of tramway.	Number of cars.	Horse-power.
Germany	618	1,545	13,810
France	67	180	4,200
Great Britain and Colonies	167	269	9,617
Austria and Hungary	120	265	5,060
Italy	50	149	2,460
Switzerland	30	83	1,570
Belgium	90	157	2,550
Russia	30	87	1,150
Other countries	30	50	111

Table III.—*Comparison of Railways and Tramways in America and in England.*

Railways R. Railways T.	Capital expenditure. £	Total mileage	Gross Receipts G £	Total expenses. E £	Ratio E to G %	Passengers carried.
America T	2,354,200,000	240,000	219,000,000	154,000,000	70	544,000,000
America R	280,000,000	14,000	32,850,000	22,700,000	68	3,000,000,000
United Kng'dm R	820,000,000	20,000	77,025,000	40,100,000	52	775,200,000
United Kng'dm T	13,000,000	1,000	3,540,000	2,640,000	75	480,000,000

Table IV.—*Cost of Tramways in small and large towns in Massachusetts.*

Per mile of single line.	Springfield.	West End.
Construction and equipment	£4,939	£11,323
Other permanent property	£1,761	£7,959
Total cost	£6,701	£19,282
Capital investment	£6,197	£20,152
Passengers carried ....total	10,163,011	166,862,288
„ „ ....per mile	180,547	648,568

Table V.—*Passengers carried on Tramways and on Railways.*

—	1895.	1896.
Worked by horses only ....miles	61·799	35·132
„ „ electricity only....miles	1,002·756	1,241·363
„ „ horses and electricity ...miles	22·62	14·54
Total income ....£	2,649,274	2,980,188
Dividend....per cent.	5·76	5·87
Passengers carried ....total	259,794,308	292,358,943
„ „ by electricity	205,866,134	236,544,417
„ „ by railway	53,928,174	55,814,525
„ „ excess by electricity	151,937,960	180,729,892

Table VI.—*Growth of Massachusetts Tramways during Ten Years*, 1887-96.

Yr.	No. of Cos.	Miles of main line.	Miles equipped for horses.	Miles equipped for electricity.	Cost of construction.	Cost of equipment.	Capital investment.
1887	44	470·27	470·27	...	£3,524	£1,666	£6,534
1888	46	533·59	533·99	...	3,384	1,464	6,461
1889	46	574·17	523·65	50·52	3,276	1,576	6,781
1890	48	612·38	451·52	160·86	3,467	2,131	7,651
1891	56	672·45	383·42	289·03	3,584	2,323	8,178
1892	61	754·85	258·55	496·30	3,904	3,043	9,230
1893	60	874·14	163·06	711·08	5,358	2,347	10,673
1894	68	938·84	103·87	824·97	5,349	2,305	10,592
1895	75	1077·99	61·80	1016·19	4,797	2,096	9,820
1896	83	1276 75	25·13	1241·62	4,679	1,961	9,278

Year.	Passengers carried.	Car-Miles run.	Persons employed.	Cars.	Horses.	Motors.
1887	124,787,328	20,625,846	5,223	2,633	11,874	...
1888	134,478,319	23,244,767	5,531	2,588	11,391	...
1889	148,189,403	24,259,491	6,302	2,942	11,817	...
1890	164,873,846	26,516,937	6,246	3,247	11,241	...
1891	176,090,189	27,670,166	6,449	3,494	10,640	...
1892	194,171,942	29,678,036	7,185	3,679	6,734	...
1893	213,552,009	34,507,282	8,070	4,040	3,531	3,013
1894	220,464,099	36,722,973	7,451	4,058	2,014	3,906
1895	259,794,308	43,655,560	8,048	4,476	1,436	4,704
1896	292,358,943	53,613,685	9,130	4,913	878	5,958

that mechanical motive power on tramways is dangerous to the public safety. In America, where comparatively high speeds are allowed, the Railroad Commissioners report that the proportion of passengers and employés killed during the last two years of electric working appears to have been about the same as with the use of horse-power in 1888. For all practical purposes the present subject may be considered under the three headings of outside work, rolling stock, and power station.

Outside Work : Wires.—The overhead line of conductors may be supported either by brackets attached to poles or to houses, or by a span-wire stretched between poles or rosettes fixed to house-fronts. For the sake both of appearances and of smooth running, the conducting wire should be strained as tight as is consistent with its tensile strength and with the minimum temperature which obtains in the locality. The best practice does not allow more than 2,000lb. strain on a No. 0 Brown and Sharpe (0·325in. diameter) hard-drawn copper wire at the lowest temperature to which it will be exposed. With this limit the strain to be put on the wire when erected can be easily ascertained from tables. For fixing the maximum sag to be allowed in the average span of 120 to 140ft., the curves given in Fig. 1 are useful. A rough but safe rule in this

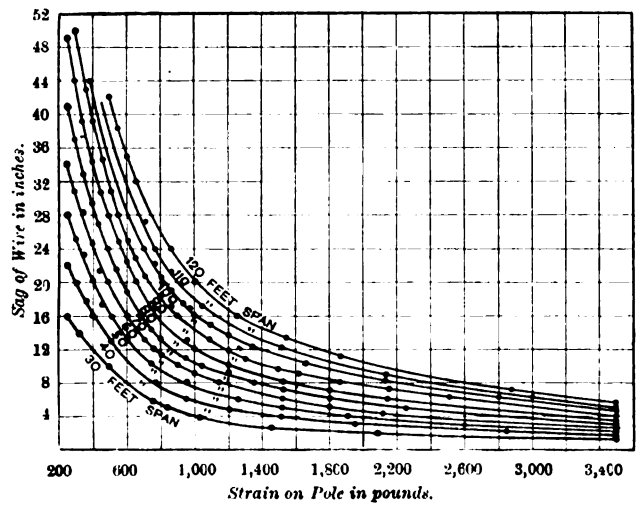

Fig. 1.—Sag on Span Wire. Single Track Cross Suspension and corresponding Strain on Poles in pounds. 125 feet Span of Trolley Wire, Copper No. O. B. & S. Gauge = 0·325 inch Span Wire, Steel, seven stranded $\frac{1}{8}$inch diameter.

country, where rarely more than 20°F. of frost is to be expected, is a sag of 0·75 per cent. of the span at an average temperature of from 60deg. to 65deg. The trolley wire should be of absolutely even quality, and supplied in lengths of slightly over half a mile. The joints should be silver-brazed in the copper ingot before it is rolled. The diameter of the wire should not be allowed to vary more than 0·0004in. The breaking strain of the wire should be at the rate of 56,000lb. or 25 tons per sq. in. In span-wire construction it is necessary to determine both the height of the eye-bolts from which the span-wire is suspended, and also the sag. In Table 7 are given data of galvanised steel span-wires generally used.

Table VII.—*Galvanised Steel Span-Wires.*

Thickness of Wire { wire-gauge No.	15	12	11	10
{ ..... inch.	0·070	0·110	0·120	0·135
Number of strands	7	7	7	7
Total approximate diameter.....in.	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$
Weight per 100ft. run.....lb.	10	21	29	36
Tensile strength absolute.....lb.	1,600	3,360	4,640	5,720

Poles.—Upon the amount of sag allowed for the span-wires depends the strain which the side poles must stand. Round curves these strains are often great, and tubular poles composed of ordinary pipes wedged together by liners are useless. In Table VIII. are given certain data of standard poles specially designed for this work, and a drawing is shown of one of the poles. All poles must be of such strength that when in position they will stand without permanant set the greatest side strains to which they may be subjected. Terminal poles and pull-off poles on curves should be the strongest. Ordinary side poles must stand a direct strain of at least 500lb. without deflecting more than 4in. to 6in. Their strength must be sufficient to carry, besides the trolley wire itself, the additional weight when the wires are covered with ice and snow. The poles are always subject to vibration communicated from the trolley wire. It is of the utmost importance that joints should be well constructed, which renders it necessary that the several lengths of the pole should be sweated together, as shown in Fig. 2. The joint is

Table VIII.—*Standard Tubular Poles.*

Total length of pole.	Length and outside diameter of three component pipes.			Total weight.	Free from permanent set at
Ft.	ft. in.	ft. in.	ft. in.	lbs.	lbs.
29	16½ × 10	8 × 8	7¼ × 7	1,503	4,500
30	17 × 10	8½ × 8	7¼ × 7	1,552	4,400
31	17 × 10	9⅓ × 8	7⅓ × 7	1,593	4,200
28½	16 × 8	8 × 7	7¼ × 6	1,193	3,400
29½	16 × 8	9 × 7	7¼ × 6	1,224	3,200
30	17 × 8	8½ × 7	7¼ × 6	1,259	3,150
28½	16 × 7	8 × 6	7¼ × 5	769	2,000
29½	16 × 7	9 × 6	7¼ × 5	991	2,000
30	17 × 7	8½ × 6	7¼ × 5	998	1,800
28½	16 × 6	8 × 5	7¼ × 4	689	1,200
29½	16 × 6	9 × 5	7¼ × 4	613	1,000

made by heating the outside pipe to a welding heat, slipping it over the inner pipe, and then passing the two together through special rollers. After completion, if a piece is cut from the joint between A and B, the two pipes will be found solidly welded together, the joining line AB having entirely disappeared. This is known as the "SSS" joint, the abbreviation meaning solid, swaged, and sweated. The tubes used in making poles are all lap-welded, and the larger sizes are also riveted along the seam with countersunk rivets. The lengths of pipe are so put together that the seams of

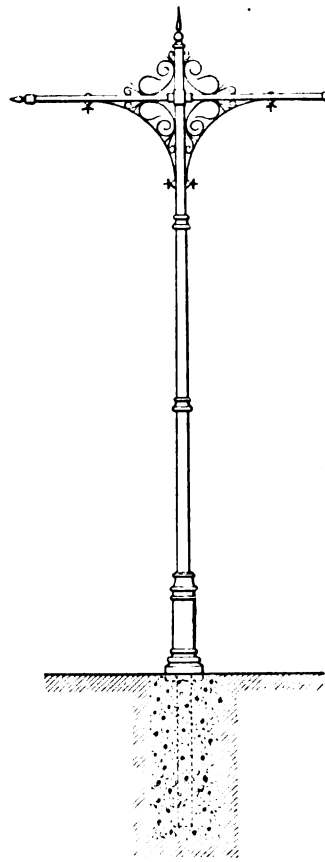

Fig. 1A.

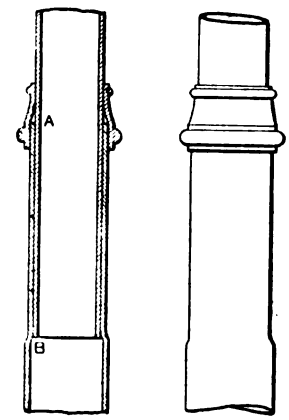

Fig. 2.

each consecutive length are 120deg. apart (Fig. 3), when the poles are made in three lengths, as is generally the case. If joints are not so made, the pole, instead of bending uniformly as shown in Fig. 4, after a short time gives at the joints, as shown in Fig. 5. Poles constructed with SSS joints can be accurately calculated to stand any determined strain without exceeding a fixed temporary and permanent deflection. This is not possible with other joints, which always give trouble sooner or later. For the standard poles used at Bristol and Dublin five sizes are required, all 31ft. long, and set in the ground to a depth of 6ft. No. 1 has to stand a lateral strain of 350lb. applied at top, with maximum temporary deflection of 6in. ; and a strain of 700lb. with maximum permanent deflection of ½in. For the four others the corresponding limits are :—

No. 1	350lb.	with 6in. and	700lb.	with ½in.
No. 2	500lb.	„ „	1,000lb.	„
No. 3	700lb.	„ „	1,200lb.	„
No. 4	1,000lb.	„ „	1,700lb.	„
No. 5	2,000lb.	„ „	2,600lb.	„

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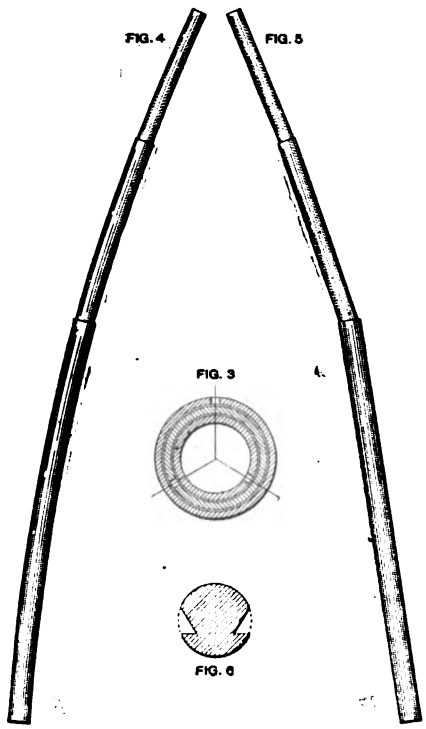
The poles are required to be as nearly round as possible. A difference of $\frac{1}{8}$in. between maximum and minimum diameter is all that is allowed. In order that they may all be as nearly uniform as possible, $\frac{1}{16}$in. more or less than the prescribed dimensions is all that is allowed. The greatest distance out of the true that is allowed at the top of the pole is $\frac{1}{4}$in. Ten per cent. of each lot of poles are tested; should three poles fail to come up to the requirements, the right is reserved to reject the entire lot. The poles are dropped three times, butt foremost, from a height of 6ft. upon some solid substance; after which they must show no signs of telescoping or loosening in the joints.

Insulators.—Insulators must be mechanically strong, and the insulation protected by a metallic covering from external injury. Special insulators have been designed for every variety of service, samples of which are exhibited. For ordinary tramway service the wire is usually soldered into the gun-metal ears of the insulators; but the heavy "figure 8" wire, used for light railways and high-speed lines, is supported by mechanical clips. Occasionally an extra heavy round wire is used, which is then milled out by a portable tool at the points of support, in order to afford a proper grip for the mechanical ears, as shown in Fig. 6.



Rolling Stock.—This can be subdivided into car-bodies, trucks, motors and their accessories. The bodies possess no special features, except that all framing must be extra strong.

Trucks.—The supply of suitable trucks for both motor and trailer cars is of the utmost importance. The introduction of electric traction has revolutionised the construction of running gear. In former days, when horses and mules were the only motive power for street cars, it was considered quite sufficient to support the car body upon a single set of springs carried by the boxes, a simple bar being often the only connection between the two sets of wheels. The adoption of the electric power and of cars equipped with single or double motors added immensely to the weight carried by the axles, and rendered it necessary to adopt efficient methods for cushioning and suspending the motors over the axles, while maintaining a rigid connection between motor and axle. At first the motors were rigidly attached to the bottom of the floor of the car body. This construction did not prove a success, for both car floor and motor deteriorated rapidly, and access to the motors was also difficult. Experience demonstrated that the only effective plan was to attach the motors to an independent truck frame, and to have all the mechanism of the car entirely independent of the car body. For this purpose an independent truck was introduced, consisting of pedestals secured by centre bars; upon the pedestals the motors were suspended by cross-bars connecting the side frames of the truck together. While these trucks supported the motors independently of the car body, they did not properly support the car body itself, which had increased in length and width. The increased length and width of the electric car, together with the increased speed at which it ran, rendered a stronger and longer truck necessary. At first the old street-car pedestals were fastened to a separate pair of sills. The axle-boxes still played up and down in these pedestals to the full extent of the motion of the car body. This device proved insufficient. The next step in advance was to secure the pedestals carrying the axle-boxes to side frames, which carried the springs supporting the car body. This construction, however, allowed excessive swaying of the car body, owing to the fact of the connection between the wheels and the body not being sufficiently rigid. Moreover, no provision had been made for easily removing the wheels, which required the truck to be practically taken to pieces. The brakes were hung to the upper chord of the truck, the effect of which was that, when the springs were compressed, the brake shoes dropped lower on the wheels, changing the distance between the shoe and the wheel.

The introduction of mechanical motors, occupying so little room that a capacity of 50 H.P. or 60 H.P. can readily be placed in the space allowed by the truck, has lead to a large increase in the weight of the car body, and a consequent lengthening of the wheel-base. The modern electric-car bodies carried on four wheels are seldom shorter than 18ft. over the end panels, and sometimes reach 22ft. length, exclusive of the platforms, while the whole length of the car over the platforms is from 30ft. to 32ft. This increase of nearly 25 per cent. in the length and more than 25 per cent. in the weight of the bodies has been

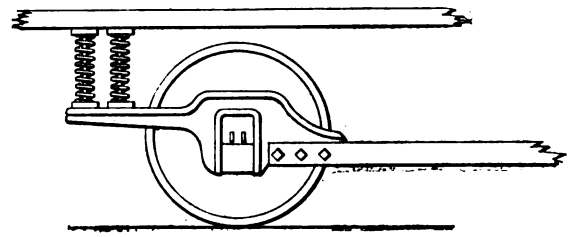


FIG. 7.

accompanied by an increase of only about 20 per cent. in the wheel-base of the trucks. As a result, a long and rigid spring-base is an absolute necessity for a modern electric truck. Without this the whole stress of carrying both the dead weight of the car and platforms, and the fluctuating weight of the load would fall on the car sills and body, and the motion of the car would continually wrench and strain its framing. In the conditions met with in street service the wheel-base cannot be lengthened much over 7ft. or 7½ft.; and on this account a long spring-base must serve the purpose of an increased wheel-base for the long cars now employed. To obtain easy riding it is necessary that all the springs should be sufficiently light to obviate vertical motion in the car body; consequently these light springs, in order to prevent excessive motion of the ends of the car, must be carried out just as far apart as it would be necessary to carry the wheels if the old horse-car arrangement were adopted for the modern long-car bodies. To secure the necessary rigidity of the long side-frames, and at the same time keep their weight within reasonable limits, different plans have been adopted. In earlier designs it was attempted to overcome the difficulty by casting the pedestal and overhang in one piece, and lengthening the joint between these castings and the bars, connecting them as shown in Fig. 7, which represents one of the early

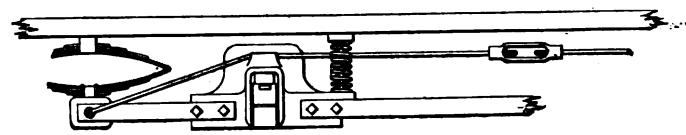


FIG. 8.

forms of the extended spring-base. Another method consisted in trussing the overhang with straining rods running over the tops of the pedestals (Fig. 8), and provided with turn-buckles for taking up the strain as the overhang worked down; but turn-buckles slack off, and the bolted joints wear loose, and a continual wear and rattle was the result. Some makers constructed the side frames of the truck in one piece by bolting heavy centre-bars to the pedestals. Others again forged the side frame of the truck, and welded the whole together into one piece. But these designs have not proved sufficiently strong to support properly the permanent pressure upon the ends of the overhang, when the overhang is carried out to the length of the modern car-body.

(To be continued.)

Electric Railways and Scientific Laboratories.—It is reported from Munich that the managers of the Royal Observatory at Bogenhausen have protested against the introduction of an electrical system on the line in that district, as this would affect their magnetic instruments.

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HERTZIAN TELEGRAPHY AT THE PHYSICAL SOCIETY.

For reasons which are fairly obvious, the Physical Society is not remarkable for overcrowded meetings, but on Friday last the Society and its visitors taxed to the utmost the accommodation of the Chemical Society's room in Burlington House. The occasion was to hear Prof. Oliver Lodge's discourse on "Wireless Telegraphy," as the new telegraphy is popularly termed. An unannounced event opened the proceedings, when Prof. Fitzgerald exhibited some photographs, sent by Mr. Tolver Preston, showing the spectra of zinc, cadmium and iron, exhibiting the Zeeman effect. The action of the magnetic field on different lines varied considerably, and in some cases where a triple line should appear a doublet was seen or a quadruplet, the two inner members of which were comparatively faint. Arguing on the generally-accepted theory of the Zeeman effect, the varying action of the field on different lines can scarcely be due to difference of amplitude, except indirectly, or in so far as the amplitude depends upon the mass of that portion of the atom which takes part in the vibration corresponding to the particular line. In applying, however, any results based upon the preliminary assumption of a comparatively simple vibrating system, it must be remembered that the iron atom is not likely to be a very simple affair, or it would not have so many distinct periods of vibrations as are indicated by the number of the lines in its spectrum. The whole question of the revolution of the electrically-charged atom or of the charge on the atom has acquired increased interest in another direction by Prof. Fleming's hypothesis as to the structure of the ferromagnetic

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molecule. But this takes us quite beyond the range of the Physical Society's meeting, and of the subject of Hertzian signalling.

After drily remarking that the public seem to think they want "wireless telegraphy," Prof. LODGE said that in 1894 he had not considered it likely his researches would have any practical value in this direction. Incidentally, he mentioned that the title given to his Paper on the agenda was incorrect; he had proposed "Signalling without *Connecting* Wires"—one of the best names yet suggested for the erroneously-termed "wireless telegraphy." As to the practical applications, there were occasions when one wanted to "shout to the world"—as in distributing political speeches to the Press—and for such a purpose the Hertz-wave and the coherer might be of service. But did not Prof. LODGE forget that no one wants to pay for shouting to the world on a system by which it would be impossible to prevent non-subscribers from benefitting gratuitously? In respect of practical signalling, the whole matter is to arrange some way in which there can be a sufficient degree of "tuning." Prof. LODGE's exposition of the conditions that an apparatus must comply with to be able to permit of this was a good example of the scientific rather than the haphazard method of invention. The first thing needful is to have a persistent vibration to which to tune, and not one that dies off rapidly and irregularly. This at once excludes the simple RIGHI transmitter. To get persistency, capacity is necessary; the period can be altered by varying either capacity or self-induction. Prof. LODGE introduces both into his system, and tunes with the latter. The coherer is connected up with the resonator in such a way as not to damp the vibrations, but to take the overflow when resonance is set up. The receiver is therefore a real resonator, and not a mere collector of vibrations. The receiver closely resembles the transmitter, except, of course, that the spark gap is removed from the former; the most markedly novel feature is the coil of copper introduced between the two triangular wings. An incidental result of the method of tuning is that the waves used are over 30 yards long. From one point of view this ought to be no disadvantage, since the "shadow" of any obstacle of moderate size would be so much the shorter. In fact, the Hertz-wave would bend round behind it as much as a sound-wave does. Once upon a time Prof. LODGE used to work with 8in. waves. The length of Mr. MARCONI'S waves was about 4ft. On the other hand, it appears that little has been done in the way of getting a plane wave-front—in other words, of sending signals in a specific direction. The dimensions of a reflector such as would be required to work effectively with waves 90ft. in length would seem startlingly large, and any method of directing them other than by reflection does not appear hopeful.

It was laid down by a famous bishop, of splendid memory, that a needle could support upon its point eleven angels. There certainly seems mystery and virtue enough in a needle's point to lend probability to the truth of the bishop's dictum. Prof. LODGE tells us that the coherer may advantageously be reduced to a single contact—*i.e.*, that a needle pressed against a flat spring is, of all coherers, the most sensitive, and that it possesses the further merit of requiring no mechanical "tapping-back." Who then, we may ask, would suffer the pangs of questioned priority, the difficulties of adjustment, and the doubtful working of a mass of filings, when better things may be attained with a bare bodkin? The needle-point coherer, however, has its drawbacks, one of which is that in certain conditions it is too sensitive; but in suitable circumstances it may be made to give better results than a Branly tube. In fact, the single-contact coherer works best with what Prof. LODGE called "electrical tapping-back." The resistance-change produced by the oscillations is found to be almost simply proportional to the power of the received Hertz-waves; moreover, a weaker discharge following a stronger is able nearly to restore the resistance to its first value. If our memory serves us aright, an effect akin to this was observed about ten years ago by Prof. MINCHIN, in relation to his photo-electric cells. One of these cells, under certain conditions, became insensitive to solar radiations, and its sensitiveness could be restored in one of two ways, namely, either by mechanical or acoustical tapping of the cell or its support, or by connecting a small battery of a few volts to the electrodes of the cell. It is surprising that the actinic aspect of the "coherer" problem has received so little attention. Prof. MINCHIN'S cell engenders electromotive force when exposed to light; that is its proper function, and it is intimately associated with the coherer—for it is alive, as the coherer is, to Hertz-waves, and to mechanical and electrical tapping back. Can the coherer be rendered sensitive to light? We suggest that it is highly probable that it can.

ON THE MAGNETIC FIELD DUE TO A CURRENT IN A WIRE PLACED PARALLEL TO THE AXIS OF A CYLINDER OF IRON.—I.

BY G. F. C. SEARLE, M.A.

§ 1. The recent discussion as to the origin of the mechanical force experienced by a "tunnel" armature has led me to examine, from the point of view of magnetic theory, the distribution of magnetic force due to a current flowing along a wire which is placed parallel to the axis of a cylinder of iron. I shall consider first the case of a cylinder of infinite radius, *i.e.*, an infinite block of iron bounded by a plane face, passing on later to the case of a solid cylinder of finite radius The distribution of magnetic force in each of these two cases is easily found by the method of images, whether the current flows in the iron or in the air. The cases of a slab of finite thickness and of a cylinder with a hole up the middle require the use of an infinite series of images, and will not be dealt with at present.

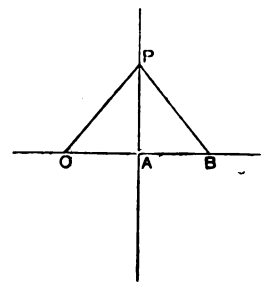

FIG. 1.

§ 2. Let AP (Fig. 1) be the trace of the plane face of the iron on the plane of the paper, the whole of the space to the left of AP being occupied by iron. Let O be the point in which the wire carrying the current cuts the plane of the paper. Let i be the strength of the current, and let it flow into the paper from the reader. Let μ be the permeability of the iron; this will be supposed to be constant. Let B be the image of O in the plane AP—*i.e.*, let AB = OA where OA is perpendicular to AP. The distribution of magnetic force which we find as a solution of this problem must satisfy the following conditions:—

(*a*) The normal component of the *magnetic induction* must be continuous at the interface between iron and air. This condition is only an expression of the fact that lines of magnetic

induction always form closed curves, or else go off to infinity, so that there are as many leaving any closed space as enter it.

(*b*) The tangential component of the *magnetic force* must be continuous at the interface. This condition follows from the fact that the magnetic force due to the magnetism on any small area of the interface is perpendicular to the surface at a point very near to the centre of that area.

To find the solution I suppose that the magnetic force in the *iron* is the same as that which would be due to two currents, i at O and u at B, if the iron extended to infinity to the right as well as to the left of AP. I suppose that the magnetic force in the *air* is the same as that which would be due to a single current, v at O, if the iron were removed. I shall show that u and v can be determined so as to satisfy the two conditions (*a*) and (*b*). The positive direction of all the currents is into the paper from the reader.

Now the magnetic force at P due to the current i at O is $2i/OP$ at right angles to OP. Hence the magnetic forces due to i, u and v normal to AP in the direction from left to right are respectively

$$\frac{2i\,AP}{OP^2}, \quad \frac{2u\,AP}{BP^2}, \quad \frac{2v\,AP}{OP^2},$$

and those tangential to AP, vertically upwards in the diagram are

$$-\frac{2i\,OA}{OP^2}, \quad \frac{2u\,AB}{BP^2}, \quad -\frac{2v\,OA}{OP^2}.$$

Here of course since B is the image of O,

$$OA = AB \text{ and } OP = BP.$$

Expressing condition (*a*) we have

$$\mu(i+u) = v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and expressing condition (*b*) we have

$$i - u = v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Solving equations (1) and (2), we find

$$u = -\frac{\mu-1}{\mu+1} i \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$v = \frac{2\mu}{\mu+1} i \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The distribution of magnetic force due to these two systems of currents does not entail any accumulation of magnetism at any point either in the iron or in the air. Thus, these values of u and v satisfy all the conditions, and hence constitute a complete solution.

We notice that when μ is large the current at B, which flows in the opposite direction to i, is nearly as great as i. Hence AP must be nearly a line of induction, and hence very few lines of induction will cross the surface. The magnetic force in the air is the same as that due to a single current y at A, whose strength is nearly twice as great as that of i. The lines of magnetic force in the air are thus circles about a common centre, O.

In order to give a clearer idea of the distribution of the lines of induction in this case, I have drawn Fig. 2 by Maxwell's method for the case in which $\mu = 9$. We have here, consequently, $u = -\frac{4}{5} i$ and $v = \frac{9}{5} i$. It will be seen that the lines of induction crowd in between the wire and the face of the iron, and that only a few escape into the air. With a high value of μ it would be almost impossible on a diagram of moderate size to draw the lines of induction in the iron so close together as to show any of them going out into the air. I had therefore to be content with a low value for μ.

The lines of induction near O are very nearly circles about O as centre. Thus our solution will still hold when a small tunnel is bored in the iron for the wire to pass through.

§ 8. If we repeat the investigation just given for the case in which the iron is on the right instead of on the left of AP in Fig. 1 we have the solution of the case where a current flows along a wire in the air, the wire being parallel to the face of the iron. We find

$$u = \frac{\mu-1}{\mu+1} i \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

$$v = \frac{2}{\mu+1} i \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Here, as before, u is nearly equal to i, but now u flows in the *same* direction as i. The face of the iron is thus very nearly perpendicular to all the lines of induction in the air. It is therefore nearly an equipotential surface. The value of v is small, so that the magnetic *force* is small in the iron, but, on

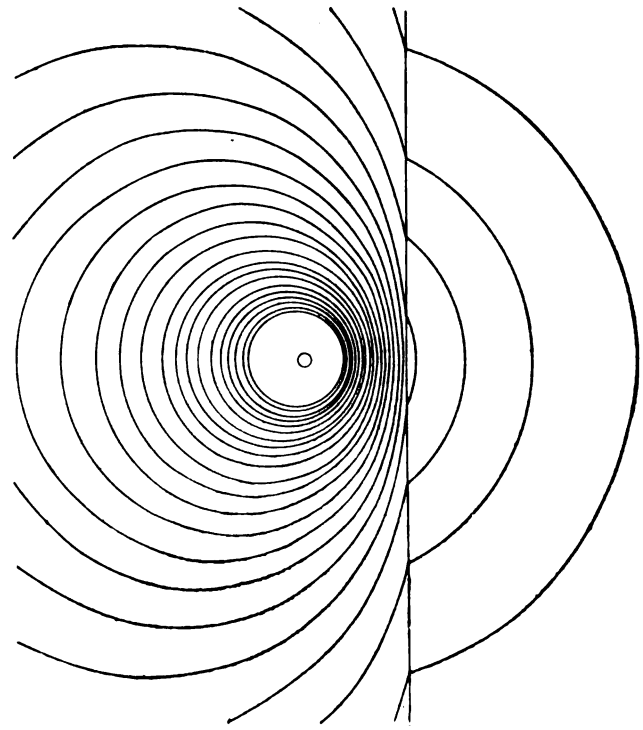

Fig. 2.

account of the large value of μ, the *induction* in the iron is of the same order of magnitude as the magnetic *force* in the air Fig. 3 shows that nearly all the lines of force in the air meet the iron and there complete their course round the current as lines of induction, being then in the form of circles about O.

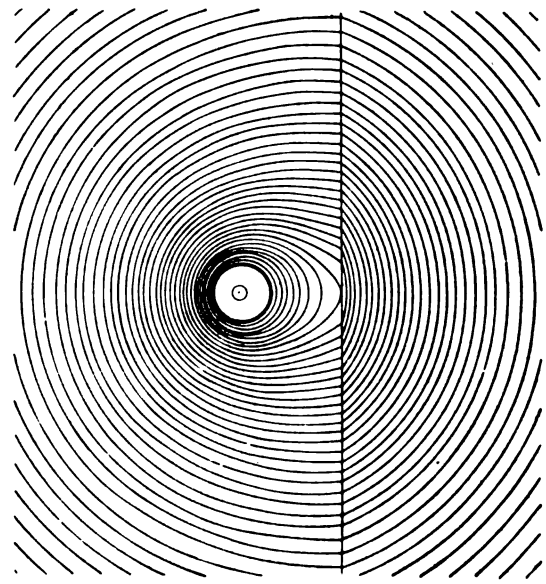

Fig. 3.

The current i will be attracted towards the iron, the force being the same as that between the two currents, i at O and u at B, in air. The force is thus

$$\frac{2iu}{OB} = \frac{i^2}{OA} \cdot \frac{\mu-1}{\mu+1} \text{ dynes per cm.}$$

The last two diagrams show very plainly the so-called refraction of the lines of induction in passing from air to iron.

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§ 4. One most important advantage is gained by leading the wire through a tunnel, viz., that the mechanical force experienced by the wire when carrying a current in a magnetic field is very much smaller than it would be if the wire were outside the iron. The electromotive force produced in the wire, when the armature revolves between the field magnets, is the same as if the wire were placed outside the iron, instead of passing through the tunnel, and the mechanical couple required to turn the armature is the same in both cases. The iron in fact experiences nearly all the force which the current would experience if it were outside the iron. As there seems some misconception as to the manner in which the force gets hold of the iron, it may be useful to consider the matter a little more closely.

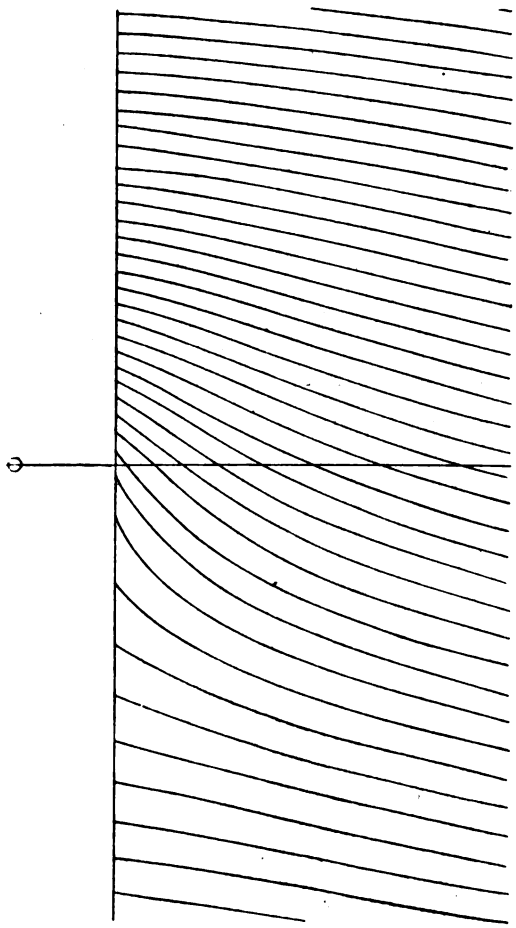

Fig. 4.

I have drawn Fig. 4 to represent the form of the lines of force in the air when the system represented in Fig. 2 is placed in a uniform magnetic field whose lines of force are normal to the face of the iron. The current flows into the paper from the reader through the small circle on the left o the diagram, and the direction of the uniform field is such that a north-seeking pole would be urged from the left to the right of the diagram. Let $\mathbf{H}_0$ be the strength of this uniform field. The diagram shows how the lines of force, which naturally would be normal to the iron, are distorted by the action of the current. I have made $\mathbf{H}_0$ not great compared with the magnetic force due to the current at the points in the air nearest to the current. In the case of an actual dynamo, the distortion will be less, because $\mathbf{H}_0$ will be so much larger, but there will be distortion, and it is this distortion which gives rise to the mechanical force. The form of the lines of force, all sloping downwards as they leave the iron, shows very clearly how the downward force which the iron experiences is brought about. When we remember that the ether is in a state of stress, and that this stress consists of a tension along the lines of force and a pressure at right angles to them we cannot help seeing that the iron experiences a force urging it downwards in the diagram. If we take any plane in the ether parallel to the face of the iron, and to the right of that face in Fig. 4, there is a tension across this plane tending to make all the system on the left of the plane move towards the right hand. But there is also a shearing stress across this plane tending to make all the system on the left of the plane move downwards. I think that perhaps this shearing stress is not so well understood as the tension.

§ 5. In order to bring out more clearly the part which the ether plays in producing the force experienced by the iron, I will find the total amount of this shearing stress across any plane parallel to the face of the iron. Maxwell* has shown that when there is no permanent magnetism the stress in the medium consists of

(i) A hydrostatic *pressure* $\mathbf{H}^2/8\pi$ dynes per square centimetre,

(ii) A longitudinal *tension* $\mathbf{BH}/4\pi$ dynes per square centimetre along the lines of force,

where $\mathbf{H}$ and $\mathbf{B}$ are the magnetic force and the magnetic induction respectively. In our case we may put $\mathbf{B}=\mu\mathbf{H}$ in the iron and $\mathbf{B}=\mathbf{H}$ in the air.

We must first calculate the tangential and normal components of the stress due to (ii) across any plane whose normal makes an angle θ with the lines of force. Consider a unit area S (Fig. 5) of the plane. The area of a normal section of the tube of force which springs from the boundary of S is $\cos\theta$. Consequently the total pull along the axis of the tube is $\mathbf{BH}\cos\theta/4\pi$ dynes. This we resolve into two parts $\mathbf{BH}\cos^2\theta/4\pi$ normal to S and $\mathbf{BH}\sin\theta\cos\theta/4\pi$ tangential to

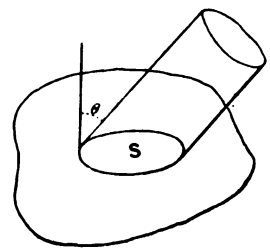

Fig. 5.

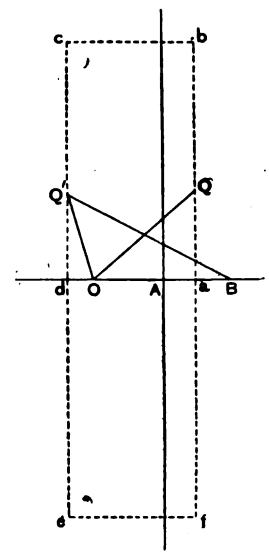

Fig. 6.

S. Hence the components of the total force acting across unit area of the plane are

(1) $(\mathbf{BH}\cos^2\theta - \frac{1}{2}\mathbf{H}^2)/4\pi$ normal to the plane.

(2) $\mathbf{BH}\sin\theta\cos\theta/4\pi$ tangential to the plane.

If N and T are the components of the magnetic *force* normal and tangential to the plane, then we can write, since $\mathbf{H}^2 = \mathrm{N}^2 + \mathrm{T}^2$,

Normal stress $= \{(2\mu - 1)\,\mathrm{N}^2 - \mathrm{T}^2\}/8\pi$ dynes per square centimetre.

Tangential stress $= \mu\mathrm{NT}/4\pi$ dynes per square centimetre.

§ 6. I shall now apply these formulæ to find the total force experienced by whatever is enclosed within the dotted rectangle *abcdef*, Fig. 6, which encircles the current through O. We must remember that the magnetic force in the air (on the right of A) is that due to a current v at O, and that the magnetic force in the iron (on the left of A) is that due to the two currents i at O and u at B.

Let Q be any point on *ab*, and let $Oa = x$, $aQ = y$. Then the components of the magnetic force at Q due to v in the directions *Oa* and *ab* are, by § 2, $2vy/(x^2+y^2)$ and $-2vx/(x^2+y^2)$.

* Clerk Maxwell, "Electricity and Magnetism," Vol. II., § 642.

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Hence, when the system is placed in a uniform magnetic field of strength $\mathbf{H}_0$ parallel to OA, the components of the resultant magnetic force at Q are

$$N = \mathbf{H}_0 + 2vy/(x^2+y^2) \quad . \quad . \quad . \quad . \quad (7)$$

$$T = -2vx/(x^2+y^2) \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Thus, by § 5 the tangential stress at Q is (since $\mu = 1$ here)

$$NT/4\pi = -\frac{1}{4\pi}\{\mathbf{H}_0 + 2vy/(x^2+y^2)\}2vx/(x^2+y^2).$$

To find the total tangential stress across a band of unit width (in the direction perpendicular to the paper) of the plane *fab*, extending to infinity in both directions, we have to integrate this expression with respect to y. We find

$$\frac{1}{4\pi}\int_{-\infty}^{+\infty} NT\,dy = -\frac{v}{2\pi}\int_{-\infty}^{+\infty}\left\{\frac{\mathbf{H}_0 x}{x^2+y^2} + \frac{2vxy}{(x^2+y^2)^2}\right\}dy$$

$$= -\tfrac{1}{2}v\mathbf{H}_0.$$

Making use of the value of v in (4) this becomes

$$-\frac{\mu}{\mu+1}i\mathbf{H}_0.$$

Hence, when μ is large the total tangential force acting across the plane *bf* is practically the same as $i\mathbf{H}_0$, the force which unit length of i would experience in the field $\mathbf{H}_0$. The two are not identical, because we have left out of account the forces experienced by the faces *bc*, *ce* and *ef* of the rectangle. Since *cb* and *ef* are at an infinite distances from O, and since they are of *finite* length, the difference of the normal forces acting on them is infinitesimal.

Let $Od = x$, $Bd = x'$ and $dQ' = y$, where Q' is any point on *dc*. Now we must remember that the magnetic *induction* is continuous, and that the value of $\mathbf{B}$ in the iron due to the applied uniform magnetic force is the same as the value of $\mathbf{H}_0$ in the air. Hence the magnetic *force* in the iron due to the applied force is $\mathbf{H}_0/\mu$.

We thus find

$$N = -\mathbf{H}_0/\mu - 2iy/(x^2+y^2) - 2uy/(x'^2+y^2)$$

$$T = 2ix/(x^2+y^2) + 2ux'/(x'^2+y^2).$$

When we integrate $\mu NT/4\pi$ over a band of unit width and infinite length of the plain *ec*, we easily find that

$$\frac{\mu}{4\pi}\int_{-\infty}^{+\infty} NT\,dy = -\tfrac{1}{2}\mathbf{H}_0(i+u) = -\frac{i}{\mu+1}\mathbf{H}_0.$$

Hence when μ is large the tangential force across the plane *ec* is small. We see that it is just the force which, when added to the tangential force across the plane *fb*, makes the total mechanical force amount to $i\mathbf{H}_0$.

If we had drawn the plane *fb* in the iron between O and A, instead of in the air, we should have found the tangential force across it to be

$$\frac{\mu}{4\pi}\int_{-\infty}^{+\infty} NT\,dy = \tfrac{1}{2}\mathbf{H}_0(-i+u) = -\tfrac{1}{2}v\mathbf{H}_0,$$

the same value as we found for the force across the plane in the air. Thus we see that the total force experienced by any portion of space bounded by two planes parallel to the face of the iron is zero except the two planes enclose the current; in this case the total force is $i\mathbf{H}_0$ dynes per centimetre.

If we take any closed curve enclosing O and find the resultant of the Maxwell stress on unit length of the cylinder, of which the curve is a section, the result will always be $i\mathbf{H}_0$ dynes.

§ 7. A few words must be added as to the mechanical force experienced by the copper conductor itself when placed in a tunnel parallel to the face of the iron. When a small tunnel is bored in a uniformly magnetised block of iron, the axis of the tunnel being perpendicular to the lines of induction, it is easily shown that the magnetic force inside the tunnel has the uniform value $2\mathbf{B}/\mu$, when $\mathbf{B}$ is the value of the undisturbed magnetic induction. In our case the value of $\mathbf{B}$ is $\mathbf{H}_0$, so that the magnetic force in the tunnel is $2\mathbf{H}_0/\mu$. The current thus experiences the force $2i\mathbf{H}_0/\mu$ dynes per centimetre of its length. This force is the resultant, parallel to the face of the iron, of the Maxwell stress taken over unit length of a cylinder drawn between the conductor and the surface of the tunnel. It is thus also the force exerted on the iron by the ether inside the tunnel. But the total force experienced by the system of iron and current must still be $i\mathbf{H}_0$. Hence the iron itself experiences the force $i\mathbf{H}_0(1-2/\mu)$. Thus, if μ is large, the iron experiences nearly the whole of the mechanical force, leaving only a small part to be borne by the conductor. If the radius of the tunnel is not infinitely small compared with the distance between the tunnel and the face of the iron, the magnetic force in the tunnel will be greater than $2\mathbf{H}_0/\mu$, and the mechanical force on the current will be greater than $2i\mathbf{H}_0/\mu$, while the force on the iron will be less than $i\mathbf{H}_0(1-2/\mu)$. It is, I believe, impossible to reduce the mechanical force on the current to a value smaller than $2i\mathbf{H}_0/\mu$ dynes per centimetre of its length when the tunnel has a circular section.

There is also a mechanical force quite independent of $\mathbf{H}_0$ tending to push the conductor away from the face of the iron. If there were no tunnel, the magnetic induction at O, Fig. 1, due to the current u at B would be $2\mu u/OB$. The magnetic force in the tunnel due to this is $4u/OB = 2u/OA$. There is thus a mechanical force $2ui/OA = 2(\mu-1)i^2/(\mu+1)\,OA$ dynes per centimetre tending to force the conductor away from the face of the iron. The actual force experienced by the conductor is the resultant of this force and of $2i\mathbf{H}_0/\mu$ which was found above.

I know of nothing in electromagnetism more strange than the effect discussed in the above paragraph. The current is able to cause a large force to act upon the iron, while the conductor itself experiences only a small force. By the astounding mechanism of the ether it is able to lay nearly all its burden upon the iron.

(*To be concluded.*)

Trial Trip of a New Electric Switching Locomotive.—Our New York correspondent writes that a party of invited guests recently attended the trial trip of a new electric locomotive on the Hoboken Shore road, a railway line running from Weehawken, N.J., to Fourth-street, Hoboken, N.J., along the water front, taking in the docks of the North German Lloyd Steamship Company, the distance being about three miles. The road has hitherto been operated by a steam drill locomotive, which will now be laid away for "future reference," since the appearance of its electric rival. The electric locomotive was constructed by the General Electric Company at Schenectady, N.Y. It is mounted on two four-wheel trucks, each axle carrying a General Electric motor, giving the locomotive a total of 540 rated horse-power. The locomotive is driven through a single reduction gear of very high ratio at a speed of eight miles an hour when hauling a heavy load. The cab is of iron with a sloping tender shield at each end. On each shield is a headlight, and on one is carried a bell and on the other a chime whistle. Beneath one of the shields are four packed card resistances, two sand boxes, the compressed air tank and equalising air tank; beneath the other there are eight resistances, two sand boxes, and the engineer's tool box. At one end of the cab is placed a controller of the series parallel type. It contains a magnetic blow-out, and is arranged to operate the motors either four in series or each two in series multiple. Fastened to the roof of the cab is an automatic circuit breaker set at 500 amperes. The overhead wire is No. 000 B. and S., suspended from wires strung between octagonal cedar poles, and the current is taken from an electric light station in Hoboken. Hoboken, it may be stated, lies in New Jersey, across the North River from New York City. The Hoboken shore line provides connecting facilities between the tracks of the various railroad companies entering Hoboken and the numerous warehouses and docks on the river front.

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AN AMERICAN ELECTRIC LIGHTHOUSE LANTERN.*

Some interesting tests are now being made at the general depôt of the United States lighthouse establishment at Tompkinsville, Staten Island, upon a gigantic electric beacon known as the Lepaute "bi-valve," or lightning lens light. The lantern consists of two lenses, each 9ft. in diameter, enclosing between them an electric arc of great power. In the central portion of each lens is a disc having two prismatic rings. Outside of this are 190 prismatic segments so arranged that the light of the arc is totally reflected in each and thrown out in a beam which is practically parallel. In this nearly the total light of the arc is concentrated in two great beams, 9ft. in diameter, directed towards opposite points on the horizon. The whole apparatus is floated on mercury, and is driven by powerful clockwork actuated by a spring. The period of revolution is 10sec., so that every point on the horizon receives a flash from the lens in each 5sec., these flashes being of about $\frac{1}{13}$th sec. duration. The lamp, lenses and supporting framework weigh about 20 tons, and the friction is so reduced by the use of the mercury float that the whole apparatus can be easily turned by the pressure of one finger.

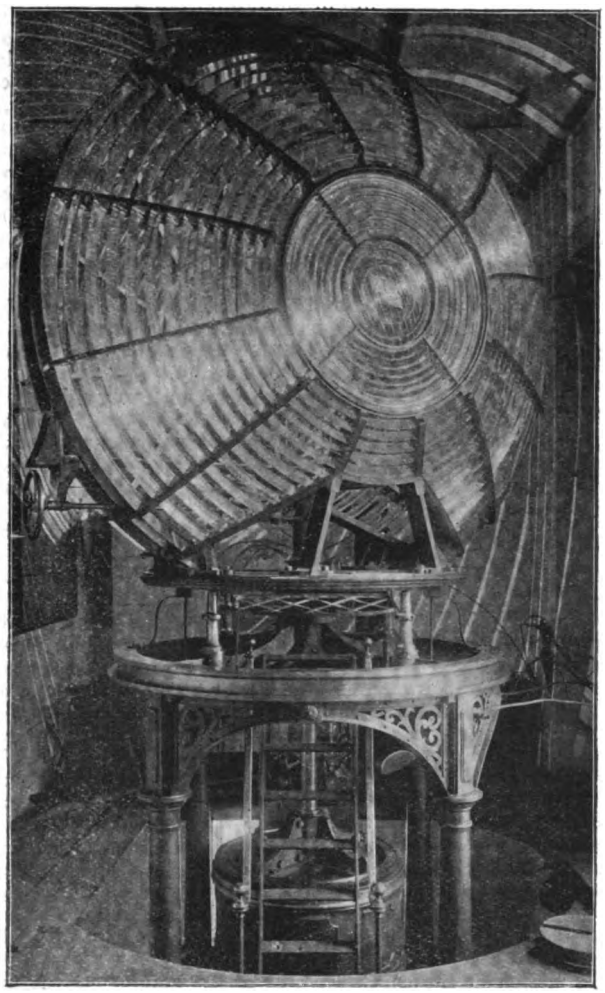

FIG. 1.—An American Electric Lighthouse Lantern.

The arc lamps, of which the lens contains two—one at its focus, and the other arranged to be brought into play immediately upon the failure of the first—are of a curiously-complicated structure, and yet very simple in principle. The arc is struck by hand. The two carbon holders are connected together by means of a chain actuated by clockwork, the last wheel being a detent, in which is engaged a small pawl operated by an electromagnet in shunt around the arc. When the arc lengthens out and its resistance increases, this coil pulls away the detent and permits the clockwork to feed the carbons together. The lamps are of the most elaborate construction and finish, but it cannot be said that their complexity commends itself. Both lamp and lens were made by Henri Lepaute, Paris, and the whole outfit was exhibited at the World's Fair, and subsequently at Atlanta and Nashville. The lamp was purchased by the United States Government; but its location has not yet been determined upon, though it will likely be installed at some point along the Atlantic coast, if the tests now in progress are satisfactory. There is every indication that they will fulfil every condition imposed upon the apparatus.

The lamps are arranged to carry carbons of from 15mm. to 60mm. ($\frac{5}{8}$in. to 2$\frac{1}{2}$in.) in diameter, the current consumption varying with the size of the carbon. The original apparatus was provided with an alternating-current generator of French make, but it has been decided to use with the lens an alternating generator made by the General Electric Company of Schenectady, driven by a 25-H.P. Ideal engine. The present tests are being conducted with current taken from the local lighting service, the frequency being 140 cycles per second, and the consumption with 30mm. carbons being about 60 amperes at 55 volts. It is estimated that the horizontal candle-power of this arc without the lenses is not less than 9,000. Mr. C. A. Lamy, superintendent of the lighthouse depôt at Tompkinsville, estimates that the total candle-power of the two beams of light is not less than 90,000,000. He arrives at this figure by adding together the candle-powers of the various beams emerging from the prismatic part of the apparatus and the lenses. The beam is of enormous power, and will be easily visible at a distance of 100 miles, if mounted in a sufficiently high tower.

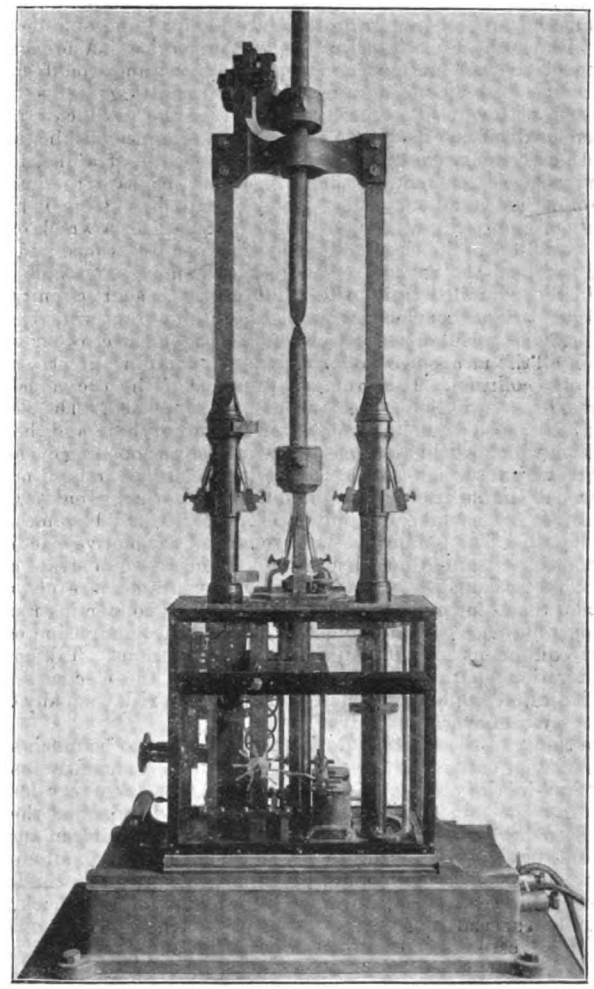

FIG. 2.—Mechanism for Producing the Electric Arc for the Lighthouse Lantern.

The accompanying illustrations (Figs. 1 and 2) give excellent ideas of the details of the lamp and lantern. When the lantern

* Abstract from the *Electrical World* of New York, Jan. 15, 1898.

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is installed in service the electric generating plant will be in duplicate throughout, to avoid any possibility of an accident. With the alternating current supplied for the arc, there seems to be no reason whatever why the rotation of the lens should not be accomplished by means of an alternating motor—a far simpler and more reliable device than the elaborate and complicated clockwork now connected with it.

A PROBLEM IN ELECTRIC TRACTION.*

BY CHARLES T. CHILD.

(Concluded from page 420.)

Provisions for Safety and Emergency.

The accident most to be dreaded in this or any other similar system is one which causes a total stoppage of traffic. The subdivision of the storage battery plant into the numerous sub-stations makes an accident of this character absolutely impossible. Even the total destruction of the central power house would leave sufficient reserve in these batteries to continue the service for a few hours and clear the tracks so that steam trains might be operated. A temporary breakdown at the power house or on the transmission line would be tided over without the least interruption to the service. A breakdown in one of the sub-stations or even its destruction would simply divide its load among its neighbours, permitting trains to be operated with but little inconvenience. If the conductor rail is broken or displaced its continuity and the presence of sub-stations in both directions, except on the terminal section of a line, insure the presence of current. Indeed, it would be hard to render a section of the conductor rail "dead" except by cutting it in two places. A short circuit, such as might be caused by a wreck on the line, would open the circuit breakers at two sub-stations, and stop every train on the section. It thus would not be possible for a wrecked or derailed train which had caused a short-circuit to be run down by another electric train. Indeed, if a train were derailed without having caused a short-circuit, a convenient crowbar would furnish all the means needed for making one and obviating the possibility of a collision. It is from the presence of the occasional fast steam express train that some danger is to be expected. The electric trains have speed enough to keep out of the way of these, and the only condition which would be dangerous would be the opening of the circuit breakers at the sub-stations, depriving an electric train of motive power. A simple system of numerous signals which would exhibit themselves if the current supply failed would be the best means of avoiding this. The liability of derangement of the motive machinery on an electric train is not greater than in the case of a steam train. Blown fuses, damaged armatures, or broken frames are not more common than blown-out cylinder heads, broken connecting rods, or leaking flues in a steam locomotive, and by the subdivision of the motor equipment into four units, much less serious. Taking into consideration all the facts it is probable that the electric service here indicated would carry passengers with less risk than any other railway system ever installed.

The safety of those whose duties require them to be much about the tracks, or those who trespass upon them, is sufficiently insured by boxing-in the conductor rail. It would not take very long to instil into the minds of track-walkers, section-hands, and the like a wholesome respect for the conductor rail, while children and the ignorant public would be protected by the covering alluded to above. Of course, anyone wilfully tampering with the conductor would do so at his peril; but it is to be doubted if the shock from 750 volts, especially of current from a storage battery, would be fatal in any case. It would certainly not encourage a repetition of the experiment, however.

Costs of Construction and Operation.

It is evident that the equipment briefly indicated here will be expensive to instal, but it is easy to show that it will pay its way from the beginning. It cannot, of course, be undertaken piecemeal, but at least one of the five suburban sections should be equipped throughout as the beginning of the complete equipment. Assuming the total equipment as here outlined to be installed, the costs will be approximately as follows :—

The steam engines, together with their boilers, condensers and other appurtenances, can be had for about £140,000. The four large dynamos, two small dynamos, switchboards, exciters, &c., would cost about £120,000, which would make the total cost of the central station, including land and buildings, about £300,000.

The sub-stations would each contain 400 cells of storage battery of 3,200-ampere hours capacity each, costing about £16,000, installed in place. The rotary transformers and booster can be installed for about £2,000. The switchboard and instruments would cost about £400, and the static transformers about £1,600. The cost of land and buildings would bring the total for each sub-station up to about £22,000.

The transmission line consists of about 155 miles of pole line, for which the iron poles, set in cement, and complete with insulators, would cost about £45,000. The copper would cost about £17,000, or say £19,000 in place, on a basis of 10 per cent. loss. The track conductors are 320 miles long, weigh 27,520 short tons, and will cost, in place, including bonding, the tile covering and the insulators, about £280,000.

The motor equipments for the 160 trains necessary for full service would cost about £2,000 each, or £320,000. The cost of the car bodies is not included in this estimate, since the seating capacity to be provided would be the same whatever the motive power used. It is fair, however, to include a sum of £60,000 for the extension of the present car service, the alteration of cars and the building of platforms.

Recapitulating the whole we have as totals :—

Power house	£300,000
40 sub-stations	880,000
Transmission line	63,000
Conducting system	280,000
Motors and extra cars	380,000
Total	£1,943,000

or in round numbers £200,000.

Turning now to operating expenses, it is seen at once that a large saving will result. The expense of the power station for coal, water and oil, may be set at £72,000 annually. For wages, the annual expenditure would be about £5,000, it being assumed that mechanical stoking is used. The expenses of the sub-stations would be dependent upon the possibility of combining them with railway stations, signal towers, or the like, but would probably average about £1,500 annually each for wages, and about £400 for oil and supplies, making a total of £72,000. Hence, exclusive of interest and repairs, the annual motive power cost would be about £150,000 in round figures.

Repairs can be fairly figured at 5 per cent. on the power station, 7 per cent. on the sub-stations, 4 per cent. on the transmission line, 4 per cent. on the conducting system, and 8 per cent. on the motors, &c., giving a grand total of £121,000 annually.

The trains can be operated by two men on each, a driver and conductor. The crews required will number, including extra men, &c., about 350, with wages at about £260 a year for each, or £71,000. This gives for the total costs of operating the trains, exclusive of interest, £342,000 annually, or, including interest at 5 per cent., £442,000.

The total annual mileage of these trains will be 9,706,000, showing an average cost of a little less than 23 cents per train mile. If the expense of manning the trains is omitted, this figure becomes 20 cents.

No estimate has been included of the depreciation and repair of the permanent way and stations. It would be impossible, even if figures were at hand giving the annual items, to differentiate the charges properly due to the steam long-distance service from those due to the electric local trains. It can be clearly seen, however, that while increased traffic might slightly increase the expense of maintaining stations, the substitution of motor cars weighing 32 tons for locomotives weighing 50 tons would decrease the track maintenance cost, even when three times as many trains are run. It is the "hammering" of the heavy reciprocating parts of the locomotives that wears out the tracks, and their life when traversed by motor-driven wheels would be greatly lengthened—how much, experience alone can decide. It is proper to add that the figures here given make no pretence to accuracy, but are to be regarded as rough first approximations, interesting only as comparisons. It is utterly impossible to calculate the traffic of the system, but an approximation of the earning power of the system may be made on the basis of the following assumptions :—

If it is assumed that each train starts from Philadelphia with its full complement of passengers, and discharges them at intermediate stations, so that it reaches its terminus practically empty, and that this process is reversed on trains running into Broad-street, it is fair to assume the total annual capacity to be about 32,000,000, which will result in a gross revenue of £640,000, at a rate of one cent per mile. This leaves a net earning capacity of about £200,000 per annum.

Conclusion.

The system here briefly presented lays no claim to special originality or merit, but is given as an illustration of the perfect ability of present-day electrical engineering to cope with the problems presented by steam railway service under peculiarly difficult conditions. It required no great gift of prophecy to foresee the electrical equipment of this and other similar suburban services in the near future. It has been intended throughout this Paper to offer simple and feasible plans, rather as suggestions than as final designs for such a system, and to attempt to show that the

* Abstract from the *Electrical World* of New York.

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electrical equipment of this railway is neither impossible nor chimerical. The alluring problem which such an installation offers to electrical engineers, the beauty of the systems which may be devised to meet the exigencies of each special case, the magnitude of the works which must be inaugurated almost immediately, and the absolute precision and certainty with which results may be predicted, conspire to render the beginning of the new era in railroading one of the most fascinating subjects with which recent progress has made us acquainted.

ELECTROLYTIC ZINC.*

The success of the electrolytic copper-refining industry naturally led electricians and chemists to turn their attention to the application of similar methods to the extraction or refining of other metals. In the case of zinc their success has been less decisive than in the case of copper. This is partly due to the much lower value of the metal itself, and partly to the absence of any great demand for pure zinc. On this account electrolytic zinc processes are only being used for exceptional purposes, and zinc is still extracted from its ordinary ores, and refined, by the usual distillation process. Electrolytic methods are being applied for extracting zinc from refractory ores, and for galvanising. In the former case the character of the deposit of zinc is of entirely secondary importance; in the latter the character of the deposit is more important than economical working. With regard to the former industry, there are three processes at work upon an industrial scale of operations, while one or two others are in the experimental stage of their existence. The more important processes are those designed for treatment of the Broken Hill ore of New South Wales. This ore contains 30 per cent. each of lead and zinc as sulphides, with 25oz. to 30oz. silver per ton of ore. The recovery of all three metals from the ore by ordinary metallurgical methods of treatment is impossible. The Ashcroft process was experimentally worked out at Grays, in Essex, and a large plant has been in operation at Newcastle, N.S.W., since March, 1897. The process is operated as follows:—The ore is crushed and roasted, and is then leached with a ferric chloride, or sulphate solution. The zinc passes into solution while the iron is precipitated as ferric hydrate, either at once or on warming. The residue in the vats, containing the lead and the silver, is smelted in the usual manner. The zinc solution, after removal of the iron, is passed through the cathode chambers of a series of depositing vats, where one-third of the zinc is obtained as metal. It is then passed through the anode chambers of the same vats, in the first third of which iron anodes, and in the remainder carbon anodes, are used. Ferrous sulphate is therefore formed in the first series of anode chambers, and is converted into ferric sulphate in the latter ones. The effluent from the electrolytic vats is then ready for further use in the leaching vats, and the process is consequently a cyclic one. The Ashcroft patents have been purchased by the Sulphide Corporation, of London, which has a capital of £1,100,000. The latest reports from New South Wales are to the effect that the first four months' run of the new plant has produced 150 tons of zinc, but the economic results are not so favourable as anticipated; and if the second run, now in progress, does not yield more satisfactory results, the directors have decided that the electrolytic plant must be stopped. The diaphragms and the ferric hydrate precipitate are the weak points of this process, and it is probably in connection with these that trouble has occurred.

The Siemens and Halske process resembles the Ashcroft process in general principles, but a solution of sulphuric acid, or an acid zinc sulphate solution is used for leaching the crushed and roasted ore. The resultant zinc sulphate solution is electrolysed in vats divided into anode and cathode compartments by imperfect wooden partitions, which act as substitutes for diaphragms. Lead anodes and zinc cathodes are used. When the free acid exceeds 10 per cent., the solution is returned to the leaching vats. This process was experimentally worked out in Berlin, where a small plant has been erected, and it is now in course of trial on a much larger scale at Illawarra, N.S.W., by the Smelting Company of Australia—nominal capital, £500,000. No details of the results obtained there have yet been made public. The process is much simpler than the Ashcroft process. Its cheif weakness lies in the acidity of the electrolyte. This will cause an increasing back electromotive force in the depositing vats, and the average energy efficiency of the process will consequently be low.

A process which has apparently solved the economic difficulties of electrolytic zinc extraction is one patented by Dieffenbach, and now at work at Duisburg, in Germany. The ore used is a zinciferous iron pyrites from the Siegen districts of Westphalia. This is first submitted to a chlorinating roasting, and is then leached with a zinc chloride solution, or with the effluent from the depositing vats. The solution of zinc obtained in this way is electrolysed in specially designed vats. This process has now been in operation for a considerable period at Duisburg, and has produced 90 tons of zinc per month, while the economic results have been sufficiently good to justify the extension of the plant.

The other processes to which allusion was made are at work in this country and in Germany, but no details of the plant or of the methods of work have been published.

With regard to electro-galvanising, the process patented by Cowper-Coles is being worked by four English firms under payment of a royalty charge to the syndicate owning the patents. In Germany there are two patented processes being worked; the one, Alexander's, at Rothenfelde, the other, Richter's, at Witkowitz, in Bohemia. Alexander's process differs from the other two in the nature of the deposit, which is an alloy of zinc with aluminium or magnesium, in place of pure zinc. Apart from this difference, all three processes resemble one another. The article to be covered with a protective coating is used as a cathode in a bath of the sulphate salt of zinc. The chief difficulty in all the processes arises from the tendency of zinc to separate in spongy form; and the maintenance of the conditions necessary for the production of a bright and smooth metallic coating over the whole of the surface of the article is found, in practice, to require very careful attention to the current-density and to the composition acidity, and concentration of the electrolyte. Very careful preparation of the article for the galvanising bath is also necessary in all these electrolytic processes, and the cost of this forms a considerable portion of the total costs of the processes. Less zinc is used per square foot of surface area covered than with the older dipping process, but with spelter at £18 per ton the gain under this head cannot amount to much, and it would seem probable that the electro-galvanising process will only find employment where specially smooth surfaces are required. It may be remarked that when the conditions requisite for obtaining a good coating have been fulfilled, the adhesion between them and the object is perfectly satisfactory, and there is no tendency to peel away even under the severest strains.

In conclusion, it may be interesting to have the cost of the electrical energy necessary for the deposition of one ton of zinc from a zinc sulphate solution. The theoretical energy required is 2,619 E.H.P. hours; the cost of this at $\frac{1}{10}$d.* per electrical horse-power hour would be £1. 1s. 10d. An energy efficiency of 33 per cent. is, however, the average efficiency obtained in the electrolytic copper-refining industry, and it is unlikely that this will be exceeded in any zinc depositing process. Multiplying the above estimate by $\frac{100}{33}$, we have, therefore, a total of £3. 5s. 6d. as the probable minimum expenditure per ton of zinc for electrical energy alone, even when generated from water power When to this are added the working costs of the process, the interest and depreciation charges, and the royalty charges for the process used, it is evident that there cannot remain a very wide margin for profit; and support is given to the assertion made at the commencement of this article that electrolytic zinc processes can only succeed when used for special purposes.

* From *Engineering*.

* This is the mean charge at Niagara and in Switzerland.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Jan. 14, 1898*

The Elevated Railways to be Equipped Electrically.—Mr. George Gould, President of the Manhattan Elevated Railway Company, in this city, made the formal announcement last Tuesday that the Company had decided to introduce electricity on its system, and that it would now proceed to effect the general installation with as little delay as possible. It will require the approval of the State Railroad Commission before these contemplated improvements can be carried out, but there is no doubt whatever that this will be forthcoming. This enterprise is looked upon as a practical death-blow to the proposed underground railway. The installation of electric power on the elevated railway system is a work of extraordinary magnitude. There is no road in the world which is called upon to do such an amount of work, to carry so many passengers, to run so many cars and trains, and to make such a train and car mileage as the elevated system of this city. In a single year the cars on the four elevated roads and the suburban elevated line north of the city ran 44,000,000 miles,

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In every day of 24 hours there are 3,500 trains dispatched upon these lines, and 330 locomotives are kept in service for the work. Each of these locomotives is capable of exerting from 200 to 250 H.P., and a fair estimate of the total average electric power needed to operate the roads is about 75,000 H.P. Whether the entire amount will be produced at one station or at a number of stations has not yet been determined. It will depend upon the comparison of the cost of the copper conductors required to distribute the currents to be employed, and the cost of separate power plants. At the present time the road burns in its locomotives 200,000 tons of coal a year, and it is calculated that there will be a saving of one-half of this fuel at least by the more economical production of power in stationary boilers and engines and transmitting the same by electric means. Although it is not yet definitely settled what system of distribution will be adopted, there is good reason to believe that the third-rail method will be selected. All of the great electric companies are anxious to secure some of the work, but at time of writing the giving out of contracts has not been announced. It has been calculated that it would take about two years to complete the contemplated improvements which will have to be carried out, without interfering with the traffic upon the lines. In view of the decision of the Elevated Railway Company to extend its system and adopt the electric method of propulsion, the Metropolitan Street Railway Company, which announced its intention to bid upon the construction and operation of the proposed underground tunnel, has decided not to bid upon the work. President Vreeland, of the Metropolitan Company, has officially informed the Rapid Transit Commission of this decision, stating that the contemplated improvements on the elevated system will probably meet the popular demand for improved rapid transit service, and that the directors do not care to stand in the way of carrying out the proposed improvements by bidding for the tunnel contract.

Conduit Across the Harlem River.—An interesting piece of electrical subway and conduit work was executed in this city recently. A wooden shell about 2ft. in diameter, built of Georgia pine, and wound with wrought iron hoops at intervals of 3ft., was laid under the Harlem River, which separates Manhattan Island from the mainland. The wooden construction contains eight conduits, in which telephone and telegraph cables may be drawn. It was constructed in three sections, which were floated into place, bound together, and then sunk into a trench which had been dredged out across the bottom of the river to a depth of about 8ft. The tubes through which the cables may be drawn are lined with 4in. iron piping, covered with asphaltum. Heretofore the cables have been simply laid on the bottom of the river, where they were exposed to damage by dredgers, anchors, and other sources of disturbance; but the new conduit is so solid and so deeply buried that when sand and mud have drifted over it it will be practically secure and free from any disturbance of a violent nature. The total length of the conduit is 557ft.

Water-Power in Mexico.—There are a number of large waterfalls in Mexico which will, in the near future, be utilised to furnish power for industries of various kinds. The falls of Juanacatlan, in the State of Jalisco, are capable of furnishing power for a great number of manufacturing concerns, and a syndicate of American capitalists is now considering the matter of establishing a large power plant at these falls similar to that now in operation at Niagara Falls, only on a smaller scale. The falls of Juanacatlan, which are called the "Niagara of Mexico," are on the River Lerma, and make a leap of 600ft. They are 200ft. wide. In addition to furnishing the power for the electric light plant for the city of Guadalajara, these falls will be used as a source of power for a large cotton mill, which is now being removed to that point from the city of Mexico. In the State of Puebla the entire river makes a leap of 997ft., and there are several falls on rivers in the State of San Luis Potosi of from 300ft. to 500ft.

Oil Fuel for Locomotives.—The Baltimore and Ohio Railroad Company are experimenting with oil fuel in their steam locomotives, and have already effected a saving, especially in the cost of kindling fires. It will be remembered that it is this American railway company which is using large electric locomotives on a section of its main line.

The Development of Niagara Power in Canada.—A motion has been introduced in the Ontario Legislature to the effect that, in the opinion of the House, the water power of Niagara Falls and Rapids, being one of the great natural resources of the province, should be developed and utilised for the benefit of the Canadian people, and to this end the Government should favour all *bonâ fide* enterprises proposing the development of this power.

CORRESPONDENCE.

THE ATLANTIC CABLE, 1857—1858.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Considerable latitude is always accorded popular lecturers in the way of cracking jokes or raising a laugh, in order that what they say may be pleasing as well as instructive to their audiences; but it is not generally allowed them that in doing this they should hold lightly the good names of others. Shakespeare gives us the net result of this sort of thing.

Lecturing at the Royal Institution lately, Prof. Lodge informed his hearers that the first Atlantic cable was "killed by the ignorance of the electricians of those times." To say the least of it, this is hardly the fact. The Doctor also said that the cable "expired with a short message of congratulation at its birth"; and this, too, was not quite correct. Surely it is well known that on the delivery of it from the ship the cable, if not actually still-born, was moribund; and it was positively no occasion for any sort of congratulation! On the other hand, I know for a fact that it made some men's hearts sink within them, considering what was at stake, and there existed real cause for sorrow instead. Lord Kelvin has described the state of the cable at that time as follows: "I have no doubt it was owing to defective insulation, becoming worse and worse from the landing of the cable in the forenoon of Thursday, August 5th till Monday midnight, that we never received anything that we could be quite certain was a signal current." What was then to be done—give it a decent burial, and go into mourning? No! Resuscitation or resurrection was the word; and the electricians—among whom, too, be it understood, Lord Kelvin himself was to be found—resorted to the application of "an immensely powerful current, with the result that the cable must have literally (and positively) turned blue." So far from their killing the cable by this—fortunately for all concerned—it was the means of galvanising it into life, albeit only a miserable existence, not amounting to a hundredth part of the animation it ought to have possessed. At last going from bad to worse—its life ebbing from every pore and wound—on October 20th (the date of "the last effort," according to Lord Kelvin), it ceased to respond to any current, however "immense," any more than the proverbial "dead horse" is said to be affected by a kick.

Nearly all Dr. Lodge's references to the cable at the lecture I have referred to admit of, at least, qualification. It is certain that the failure of the original Atlantic enterprise is only to be attributed to the pardonable *inexperience* of all connected with it—manufacturers included—as nothing of its class, even approaching it in magnitude or importance, had up to that time ever been attempted. The cable, therefore, was *not* "killed" through the *ignorance* of anyone engaged on it, as it is equally certain that the cable was not saved, or its ultimate demise even arrested, by any useful suggestion of anyone connected or not connected with it at the time.

I only take up my pen now in the hope of removing any unfortunate impression that may possibly be created with respect to some dead-and-gone electricians, around whom up to the present date there has existed the halo of a certain measure of celebrity, and with whom and their qualifications, 40 years ago, I personally had some acquaintance.—Yours, &c.,

J. W. WILKINS.

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LEGAL INTELLIGENCE.

Improved Electric Glow Lamp Co., Ltd. v. The Edison and Swan United Electric Light Co., Ltd.

In the Q. B. Division yesterday (Thursday), this case was heard by Mr. Justice Mathew. It was an action brought by the plaintiff Company to recover damages from the defendant Company for alleged breach of contract. The case for the plaintiffs was that by an agreement in writing, contained in a letter from plaintiffs to defendents, of November 3, 1896, and in a letter from the defendants to the plaintiffs of November 9, 1896, the defendants agreed to manufacture for plaintiffs 100,000 electric incandescent lamps of their own make, one-third to be round and two-thirds conical shaped lamps. The defendants agreed to deliver a minimum weekly quantity of 2,000 lamps, delivery to commence within five weeks from the date of the acceptance of the contract. The plaintiffs alleged that defendants had failed to deliver the minimum quantity, by reason of which the plaintiffs were unable to purchase the lamps elsewhere, had been unable to carry on their business, had lost the large profits they would have made out of the sale of the lamps, and had been greatly injured in their business. The defendants, in their defence, did not admit the contract, and alternatively pleaded that if they did do so they were prevented by the acts of the plaintiffs from delivering the lamps on the agreed dates. They had otherwise delivered all the lamps contracted for, and they denied that the plaintiffs had suffered any damage.

Mr. Bousfield, Q.C., M.P., Mr. Wallace, Q.C., and Mr. A. J. Walter were counsel for the plaintiffs; Mr. Fletcher Moulton, Q.C., and Mr. J. C. Graham represented the defendants.

In the course of the case the defendants admitted that there had been delay in delivery, and after consultation between the parties a verdict was by agreement entered for the plaintiffs for £750 and costs.

National Company for the Distribution of Electricity by Secondary Generators (Limited) v. Gibbs.

Mr. Justice Stirling on Saturday heard a motion for judgment in this action, which was for judgment in default of defence.—Mr. Rawdon, for the defendant, asked for leave to defend, otherwise injustice would be done to his client, who was resident in France.—Mr. Gore Brown, for the motion, said the other side had already had plenty of time. This was a claim made by the Company against two gentlemen who assigned certain patents, relating to electrical distribution, for £220,000, with a warranty that the patents were valid. The price was to be £200,000 in shares and £20,000 in cash, and the vendors undertook to establish their title to the patents and transfer them to the Company; but the patents had not been transferred, and had been found in great part to be invalid and void. The defendant was administratrix of one of the patentees, and a claim had been made for the assignment and damages for breach of the agreement. The writ was issued on December 16, 1896, leave to serve was given on February 22, 1897, and she entered an appearance under protest on March 3rd. There had been thus 10 months' delay. There had been litigation going on in France in connection with the same matter, and in 1894 the Company obtained judgment entirely in their own favour, a decision which was affirmed on appeal, and there was really no ground for disputing the agreement.—After some further argument, his Lordship ordered the motion to stand over until the first day on which he took non-witness actions.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

SPECIAL NOTICE.—The 1897 (fifteenth annual) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK can still be had. Price 7s. 6d.; post free, 8s. 3d; abroad, 9s. About 1,300 pages. 1898 Edition in preparation, and will be published at the end of this month.

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System o Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J WADE. *In the Press.*

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 will be ready IN A FEW DAYS. Many new features of interest to the profession will be introduced, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, will be brought up to date and amplified where necessary. Subscription and advertisement orders, new names and addresses, and alterations to existing entries must be sent in *by Monday, 31st January.*

Tenders Invited.—The County Borough of Brighton invite tenders for the completion of the electric light wiring, &c., of the Town Hall. Tenders to Mr. F. J. Tillstone, town clerk, Town Hall, Brighton, before 10 a.m. on Monday, 31st inst.

——— The Redditch Urban Council invite tenders for the following work in connection with their proposed electricity supply station:—(1) Erection of central-station buildings, &c.; (2) gas-producing plant for 230 H.P.; (3) double-cylinder gas engines, total power 350 H.P.; (4) alternators, total output 230 kilowatts; (5) concentric lead-sheathed armoured cables; (6) ten 20-kilowatt alternating-current transformers; (7) switchboard and instruments; (8) counter-shaft, pulleys, ropes and belts. Specifications may be obtained from the consulting engineer (Mr. J. A. McMullen, M.I.E.E.), Hornchurch, Essex; and tenders must be sent to the clerks to the Council (Messrs. Browning and Hobson) by Feb. 4. An advertisement elsewhere contains further particulars.

——— The Corporation of St. Helens invite tenders for plant, &c., in connection with the supply of electricity for traction purposes. The requirements include engines, condensers, dynamos, switchboards, battery, overhead conductors, poles, and other appurtenances. Specifications and drawings can be seen at Dr. J. Hopkinson's offices, 34, Victoria-street, London, S.W., at 29, Princess-street, Manchester, and at the Town Hall, St. Helens. Tenders have to be in to Mr. W. J. Jeeves, town clerk, Town Hall, St. Helens, by Feb. 21. Some further particulars will be found in our advertisement columns.

——— The Edinburgh Corporation invite tenders for the wiring of the Police Station at Abbeyhill. Some further particulars are given in our advertisement columns. Specifications, &c., may be obtained at the offices of the Resident Electrical Engineer, 5, Dewar-place, and tenders must be sent in to the town clerk (Mr. Thomas Hunter, W.S.), City-chambers, Edinburgh, by Feb. 5.

——— *Extension of Time.*—The time for sending in tenders for the supply of electric lighting plant, &c., for the Stockport Corporation has been extended to *noon of Feb. 3.* Plans and specifications may be seen at the offices of the consulting engineer (Mr. James N. Shoolbred, C.E.), 47, Victoria-street, Westminster, S.W., or at the Millgate Gas Works, Stockport. Tenders must be addressed to the Chairman of the Electric Lighting Committee, Gas Offices, Millgate. Mr. Walter Hyde is town clerk.

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Tenders Invited.—*Extension of Time.*—The Marylebone Guardians have extended the time for sending in tenders for the wiring of the new administrative buildings of their workhouse to the 31st inst. Tenders must be sent to the clerk, Northumberland-street, W.

——— The Country Borough of Brighton invite tenders for the supply and delivery of dynamos, motors, switchboards, and the necessary wiring at the municipal school of science and technology. Tenders to Mr. F. J. Tillstone, town clerk, Town Hall, Brighton, by 10 o'clock of Monday, 31st inst.

——— The Corporation of Rochdale require tenders for steam dynamos, balancer and boosters, &c. Tenders to Mr. James Leach, Town Clerk, Town Hall, Rochdale, by Saturday, Feb. 19.

——— The Wimbledon Urban District Council invite tenders for the supply and erection of (*a*) water tube boilers, pumps, &c.; (*b*) condensing plant, steam pipes, &c.; (*c*) overhead crane; (*d*) high-speed steam engines and alternators; (*e*) switchboard; (*f*) underground mains, conduits, &c. Tenders to Mr. W. H. Whitfield, Council's offices, Wimbledon, by 5 p.m. on Feb. 2.

——— The Asylums Committee of the London County Council invite tenders for the supply of electric lighting sundries to the Claybury Asylum. Forms of tender may be obtained at the offices of the Committee, 21, Whitehall-place, S.W. Tenders by February 16.

——— The Municipal Authorities of Valderas invite tenders for the concession for the electric lighting of the town for 17 years. Tenders to El Secretario del Ayuntamiento de Valderas (Leon), Spain, by Feb. 11.

——— The Municipal Council of Sophia, Bulgaria, are again inviting tenders for the concession for electric lighting and tramway works. The Council invited tenders in July last, but as no adjudication was made, fresh proposals are now required. Tenders to and particulars (in French and Bulgarian) from the Mairie, Sophia, by March 5 (17).

Tenders Accepted.—The following tenders have been received for the alterations required to the fire alarm system of the South-Eastern Hospital:—

	Alterations.	Maintenance (per ann.)
Private Wire and Telephone Installation Company (*accepted*)	£122 10 0	£10 10 0
G. Stegmann	121 10 0	6 10 0
Cox Walkers	139 13 6	10 0 0
J. and F. Mahon and Co.	144 12 8	30 0 0
Julius Sax and Co. (Limited)	144 18 0	10 0 0
Electrical Erection Company	165 0 0	3 10 0
W. J. Fryer and Co. (Limited)	184 0 0	8 0 0
New Fowler-Lancaster (Limited)	194 13 6	4 5 0
Stuart and Moore	261 19 0	13 0 0
Jackson and Coleby	387 10 0	30 0 0

Tenders Received.—The following tenders have been received for the electric lighting of the School Board offices and Dering-place Schools, Croydon:—

	Offices.	Schools.
*Christie	£54 17 0	£89 17 0
Ellis and Co.	80 0 0	180 0 0
Waterhouse	76 19 0	133 14 0
Patey	63 1 0	158 16 9
Wenham and Co.	55 0 0	125 0 0
Hammond and Co.	55 0 0	120 0 0
Laing, Wharton and Down	59 17 0	92 9 3
Peto and Radford, Ltd.	56 0 0	80 0 0
Bishop	49 5 0	95 10 0

* Recommended for acceptance, subject to approval of Education Department.

Electric Railway Contracts.—It is stated that the General Electric Company of America has received an order for 32 new electric locomotives for the Central London Railway.

Appointments Vacant.—The Corporation of St. Helens invite applications for the office of resident electrical engineer for their lighting and traction plant. Commencing salary £200 per annum. Applications to the town clerk (Mr. W. J. Jeeves), Town Hall, St. Helens, by Tuesday, Feb. 15. An advertisement on another page gives some further particulars.

——— The Corporation of the borough of Southend invite applications for the position of electrical engineer. Commencing salary £200, rising by annual increments of £25 to £300. Some further particulars are given in our advertisement columns, and applications must be sent in by noon on Wednesday, Feb. 2, to the town clerk (Mr. William Gregson), Southend-on-Sea.

——— The Corporation of Barrow-in-Furness invite applications for the post of resident electrical engineer. Commencing salary £200 per annum. An advertisement elsewhere contains further particulars of the Council's requirements, and applications, addressed to the Chairman of the Electric Lighting Committee, must be delivered at the Town Hall, Barrow-in-Furness, on or before Tuesday, Feb. 8. Mr. C. F. Preston is town clerk.

Vacancy.—There is a vacancy for an improver in the electricity department of the Dundee Gas Commissioners. Salary 20*s.* per week. Applications to the city electrical engineer (Mr. W. H. Tittensor) by Monday, Feb. 7. See advertisement.

Apparatus for Sale.—Particulars are given in an advertisement of a quantity of apparatus for sale by Messrs. W. Pope and Sons, engineers, of Slough. The apparatus is Messrs. Elliott Bros'. make.

Business Notices.—Messrs. F. Hutchins and Co., experimental engineers, of 13, Victoria-street, Westminster, S.W., have taken new works-premises at Gray-street, Blackfriars, S.E.

——— Arrangements have been concluded by which the Western Electric Company, of 79, Coleman-street, London, E.C., has taken over the business and works of the Fowler-Waring Cables Company (Limited), as from Jan 1 last. All debts to or by the Fowler-Waring Company will be dealt with at the offices, 110, Fenchurch-street, London, E.C. By this acquisition the Western Electric Company adds to its already extensive business the manufeature of telephone cables and wires.

——— Mr. J. W. Westmoreland, F.I.C., has opened a laboratory and assay office at 3, Love-lane, Eastcheap, E.C.

Liquidations.—A meeting of the Westralian Electric Lighting and Supply Company (Limited) will be held at 54, Old Broad-street, London, E.C., on Mar. 2, to receive an account of the winding-up.

——— A meeting of the creditors and shareholders in the winding-up of the Ward Electrical Car Company (Limited), was held at the London Bankruptcy Court on Wednesday. Mr. A. S. Cully, assistant official receiver, reviewed the statement of affairs, and stated that the facts connected with the Company was somewhat peculiar. It had been registered with a capital of £300,000, and was apparently promoted by Mr. Ward and the late Col. M'Murdo to acquire Ward's inventions relating to electrical vehicles and to carry on the business of electrical engineers. The whole of the capital had been paid to Mr. Radcliffe Ward as purchase money in consideration of the transfer of his interests in his inventions, and he became managing director at a salary of £1,000 per annum—to be paid out of profits! In order to provide working capital M'Murdo advanced £10,000, £1,000 of which was to go to Ward and £9,000 to the Company. Col. M'Murdo died in 1889, after paying £4,362 to the account. Other financial arrangements were subsequently entered into by Ward with M'Murdo's executors, and in April, 1896, the Directors of the Company referred to disposed of the whole undertaking to a new Company for £30,000 in shares and £5,000 in cash. This arrangement, however, was not carried out, but Mr. W. Marshall now appeared upon the scene, and with Ward floated a Company called the London Electrical Omnibus Company (Limited), which was to acquire other inventions belonging to Mr. Ward for £100,000, of which £20,000 was to be in cash; the whole amount being divided between the two Directors. Litigation might ensue regarding this transaction, as the inventions sold to the London Electrical Omnibus Company were stated to be improvements upon the original inventions, and the question would probably arise as to the title of the new Company to the inventions. Marshall's estate was now in the hands of a trustee. The original patents appeared to have lapsed, and the original Company now apparently had no assets except its interest in the shares of the London Electrical Omnibus Company (Limited). Unsecured liabilities amounted to £863, fully secured £2,435, assets £1. 9*s.* 1*d.*! Mr. Ward was present at the meeting and expressed a desire to present to the shareholders of the Ward Electrical Car Company shares in the London Electrical Omnibus Company, which he contended was now in a position to make considerable profits by running electrical omnibuses. This offer and the whole business is left in the hands of the Official Receiver as liquidator.

Bankruptcies.—By the consent of all parties concerned the application of Messrs. Paterson and Cooper for their discharge in bankruptcy, which was to have been heard last week, was adjourned for a further period of two months. The assets are in course of realisation, and it is desired to await the result before proceeding with the application.

——— The discharge in bankruptcy of Wm. A. Fraser, electrical engineer, late of 18, Cecil-court, London, W.C., and Guildford, has been suspended for two years.

"Stearn" Lamps.—The Zurich Incandescence Lamp Company, of 47, Victoria-street, Westminster, London, S.W., have just issued a useful list showing various types of Stearn lamps of all voltages from 50 to 230, and all candle-powers from 1½ to 100. Accompanying the catalogue is a circular giving a list of electric supply stations where Stearn lamps are supplied. The catalogue can be obtained by the trade free on application.

Conduit Pipes.—Messrs. Drake and Gorham have recently patented a system of iron conduit pipes, which is claimed to effect a considerable saving in labour over the screwing method.

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Intercommunication Telephones.—Messrs. J. D. F. Andrews and Co. claim to have introduced an improvement of importance into this application of the telephone. The feature of the improvement is shown in the illustration which we here reproduce. By pressing a push button the station to be spoken to is notified by the call bell. When the conversation is completed, the instrument is reinstated in its normal condition by replacing the receiver on the hook. If, after completion of the first conversation, it is desired to communicate with another station, this is effected by simply pressing another push, this action putting the first push out of connection. Communication can be effected with more than one station at a time by simultaneously pressing the pushes, the normal condition being again automatically attained by replacing the receiver. The pushes are permanently connected to the various lines by a flat spring, and, as will be seen, are placed in a row opposite an oscillating bar, against which any one or more of these may be pressed. The push springs are so contrived that when pressed they hook on to the bar, and in so doing deflect it, and

release any spring that has been pressed. The oscillating bar is connected to the home receiver and microphone. Each push can be pressed beyond the oscillating bar on to another bar connected to the battery direct for the purpose of ringing the call bell. When the receiver is replaced after speaking, the hook upon which it is hung catches on the oscillating bar and moves it so as to release any line springs that may be connected.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 19 to Jan. 25, with the ports of destination :—

Argentina—Buenos Ayres, £209 ; Rosario, £114. *Australasia*—Adelaide, £178 ; Hobart, £15 ; Melbourne, £72 ; Port Darwin, £12 ; Sydney, £1,017. *Belgium*—Antwerp, £154 ; Ostend, £10. *Burma*—Rangoon, £23. *Canary Islands*—Orotava, £10. *Ceylon*—Colombo, £9. *China*—Shanghai, £163. *Cochin China*—Saigon, £11. Colombia—Santos, £120. *Denmark*—Copenhagen, £24. *Egypt*—Alexandria, £23. *France*—Boulogne, £37. *Holland*—Amsterdam, £60 ; Rotterdam, £55 (telegraph material). *India*—Bombay, £53 (including £47 telegraph material) ; Calcutta, £44. *Italy*—Genoa, £297. *Malta*, £48. *Siam*—Bangkok, £24. *South Africa*—Cape Town, £241 ; Durban, £58 ; East London, £10 ; Mombassa, £27 ; Port Elizabeth, £421. *Spain*—Cadiz, £112 ; Vigo, £10,920 (telegraph cable). *Straits Settlements*—Singapore, £32. *Sweden*—Gothenburg, £630 ; Stockholm, £101 (telegraph material). Total, £15,321, against £30,815 in the corresponding week last year (Jan. 20 to Jan. 26).

Alloa.—The convener of the Gas Commission announced at the last meeting of the Burgh Commissioners that for some time past the question of the introduction of the electric light had been under consideration. The scheme was not yet complete ; but estimates had been received, and he had no doubt that in due course a system of electric supply would be established. A gas-driven plant would be put down, and the total estimated capital expenditure would be about £3,000. The question will be discussed at the next meeting of the Commission.

Barnet (Herts).—For many years this district has been the hunting ground of the electrical engineer. Electric lighting enterprise may be said to have done its best and worst in this district. Once again the subject is on the *tapis*, and a firm of electrical engineers has been found bold enough to seek the position of consultants to the District Council in connection with its Provisional Order obtained in the early days of electric lighting activity. At a recent meeting of the Council the clerk notified that they were supposed to apply to the Board of Trade annually for the renewal of their Order, and they had been given to understand that so long as no outside competition was threatened the Order would remain in force notwithstanding its expiry by the effluxion of time. The Council have taken advantage of this concession, and Barnet bids fair to remain in the partial obscurity of gas until some enterprising firm threatens to invade the territory by applying for powers to supply electric current. Certainly there seems little likelihood of the Council themselves taking any steps to improve the illumination of their badly-lighted district.

Bilston.—The District Council have decided to support the application of the Midland Electric Corporation for Power Distribution for a Provisional Order for the South Staffordshire district. This step has been unanimously decided upon, and it is probable that as soon as the Company are in a position to supply current the Council will take a supply for street lighting.

Bromley (Kent).—The Board of Trade have intimated their approval of the proposed transfer of the Provisional Order to the Bromley (Kent) Electric Light and Power Company.

Burnley.—Mr. W. A. Ducat held a Local Government Board inquiry, at Burnley, on Monday, into the application of the Town Council to borrow £25,000 for electric lighting purposes. The Town Clerk (Mr. W. T. Fullalove), who appeared in support of the application, said that the electricity works were started four years ago, and the amounts already sanctioned were as follows :—1892, £21,250 ; 1895, £5,500 ; 1897, £3,006 ; making a total of £29,756. With the additional borrowing powers the Corporation would be enabled to extend the plant and the mains into the more distant parts of the town. There was no opposition.

Canterbury.—At the meeting of the Town Council last week, tenders for the supply of electric lighting plant were accepted. These tenders were recommended for acceptance by the Electric Lighting Committee, and appeared in our issue of the 14th inst. The consulting engineer (Mr. Robert Hammond) was in attendance.

Chester.—With a view to improving the lighting arrangements at the Cathedral the Dean and Chapter are making experiments with the electric light. The nave has been selected for the experiment, which has, it is stated, given entire satisfaction. It is probable that a complete installation will shortly be provided.

Clubs.—Those of our readers interested in clubs, political and otherwise, can obtain from Messrs. Spottiswoode and Co., price 1s. or 2s., a list of 2,250 clubs "frequented by the English in all parts of the world."

Dorking.—Some time ago Edmundson's Electricity Corporation submitted terms for establishing electricity supply works in this district. Under the proposed arrangement the Council had the right to purchase the undertaking any time after 10 years upon paying the amount of capital expenditure, plus 15 per cent. for street lighting. The Company offered to provide and supply 10 arc lamps at £21 each, and 200 incandescents at an inclusive cost of £572. 10s. The charge for current to private consumers would not exceed 8d. per unit. Mr. Warden-Stevens was called in to report upon this offer, and also as to the advisability of the Council itself establishing electricity supply. This report, which has just been submitted, is strongly in favour of a municipal scheme. Mr. Warden-Stevens outlines a project which would entail a total outlay of about £15,500. Figures are given of the annual cost of maintenance, and anticipated receipts, from which it is estimated that the actual net profit will be about £83 per annum. A meeting of the District Council was held last week to consider this report, and the matter will again come up for consideration at the next meeting.

Douglas (Isle of Man).—The question of improving the lighting of the town was again considered at Monday's meeting of the Town Council, when the tenders of the Isle of Man Tramways and Electric Power Company and the Gas Company for the lighting of the Promenade were further discussed. Eventually it was decided to accept the Gas Company's tender for one, two, or three years ; but Prof. J. A. Fleming has been engaged to report on electric lighting, more particularly as to the advisability of erecting municipal supply works.

Edinburgh.—On the recommendation of the Cleaning and Lighting Committee, considerable extensions of the system of electric street lighting have been decided upon, requiring in all 91 lamps. The cost for current, &c., has been fixed at £15 per annum.

Exeter.—During the past year the equivalent number of 8-c.p lamps connected rose from 7,400 to 10,000. The report of general progress is satisfactory.

Exhibition.—The Dudley Trades and Industrial Exhibition was opened on Monday. Amongst the exhibitors of electrical apparatus were Messrs. E. C. Theedam, Whittaker Bros. and Webster and Michelson. The electric lighting arrangements were entrusted to the latter firm.

Glasgow.—The City electrical engineer (Mr. W. A. Chamen) will enter upon his duties on the 28th inst. At the meeting of the City Council last week the report of the Tramways Committee recommended the acceptance of a tender for the supply of steel rails, with the necessary fish plates, &c., at £6. 6s. per ton. The report was, however, withdrawn, and the matter was recommitted.

The Lord Provost explained that there was a good deal of feeling about the proposal to send the contract out of the country. The tender of the foreign firm had been withdrawn, and the position was that they had to fall back upon another tender from a Leeds firm. There is, we understand, £1,700 difference between the German and English tenders. By-the-way, the latter was the only British tender received.

A fresh report on the electric lighting of the Springburn route has been issued, and deals with the subject from the point of view of the Tramways, Electricity and Lighting and Watching Committees. The estimated cost of laying the necessary mains, including provision for private lighting, is put at £12,566. The cost of supplying electric current to 104 arcs along the route would be £187. 2s. per annum.

At the request of the stallholders at the dead meat and fish market, the Corporation have decided to supply electric current for lighting the market.

Guernsey.—At the meeting of the Court of Chief Pleas last week the project for the concession for the electric lighting of the town was considered and approved.

Hampstead (London).—The Vestry have increased the salary of the chief electrical engineer (Mr. G. H. Cottam) from £400 to £450 per annum, and that of the chief assistant (Mr. Egerton Sayer) from £200 to £250. Various additions to the salaries of other members of the staff have also been made.

Hornsey (London).—Notice of opposition to the District Council's application for a Provisional Order has been lodged by the Hornsey Gas and Great Northern Railway Companies.

Horsham.—As the result of a discussion on the advisability of establishing electricity supply in the district it has been decided to obtain expert opinion on the question at a cost not exceeding £20.

Hull.—At the meeting of the Electric Lighting Committee on Wednesday the income of the Committee during the year was estimated at £11,250, and the expenditure at £970 less.

Islington (London).—The Electric Lighting Committee reported at the last meeting of the Vestry that in consequence of the heavy demand for electric current to the Upper-street and its vicinity it was found necessary to supplement the present mains in that district with additional feeders. It appeared from the report of the electrical engineer (Mr. Albert Gay) that when the cables are laid from the works along Holloway-road, to supply the Highbury Newpark district, and the Canonbury and Essex-road districts, the capacity of the conduits in Holloway-road from Eden-grove to Highbury station will be exhausted. It has been decided to open up a fresh route from the works through Wellington-road to St. James's-road and thence along one side of Liverpool-road to Upper-street, which will permit the whole of this district, including Upper-street, to be supplied from two sets of mains. The Committee stated that as the demand for current was increasing at a rapid rate, it was essential that the extension work should be carried out before the ensuing winter. The Vestry were further recommended to extend the arc lighting system along Liverpool-road. The estimated cost, including the provision of 40 arc lamps, with columns, cables, &c. and labour was £2,500, while the estimate for the necessary cast-iron conduits, surface boxes, taking up and relaying footway and all accessories, including cable, labour, &c., for the purpose of improving the distribution in Upper-street, was £3,164. The whole of the recommendations have been adopted.

Kingston-on-Thames.—The electric light works are to be insured with the Fine Art Insurance Company for £10,000, at 4s. 9d. per cent. Councillor Collings, Chairman of the Electric Lighting Committee, made a statement at the last meeting of the Town Council as to the financial position of the electricity department. The receipts for the past year amounted to about £3,900, against works costs £3,061, leaving a balance of £835. 10s. 9d. He thought this was a very good result, as if they had been an ordinary trading company they would have been able to pay 3¼ per cent. on the capital outlay. After paying interest, and allowing for sinking fund, there would, however, be a net deficiency of about £19.

Limavady.—On the 19th inst. Major P. Cardew, R.E., visited the electric supply station at Limavady, Co. Derry, Ireland, and inspected the electric supply undertaking in the town. The power station is entirely driven by water from the River Roe, and is equipped with five turbines of an aggregate of about 500 H.P. on a 35ft. fall. The two principal machines are each 60-kilowatt Siemens single-phase alternators. There are also several continuous-current machines used for driving motors. A 120-kilowatt Siemens two-phase generator for transmission of power is about to be erected. We understand that with the exception of a few minor recommendations Major Cardew passed the whole plant as satisfactory. The station has been working since June 1 last.

Limelighting.—Regulations have just been issued by the London County Council as to the use of limelight on licenced premises. The Council point out that the growth in the number of public entertainments at which limelight is utilised shows a considerable increase, and recommends in all cases where possible that the electric light shall be substituted. We recommend this suggestion to firms of photographers who nightly give their flash-light demonstrations at public dinners. The present method of taking flash-light photographs is open to considerable improvement from every point of view, including that of the danger of the present arrangements.

London County Council.—At the Tuesday meeting Mr. Beachcroft asked whether it was a fact that the Council has given its consent to an agreement with the Telephone Company for the laying of its wires underground. Was it not a fact that hundreds of people who wished to be connected with the Company's service were kept waiting for the results of the Committee's negotiations as to a reduction in the telephone rates? Mr. Cornwall inquired if the Chairman of the Committee was aware that the Telephone Company had increased its charge to subscribers in the way of now charging 3d. for the use of the call offices. Earl Russell said he had no official knowledge of the latter circumstance, but, subject to the Council's consent, an agreement had been entered into with the Company to put their lines underground.

The Highway Committee presented a report on the lighting of the Thames Embankment and the Westminster and Waterloo bridges, pointing out that in May last they submitted a proposal for this work, and the Council passed a resolution approving of the estimate for £22,000. The Committee were then instructed to report further to the Council on the details of the installation, and these details were presented in July, when authority was asked for the Committee to invite tenders for the erection of a generating station and the supply and erection of the necessary machinery, mains, lamps, standards and other plant. At that time the Bridges Committee reported that permission had been asked by the Charing Cross and Strand Corporation to lay its mains across Waterloo Bridge, and the Council gave this permission on the condition that the Corporation supplied current to the lamps and maintained the lamps free of cost. This necessitated the revision of the Highway Committee's scheme, and they have now made no provision for lighting Waterloo Bridge. The project includes, however, the lighting by electricity of the parapet lamps on the Embankment. Thus the saving effected by eliminating Waterloo Bridge from the Committee's scheme is more than counterbalanced by the addition of these parapet lamps. The scheme now presented includes 129 arcs for the Embankment, five for the piers adjacent, and ten for Westminster Bridge and approaches. The parapet lamps and alternate lamps on the Embankment it is proposed to extinguish at midnight. The machinery included in the original scheme will, the Committee estimate, be sufficient for the purpose of the revised project, even should the Council at any time decide to light all or any of the subways by electricity in cases where "safety" lamps are now used, which are at times a source of trouble. The total expenditure of the revised project would be £25,300, made up as follows:—Buildings £6,900, boilers and machines £9,600, mains £4,200, lamps, standards, &c., £4,300, salaries £300. The estimated annual upkeep expenses are put at £3,509, the capital repayments being estimated upon a 42 years' basis. The report concludes with a recommendation that the proposal of the Highways Committee should be approved, and the Committee be authorised to invite tenders for the work. Mayor Probyn asked that an alternative scheme for lighting should be obtained from one of the electric supply companies, and he pointed out that the companies now possessed improved facilities for this class of work over those existing some time ago. Possibly the company which was lighting Waterloo Bridge would be in a position to supply current for the Committee's scheme at a cheaper rate than the Council could itself generate the necessary supply. The report was postponed for a week.

Morecambe.—An arbitration took place at Morecambe on Monday into the dispute between the Council and the Morecambe Electric Light and Power Company (Limited) on the former taking over the latter company's undertaking. Both parties were legally represented, the respective arbitrators being Mr. F. Thursfield, city electrical engineer, Chester, and Mr. A. H. Gribbings, city electrical engineer of Bradford. It appeared that the Council agreed to give £3,897 for the company's undertaking and portion of plant, cables and fittings, and a deed executed in Feb., 1896, contained a covenant stipulating that until the undertaking had been formally taken over the Company were to keep the plant in the same state of repair as at the original valuation. The Council now alleged that the plant had deteriorated in value through being improperly stored and the cables not properly looked after, the latter being stated to be now useless for the Council's system, and worth £2,000 less than at the time of the valuation. In support of this contention Mr. Parkinson, resident engineer, gave evidence as to recent tests, and was corroborated by Mr. Woodson, electrical engineer, Lancaster Waggon Works; Mr. Hedgecock, of the British Insulated Wire Company

and Mr. Burton, of Messrs Callender and Co., London. The Chairman and surveyor also spoke to the unsuitable place in which the stores were kept. For the Company, it was contended that the mains were practically as good as when originally valued, except for 10 per cent. allowance for depreciation. Mr. Clirehugh, consulting engineer, and Mr. Davidson, from Messrs. W. T. Glover and Co., Salford, who supplied the original cables, were called to show that the Council's tests were not taken under favourable circumstances. It was further contended that the cables could be put right for £50. The proceedings lasted several hours, and at the close the arbitrators intimated they would personally test the mains.

Public and Private Lighting Contracts.—Messrs. Drake and Gorham forward a formidable list of electric lighting installations carried out during 1897. The work undertaken by the firm includes installations of infinite variety, from what is claimed to be the largest installation in the country (the Prudential Assurance Company's offices) to the comparatively smaller class of country house. The work at the Prudential offices comprises several complete sets of slow-speed direct-coupled dynamos, which are upwards of 300 H.P. each, no less than 6,500 16-c.p. incandescents being required in the lighting of these extensive premises The Linotype Company's new works at Altrincham accounts for 254 arcs and 237 incandescents, this work being done by Messrs. Drake and Gorham's Manchester branch. The works of Messrs. Tootall, Broadhurst, Lee and Co. (where three gas engines have been put down) uses 1,172 incandescents, the *Sporting Chronicle* offices at Manchester 40 arcs and 200 incandescents, and the long list of public buildings includes theatres, churches, free libraries, public baths, hospitals, and the Manchester Royal Exchange. Town house installations include 500 additional lights for the Marquis of Lansdowne, and many of the country house installations are almost equal in size. They are too numerous for inclusion in this column, but show a healthy increase in the business of the firm for the past year.

Redditch.—The District Council held a special meeting last week to consider Mr. J. A. McMullen's report on the electric lighting question, and after discussion it was decided to adopt Mr. McMullen's recommendation to establish electricity supply works. The initial capital expenditure is estimated at £8,000, the annual upkeep, interest, sinking fund, &c , £1,200, and the estimated net profit £210 per annum. A list of the Council's plant requirements in connection with the undertaking appears in our advertisement columns.

Shanklin (Isle of Wight).—A communication from an electrical engineer offering to prepare a report on the electric lighting question has been referred to a committee.

Sittingbourne.—The water works at Keycol Hill have been supplied with an electric lighting installation.

South Staffordshire.—A meeting of the South Staffordshire Iron and Coal Trades' Associations was held on Thursday last to consider the scheme of the Midland Electric Corporation for Power Distribution, for providing electricity for lighting purposes throughout the South Staffordshire district. There was a large attendance. The gathering was very representative. The chairman (Sir B. Hingley) referred to the development in electrical matters during recent years. In their district the iron and coal masters depended upon old-fashioned methods which involved the use of steam engines, boilers and fuel, and much expensive labour. On the continent and in America electric power had been more extensively used, and even, to a limited extent, had been applied nearer home with economy and success. He knew that such changes were expensive, but if manufacturers were to hold their own they must face the expense and abandon their old-fashioned ways. It was obvious to those engaged in manufacture that to have power carried to their doors without investing their own capital and without burdening the district with rates would be much better than for the Local Authority to borrow money and supply it. Other speakers followed in a similar strain, and eventually the following resolution was adopted: "That in the opinion of this meeting the proposal for electric power distribution for industrial and manufacturing purposes in this district is worthy of consideration, and should be encouraged instead of opposed by local authorities, subject to fair conditions, so as to secure economical terms to consumers."

The Company's scheme is being discussed by the various local authorities affected by this proposal, but those Councils which already possess electricity supply works have decided to oppose the scheme, as they consider that the Company's operations are likely to interfere with the success of their electricity departments. On the other hand, some of the smaller Corporations, notably Bilston, Handsworth, Oldbury and Tipton, seem favourable to the project.

Southport.—Mr. Tesler, who has been a pupil at the electricity works, has been appointed to the position of assistant to the borough electrical engineer (Mr. C. D. Taite). The new post office is to be lighted electrically. About 250 8-c.p. incandescents will be employed. Current is to be taken from the Corporation mains.

St. Olaves (London).—The County of London and Brush Provincial Company have applied to the Board of Works to change their proposed system of electricity supply from continuous to alternating current. At the last meeting the Works and Finance Committee reported in favour of sanction being given, but after discussion the matter was re-committed.

St. Pancras (London).—The Electricity Committee have presented a report dealing with the proposed extensions of the Stanhope-street generating station. The scheme provides for the erection of chimney shaft and buildings, including an additional boiler house and extensions to the engine room, so as to accommodate four 750 H.P. engines. At the outset it was only proposed to erect two 750 H.P. engines and dynamos, four boilers, feed pumps, &c. Detailed plans of the proposed extensions, prepared by the chief electrical engineer (Mr. Sydney W. Baynes) were submitted. The capital expenditure entailed was put at £26,439. The extensions are absolutely necessary to meet the increasing demand for current. The proposals of the Committee were sanctioned.

The Strike.—It is expected that the result of the poll of the men as to the acceptance or rejection of the final terms of the engineering Employers' Federation will be made known to-day (Friday) or to-morrow. The interest in the strike and lock-out has naturally centred round the result of this poll. Everything points to the return of the men to work on Monday—or such of them as room can be found for. It will, however, be found that a very considerable minority have voted for a rejection of the masters' terms, and these men will form a nucleus towards which the discontent of the dissatisfied section of the men will gravitate. It will consequently be the duty of the masters to see that no step is left untaken to acquaint themselves with the views of their own men, and it will doubtless be advisable, as soon as matters have settled down, that the masters should meet their employés and endeavour to nip in the bud any attempt to tamper with the even working of the shops. The discontent which is openly expressed against the leaders of the men's unions for the very crushing defeat which the engineers have experienced should unquestionably be taken advantage of by the masters, who by closer contact with the workmen would at this critical juncture alienate the sympathies of the men from the unions for every other purpose but legitimate combination "in defence of the scale." This should be the primary object of trades unions, and this point should be urged upon the men at this stage of the dispute. An important manifesto has been issued by the National Free Labour Association, in which the tactics of the men's leaders and advisers is severely criticised. Reference is made to the comparatively easy victory of the employers in this dispute, the tenour of the manifesto being to charge the leaders with a want of knowledge of the conditions of the engineering trades before the strike against the London masters was authorised. An appeal is made to the men to leave the unions, but we question the advantage to either masters or men in the latter leaving their existing unions to join an association which may ultimately become too strong for the masters. There can be, and there is, we believe, no rooted objection in the masters' minds to the trades unions while these work only in the direction for which they were originally established.

The report late last night was to the effect that while the returns from English branches of the A.S.E. would show a considerable majority in favour of the acceptance of the masters' terms, the Scotch polling, as far as has come to hand, shows a large majority against the acceptance. The men will, however, return to work next week under protest. It will be found that the number of abstentions from voting is very great; at Belfast only about 20 per cent. of the men affected by the strike voted, the numbers being 293 against acceptance and 117 for.

The Telephone in London.—At yesterday's meeting of the City of London Court of Common Council it was resolved, on the motion of Mr. A. C. Morton, to hold a conference of the local authorities of London to discuss questions connected with the telephone service of the metropolis.

Village Lighting.—Since the recent introduction of the electric light by the Parish Council of Treeton (Yorks.) there has been considerable correspondence in the local Press as to the identity of the village which first adopted the electric light. Several claims have been made for this honour, and in the *Yorkshire Evening Post* of the 26th inst. Messrs. George Harrison and Co., of Ripon, write to say that Ure Bank, Sharow, Ripon, has been lighted electrically by them for the Parish Council since August, 1895, at a cost to the ratepayers of 2d. in the pound. An 8-c.p. light is supplied to the artisans' dwellings at 3½d. per light per week, and 3d. if more than one in any single house, Messrs. Harrison finding and fixing all material and renewing lamps when necessary. The supply is, strange to say, practically confined to the streets and artisans' dwellings, the middle-class residents holding aloof.

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Dinners, Entertainments, &c.—Employés of the Ponder's End Works of the Edison and Swan Company held their annual entertainment at the People's Palace, Mile End, E., on Friday last week. 1,100 workpeople and their friends were present. Mr. Gimingham, Mr. Proctor (managers of the works), the heads of departments, and a number of the head-office staff attended.

——— The fourth annual dinner given by Sir Daniel Cooper, Bart., G.C.M.G., to the staff and long-service employés of the Electric Construction Company (Limited), took place at Wolverhampton on the 8th inst., Mr. J. W. Barclay presiding. Sir Daniel Cooper was unable to be present. About 240 guests teok part iu the proceedings. Mr. Barclay, in proposing the toost of "The Electric Construction Company," was able to congratulate those present on the friendly relationship between the Directors and the workers.

——— A smoking concert of the Electro-Harmonic Society will be held this (Friday) evening at the St. James's Hall Restaurant at 8 o'clock.

——— The annual dinner of Messrs. Rosling and Appleby was held Friday last week, a party of about 100 participated.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

Report of the fifty-first half-yearly ordinary general meeting, held on Thursday, Jan. 20, 1898, at Winchester House, 50, Old Broad-street, the Marquis of Tweeddale in the chair.

Mr. George Draper (the Secretary) read the notice convening the meeting and the minutes of the half-yearly general meeting held on July 22, 1897.

The CHAIRMAN having signed the minutes, and the report being taken as read, said: Gentlemen, it is now my duty, and an agreeable one, to ask your approval of the report and accounts, which have been in your hands some days, and which I presume you will take as read. I regret the absence from illness of two of the members of our Board, and I trust they will soon be able to be among us again. The gross revenue for the half-year under review amounted to £443,727, being an increase of £8,262 as compared with the groes revenue for the corresponding period of 1896. There is a decrease in the Cape and Australian traffic, but this is more than balanced by the temporary increase in the Indian and other classes of traffic. The increase in the traffic from India affords another example of what has often been remarked at our meetings—that our traffic receipts benefit from the misfortunes of nations as well as from their prosperity, for the increase really is due to the military operations on the Indian frontier, a considerable part of the traffic being press messages, which, as you are aware, are carried at very low rates. The commercial traffic of India shows, I am sorry to say, a tendency to decrease, but, no doubt, India is feeling the effects of the recent famine, the plague in Bombay, and the disturbances on our north-west frontier. The famine has come to an end; the plague, I am sorry to say, is still there; but the turbulent tribes of the north-west provinces have been, I think, brought to their senses, and I believe we may look forward to an improvement in our traffic with India.

Turning to our expenses you will find that they amounted for the half-year to September 30 to £109,243, or an increase, as compared with those of the corresponding period of 1896, of £6,867. The actual increase is due to our staff having been increased by 75 persons, and it therefore appears under the head of salaries and wages. Year by year we find that we have more work to do in order to earn approximately the same amount of money. Experience teaches us that a reduction of tariff does not not always develop traffic, or, at any rate, not to an extent sufficient to cover the extra cost entailed in the working of it. Under the most favourable circumstances it takes a considerable time to recoup us for such reductions, and in some cases an actual loss has been the result. Improvements are constantly being made in the system of working, and new instruments and apparatus are being invented which render the old ones obsolete. Signalling by hand is gradually being superseded by automatic signalling, and we must adopt the latest approved patterns in every form of apparatus incidental to our work, so as to minimise as much as possible the chance of error in transmitting telegrams. It is, as I think you know, our constant endeavour to secure greater accuracy and speed, because the better we can do our work the more work we shall have to do. All this means greatly increased expenses, but so long as we can continue to improve our earning powers without increasing our capital expenditure, the stronger will be our position, and your interests will be still further secured. I need hardly assure you—or, rather reiterate the assurance I have often given you—that the most rigid economy, consistent with thorough efficiency, is practised by the management. Notwithstanding this, however, the gradual increase in our working expenses is a factor which will have to be reckoned with in the future. It is the inevitable result of the development of our business and of giving effect to the sound principle of sharing our prosperity with the telegraphing public.

Now, turning to the expenses attending repairs and renewals of cables, which is always an important item in our accounts, you will find that they were in the half-year under notice £31,637, or an increase of £9,516 over these expenses in the same half of 1896. With regard to this item, allow me to point out that we are comparing with a half-year when the expenses for the six months were smaller than in any period during the last 20 years. Although, therefore, an increase is shown of over £9,000 this half-year, the expenses under this head are really extremely low, the average having been for some years past between £40,000 and £50,000 for six months. The Vigo-Gibraltar cable, to which I referred at the last meeting, was successfully laid by our own steamers, and is charged against the general reserve fund, which remains about the same figure as last half-year, namely, £790,000.

Some reference was made at the last meeting to the apparently large amount of our reserve fund for maintenance ships. I think that the following explanation will make the matter quite clear to you. This fund at the present time amounts to £142,000, and the amount on the expenditure, or credit side of the balance-sheet, under the head of maintenance ships is £163,500. We have five repairing ships; but this latter item represents four ships only, the remaining one having been paid for out of revenue. The maintenance ships' reserve fund is to replace the vessels as they wear out and become obsolete. We could not replace our five ships to-day for less than £200,000 or £250,000. We have decided to build a new vessel, which will be larger, faster, and a greater carrier than any we have at present. She will replace one which is old, slow, and with machinery out of date. You will therefore see that the fund is no larger than is necessary to meet our future requirements.

The marine insurance fund is another fund which perhaps calls for some explanation. It is a separate fund, and must not be confounded with the depreciation or replacement fund already referred to. It is a fund to provide against loss occurring to our ships, stores and spare cable through the many risks attending vessels at sea, and it is not any larger than it is desirable for us to have, having reference to the demands on us.

I may say here, with reference to the paragraph in the report which alludes to the reorganisation of our Capital Account, that I think it would be to the convenience of the meeting that any gentleman wishing to address me on that matter should wait until the motion respecting it has been made at the extraordinary meeting. It will save discussion which might confuse those who wish to take part in the discussion that may take place connected with the report and accounts. Apart from that, there remains one subject of interest to the shareholders on which I should like to say a few words.

From time to time a desire has been expressed—and not a very unnatural one—that some increase in the dividend on the Ordinary shares should accompany the improved financial condition of the Company. This is a question which has exercised the minds of your Directors for several years past, and it has required a good deal of resolution to resist the appeals which have been made to them in regard to it. The shareholders have loyally trusted us and strengthened our hands, recognising, as they have done, that our policy of building up our reserves has helped materially to place the property of the Company in the position it occupies to-day. If we had paid larger dividends we should have been at the same time exposed to further demands for larger tariff reductions than we should have deemed ourselves warranted in making in the interests of the shareholders. We should, moreover, have invited competition at a time when, with an inadequate reserve fund, we should have been least able to meet it. Our reserve funds, although not nearly as large as we should like them to be, have been largely augmented during the last two years, while our traffics are, on the whole, very satisfactory; and I am glad to be able to say, with respect to this altered condition of things, that if the current half-year continues as it has begun we shall be able to recommend an increase of another ½ per cent. in the bonus, making the total distribution for the year up to 7 per cent. We contemplate making at the same time certain reductions in our tariff rates, the details of which will, of course, have to be gone into with and approved by the different administrations interested. We believe that the policy of considering the interests of the telegraphing public, in conjunction with those of the shareholders will commend itself to everyone who has the interests of the Company at heart. It is a double source of satisfaction to me to be able, whilst holding out hopes of an increase in the bonus to our shareholders, to forecast a further reduction to the telegraphing public.

Gentlemen, there is one other matter to which I should like to refer, and that is to the bonus we have paid to our staff in consideration of the twenty-fifth anniversary of the Company and Her Majesty's Diamond Jubilee. The bonus consisted of 20 per cent. of their salaries to all over five years' service, and 10 per cent. to all under five years exclusively in the service of the Company. I need hardly tell you that this bonus has been highly appreciated, and allow me to add that in my opinion it has been very well merited. A more efficient set of men—men more earnest and cheerful in the discharge of their duties—cannot be found anywhere, and their duties are never light or easy; they are sometimes very arduous, and they are not infrequently attended with risk to property and even life. I feel sure that the whole body of proprietors, both those present as well as those who are absent, will heartily endorse the Directors' action (cheers). Their approval will be highly appreciated by the members of the staff both at home and abroad, and I am sure will act as an incentive to them to maintain that high standard of efficiency which characterises their work and that of the Company. Gentlemen, with these observations I beg to move the adoption of the report and accounts.

The VICE-CHAIRMAN and MANAGING DIRECTOR (Mr. J. Denison Pender): I beg to second the resolution.

The CHAIRMAN: The words of the resolution are—

"*That the Report and Accounts of the Directors to September 30, 1897, submitted to this meeting, be, and the same are hereby received and adopted.*"

Gentlemen, before putting that I invite any criticism or remarks that shareholders may be disposed to make. If they have none, I will put it. The resolution has been moved by myself and seconded by Mr. J. Denison Pender. Those in favour of the resolution will please to signify the same in the usual manner. Those of a contrary opinion. Carried unanimously.

Mr. J. DENISON PENDER: I have the pleasure of moving—

"*That the Marquis of Tweeddale, who now retires, be, and he is hereby, re-elected a Director of the Company.*"

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E.: I have great pleasure in seconding the motion.

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The CHAIRMAN: Gentlemen, you have heard the resolution which has been moved and seconded, and those who are in favour of it will please to signify the same in the usual manner. On the contrary. Carried unanimously. Gentlemen, I beg to thank you warmly for the reception which you have given to the motion just passed. I have now to move—

"That Sir Albert J. Leppoc Cappel, K.C.I.E., who now retires, be and he is hereby re-elected a Director of the Company."

Mr. J. DENISON PENDER: I have much pleasure in seconding Sir Albert's re-election.

The CHAIRMAN put the motion in the usual way, and declared it carried unanimously.

Sir ALBERT J. LEPPOC CAPPEL: I beg to thank you, gentlemen.

The CHAIRMAN: Will any gentleman in the body of the hall be good enough to move and second the appointment of Auditors?

Mr. BAINES: Mr. Chairman and gentlemen, it affords me great pleasure to propose—

"That the firms of Messrs. Deloitte, Dever, Griffiths and Company, and Messrs. Welton, Jones and Company, be and they are hereby elected Auditors to the Company for the ensuing year at the remuneration of £100 to each firm.

These firms have audited our accounts for a considerable time. Will some gentleman second the motion?

Mr. PARRITT: I will do so.

The Chairman then submitted the resolution in the usual way, and declared it carried unanimously. The business of the ordinary meeting being now concluded, the Secretary read the notice convening the extraordinary general meeting to be held "for the purpose of considering, and if thought fit approving, the provisions of a Bill now being submitted to Parliament intituled 'A Bill for the Conversion of the existing Preference shares of the Eastern Telegraph Company (Limited) and for other purposes.'"

The CHAIRMAN: I will now ask our Solicitor to read the Bill, or the marginal notes of it.

The SOLICITOR (Mr. Dawes): It is not usual to go through and read the entire Bill. I will read the side notes, which will place you in possession of the contents of the Bill. First of all comes the preamble, and the preamble is the setting out of the share and debenture capital of the Company. Then the first section is the short title of the Bill, which is "The Eastern Telegraph Company's Act, 1898." The second section is the creation and issue of new Preference stock. The Preference stock to be issued under that section is £2,000,000 of new Three and a-Half per Cent., with cumulative dividends. The third section is the conversion of the existing Preferential shares into new Preference stock, the £10 share being converted into £18. 10s. of new Three and a-Half per Cent. Preference stock; and a further part of the section states that the Act is not to affect the existing rights of the Preference shareholders. Trustees may exchange Preference shares for Preference stock. The old certificates are to be given up for new certificates. On the registration of the new stock the old shares are to be cancelled. The new Preference stock is transferable, and to have the same rights as the old shares. The word "existing," when used in this Act, means existing immediately before the passing of the Act. Then Section 4 is as to the balance of the new Preference stock, which may be issued as the Directors think fit for the benefit of the Company. Section 5 provides for the power to create additional Preference stock, but that Preference stock shall not exceed one-half of the total amount of Ordinary capital for the time being created and issued. Section 6 gives the Directors power to create debenture capital, but that debenture capital shall not exceed one-third of the total amount of the Ordinary and Preference stock capital of the Company. Section 7 provides for the deposit of a copy of the Act with the Registrar. Section 8 provides that the Act when passed shall be deemed part of the Memorandum and Articles of Association of the Company; and Section 9 provides for the costs of the Act.

The CHAIRMAN: Gentlemen, I will now move the following resolution:—

"That this meeting having considered the Bill proposed to be introduced into Parliament in the ensuing session, intituled 'A Bill for the Conversion of the existing Preference shares of the Eastern Telegraph Company (Limited), and for other purposes,' hereby approve the same, subject to such additions, alterations and variations as Parliament may think fit to make therein, and as the Directors shall approve."

Gentlemen, you are aware, of course, from what has been said, that we propose to apply to Parliament for the necessary powers to convert the Six per Cent. Preference shares into Three and a-Half per Cent. Preference stock. This action on the part of your Directors has been prompted by various reasons. I daresay there may be some present, if not many, who can remember the circumstances under which the Six per Cent. Cumulative Preference shares were issued. If not, the following particulars may prove of interest to you. They were offered to the shareholders and afterwards to the public in February, 1876, to provide capital for duplicating the cables between Suez and Bombay. The price of our Ordinary £10 fully-paid share in that year ranged between £5 and £7 (the Ordinary shares I believe are to-day £18), and it was with considerable difficulty that we were able to place the Preference shares. It took us nearly a year to complete the issue. The Company was then in comparative infancy, and did not occupy the same high position financially that it does now, although at that time we were paying 5 per cent. on the Ordinary shares. On the other hand, however, our reserve fund was a very modest one—it hardly existed—and the investing public continued for a long time very sceptical as to the value of cable property. As time went on, our credit—thanks to the policy of paying moderate but substantial dividends and building up our reserves—slowly but surely improved. In these altered circumstances we consider it most desirable that we should rearrange our issues, and, in doing so eliminate the Six per Cent. Preference, which is not only misleading as an indication of our financial status, but operates as a bar to our obtaining additional capital on the most advantageous terms. In any case our present limit of borrowing on Four per Cent. Stock is exhausted, and with a view to our probable future capital requirements we propose to convert the Six per Cent. Preference shares into Three and a-Half per Cent. Preference Stock, and to obtain the sanction of Parliament to an increase of our borrowing powers in Preference Stock to an amount equal to one-half of the Ordinary share capital. The price fixed for the conversion is £18. 10s. of Three and a-Half per Cent. Preference Stock for each Six per Cent. Preference share of £10 each—an offer which I have no doubt the present Preference holders will unanimously accept. We have only had two letters, I think, or three at the outside, from shareholders who in the first instance objected to the proposal of the Company, but who, on the scheme being explained to them, entirely withdrew their objections. In fact, one can hardly imagine that any Preference shareholder would object to what is proposed. The exact effect of the conversion will be as follows: A present holder of 100 Six per Cent. Preference shares (nominal £1,000) derives an income therefrom (less tax) of £58 per annum. If he converts them into Three and a-Half per Cent. Preference stock at the rate of £18. 10s. for every £10 fully-paid share he would receive £1,850 of the new stock, bringing him in an income (less tax) of £62. 11s. 10d. per annum, or an advantage to him in the point of income of £4. 11s. 10d. per annum and an increase to him in the nominal capital of £850. You will therefore see that the Preference shareholder will receive an appreciably higher income by the exchange, and that he will also get a considerable increase in nominal value, together with a better prospect of a further appreciation in the market price of the security. In fixing the price for conversion it was, of course, necessary to offer terms such as were likely to secure the consent of the present holders, numbering over 2,000, and secure thereby the success of an operation which, in our opinion, is calculated to benefit all classes of proprietors, and, at the same time, to maintain the new stock at par, or a premium, with a view to future issues. I may mention that whenever we have the necessity to issue any substantial amount of Preference or Mortgage Debenture Stock we shall certainly give the option of taking it up to our ordinary shareholders (cheers). There is only one other feature I will trouble you with, and that is to show you how little the proposal will affect the Company's income. The extra cost will only be £3,325 per annum in point of interest, and this is only equal to 3½ per 1,000 on the revenue, and less than 1 per 1,000 on the ordinary share capital. The immediate increase in our borrowing powers at a comparatively low rate of interest—say 3½ per cent.—will be £705,000, and 4 per cent. Debenture stock £235,000, or a total of £940,000. I therefore think you will agree with me that whether you regard this scheme from the point of view of the Preference shareholders or the Ordinary shareholders, it is one which is entirely in the interests of the Company and of both classes of shareholders. I beg, therefore, to move the resolution which I read to you at the beginning of the few observations I have thought it necessary to make.

Mr. J. DENISON PENDER: I beg to second the resolution.

The CHAIRMAN: It has been seconded by Mr. J. Denison Pender. Those in favour of it will signify to the same in the usual manner. Those of a contrary opinion. Carried unanimously. I am very much obliged to you for the reception which you have given to the proposal.

Mr. PARRITT: Before we part, I think we owe a vote of thanks to our worthy Chairman for the capable way in which he has placed matters before us this afternoon. The history of the Eastern Telegraph Company is summed up, perhaps, in one word, "Progressive," spelt with a capital P. If, perhaps, the dividend might be called moderate, still in these days of 2¾ per cent. and 2½ per cent. we must not grumble at 6½ per cent. The Eastern Telegraph Company is very well officered, no doubt, and I think we cannot do better than give a vote of thanks, not only to the Chairman and his colleagues, but also to the rank-and-file who assist us, and who make the Eastern Telegraph Company the magnificent undertaking it is.

Mr. BAINES: I have great pleasure in seconding that.

The SOLICITOR put the motion, which was carried unanimously.

The CHAIRMAN: I beg to thank you very warmly for the reception you have given to the motion just made, and I do so on the part of my colleagues and myself, and also on the part of the staff, whom Mr. Parritt has very properly commended to your notice. I do not think it would be possible to find in any company in the kingdom a staff more devoted to the services of the Company.

The proceedings then terminated.

Direct United States Cable Company (Limited).

The forty-first ordinary general meeting of this Company was held at Winchester House on Tuesday, under the presidency of Mr. E. M. Underdown, Q.C.

The SECRETARY (Mr. T. Finnis) read the notice calling the meeting, and subsequently the minutes of the last meeting; and the report of the Directors was taken as read.

The CHAIRMAN: I have very few remarks to make on the report, and you will observe that it is very short, which is not a demerit in reports of this description. You will have seen from the report how the revenue and expenditure stand, but I will just make a few remarks on them. The revenue for the six months ended December 31st last, after deducting outpayments, amounted, in round figures, to £50,098, while the working and other expenses, including income tax, but exclusive of the cost of cable repairs, absorbed £19,723, leaving a balance of £30,375 as the net profit of the half-year, making, with £3,928 brought from the previous half-year, a total of £34,303, which has been appropriated as follows: Interim dividend of 3s. per share for the quarter to September 30th £9,106. 10s., a like amount for a

dividend of 3s. per share for the quarter to December 31st, set aside to reserve fund account £12,000, and carried forward to current half-year £4,090, making a total of £34,303. It is satisfactory to say that the revenue has continued to increase during the half-year, and is still improving. The amount of the increase is £2,497, or about 5¼ per cent., as compared with the earnings in the corresponding period of 1896. The expenses in London are practically unaltered, while those at the stations are somewhat higher, owing to the additional work done on account of the increased traffic. The usual full details of the various items are given in the abstracts marked A and B in the printed accounts. Adding the remaining expenditure, which is more or less of a fixed character, it will be found that in the aggregate the expenditure shows a small reduction as compared with the same period of 1896. We have not been without cable renewals and repairs, and altogether their cost has been for the half-year under review £8,325, which, with the amount written off the Ballinskelligs buildings account, £2,000, have been debited to the reserve fund account. On the other hand, this account has been credited with £5,604 for interest on the investments and the £12,000 set aside, as I have already mentioned, out of revenue, leaving the balance of the reserve fund standing at the increased figure of £345,767. Of course, as we have often mentioned, the real value of the fund, if realised, would be considerably greater. I do not think we have any reason to complain in this matter, as recently many of our investments have increased in value. The investments have been increased during the past half-year by £12,220, bringing the total up to £330,786 at cost. I observe that the figure of the increase is given here: their present market value is about £385,800, showing a profit on the investments, as they now appear, of something like £55,000. Now you will remember that the amount of the interest to June 30th last—the end of our financial year—was made up to 3 per cent. for the whole year. We are able to keep up that amount, and I trust that the continued increase of our business will enable us to do that in future, even if we do not do better. The relation of this Company with the allied companies—the Anglo-American and the Western Union Companies—is most cordial, and every kind of mutual accommodation is carried out as between the companies, and the very best spirit is shown in acting up to the general benefits of what is commonly known as "the pool." Our part in the pool is satisfactory; but I think that a little more might be said about this matter, because I find that it is not generally understood what the advantages to the public are from our combination. The public thus has the advantage of seven cables—four of the Anglo-American Company, two of the Western Union Company, and our one. Now, it is manifest with that number of cables, when traffic accumulates, how very well it can be dealt with by arrangement between the companies. Not only that, but when interruptions do occur, as must occasionally happen, the traffic is never suspended or practically interrupted, because arrangements are made between us—more particularly between us and the Anglo-American Company—for carrying on the traffic without interruption, for which there are so many routes open to us. At the same time the independence of the companies is maintained—that is to say, that any member of the public who chooses to direct his message, or "*Vid*" his message, as it is technically called—by the Anglo-American, the Direct, or the Western Union—can do so, and that is done from time to time. It is true that the proceeds are shared among the different companies, but many people prefer one route or the other, and I am told—without for a moment wishing to boast or to depreciate our rivals—that our part of the traffic is done with extreme exactitude (I place that feature in the first rank) and with very excellent speed. A similar thing arises with respect to repairs. The Anglo-American Company has a ship always on the other side of the Atlantic, which is available for us if it is not being employed by them, and we have availed ourselves of that twice during the last twelve months. I am glad to say that our cables are in good working order. The short cable, as it is called, was subjected to interruption, and there were two repairs made to that during the six months; and I thought it advisable, with the advice of the Board and of our technical advisers, to put a considerable piece of new cable—57 miles—into that which was lying in comparatively shallow water, and to move the cable from the place where it lay into deeper water, where it is practically free and safe from damage from the anchors of fishing vessels. The dwellings of our staff at Ballinskelligs are not quite finished, but I trust that they will be completed by the end of next month. I visited the station in the autumn, and found everything very satisfactory. When these additional buildings are completed, our staff will be comfortably and properly housed. There is one very important fact which I think ought to be brought to your attention—namely, that with the exception of one year more traffic was carried over our cable in the past year than in any of the previous 15 years, showing that we are able to carry this large amount of traffic without difficulty. I do not think there is anything more to which I need call your attention, and I will therefore conclude by moving—

"*That the report of the Directors, dated January 11, 1898, together with the statement of accounts to December 31, 1897, annexed thereto be and the same are hereby received and adopted.*"

Sir JAMES PENDER, Bart., M.P., seconded the resolution.

Captain GOODSALL said he was very glad to hear that the cable had been moved into deeper water, and that it was therefore now safer. The staff had worked for them for many years, and had rendered them good service, and in consideration of the Diamond Jubilee year, he thought that the Directors might have given them a bonus of 5 per cent. on their salaries in the past twelve months. The Company had done well in the past year, as the Jubilee must have brought them more traffic. He would move a resolution to this effect if someone would second it.

Mr. JOHN NEWTON thought that the suggestion was a good one, and he believed something of the same kind had been done in connection with similar companies. He would therefore second Capt. Goodsall's suggestion.

Mr. W. S. CUFF said that he quite agreed with Capt. Goodsall, but he thought that it would be very much better not to pass a resolution on the subject, but to leave the matter in the hands of the Directors in the form of a recommendation to them.

Capt. GOODSALL said he was quite willing to do so.

The CHAIRMAN: If you will allow me I will take it in that form. This matter has arisen—and I think very reasonably—in the discussions of other companies—companies which, I may say, are wealthy and prosperous, and whose shares are standing, I think, at a premium. We can hardly say that of ourselves, however. Nevertheless, we did consider this question very closely. I may also say that we felt that if this suggestion came from us it would be a little difficult. We found that our allied companies were not dealing with the question in the same way, and we hesitated to bring this subject forward from the Board. I am, however, extremely glad that it has come from the body of the meeting without any suggestion on our part, and I think that the Board will be disposed to follow the recommendation which, I understand, has now been made. I will, therefore, put it to the meeting in this form: "That it be a recommendation to the Directors to distribute an amount equal to 5 per cent. upon the salaries of the staff generally as a bonus." Shall we state that this is in consideration of the Jubilee year?

Capt. GOODSALL: Yes, please.

The CHAIRMAN put the question in the usual way, and it was carried unanimously. He afterwards put the motion for the adoption of the report and accounts, which was also carried unanimously.

Mr. CUFF subsequently proposed, and Mr. NEWTON seconded, a vote of thanks to the Chairman and the Directors.

The resolution was carried unanimously.

The CHAIRMAN: We are very much obliged to you, and I trust that we shall continue to deserve your praises.

The proceedings then terminated.

Central London Railway Company.

The report of the Directors of this Company for the half-year to Dec. 31 last will be submitted to the shareholders on Wednesday next, and states that the expenditure during the half-year amounted to £460,727. 15s. 11d., which makes the total outlay to date £1,606,948. 7s. £228,447. 10s. 6d., which appears in the accounts as owing to the contractors, is due to them for work done as certified by the Company's engineers. The engineers report that good progress has been made with the works during the half-year. Three-fourths of the main line tunnels, one-half of the station tunnels, and nearly the whole of the lift and staircase shafts have been constructed. At the Bank station, the very difficult work in connection with the subway for pipes is complete, and the public subways are in an advanced stage.

NEW COMPANIES, STATUTORY RETURNS, &c.

CLENCH AND COMPANY (LIMITED).—This Company was registered on Jan. 21, with a capital of £80,000, in £10 shares, to acquire the business, carried on under the style of Clench and Co, at Chesterfield and elsewhere and to carry on the business of mining, electrical, mechanical and general engineers, machine and engineering tool makers, boiler makers, smelters, metal workers, &c. The first directors are: Edmund Clements, Frederick Clench, Gordon M. Clench, Harry S. Johnstone, and Capt. Samuel G. McDakin.

MOUTRIE AND COMPANY (LIMITED).—This Company was registered on Jan. 18, with a capital of £5,000, in £1 shares, to acquire the business now carried on under the style of Moutrie and Company, at Berners-street, London, W., and to carry on the business of electrical, mechanical, and gas engineers, metal workers, electro-platers, &c.

SUSSMANN ELECTRIC MINERS' LAMP COMPANY (LIMITED).—The annual return to Nov. 1 has been filed. The capital is £80,000 in 1,500 Deferred, 39,250 Preference, and 39,250 Ordinary shares of £1 each. All the Deferred, 27,073 Preference, and 28,488 Ordinary shares have been taken up. All the Deferred, 17,950 Preference, and 17,943 Ordinary shares have been issued as paid. £1 per share has been called on the others.

TAYLOR AND TUCKER ART METAL COMPANY (LIMITED).—The annual return to Dec. 20 has been filed. The capital is £5,000 in £1 shares, of which 4,400 have been taken up, and paid for in full.

TELESCRIPTOR SYNDICATE (LIMITED).—This Company's annual return to Jan. 14 has just been filed. The capital is £40,000 in £1 shares. 39,507 shares have been taken up, and 35,000 are considered as fully paid. The full amount has been called on the others.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26 5/16d. per oz. (Jan. 27). Consols (2¾ per cent.) 112½—112¾ for money, 112⅝—112¾ for account; 2½ per cent. 105¾—106 (Jan. 27.) Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Days, Feb. 8 and 22; Ticket Days, Feb. 9 and 23; Pay Days, Feb. 10 and 24; Mining Share Carry-over Days, Feb. 7 and 21.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have resolved, after placing £12,000 to the renewal fund for the half-year, to recommend the declaration of the following dividends:

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Balance dividend of 19s. 6d. per cent. upon the Ordinary Consolidated stock for the year to Dec. 31; balance dividend of £1. 19s. per cent upon the Preferred stock for the same period, both payable on Feb. 5, less income tax. A balance of about £200 remains to be carried forward. The above dividends make £3 per cent. on the Ordinary, and £6 per cent. on the Preferred for the year.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company was held on Wednesday for the purpose of considering the Bill now before Parliament for authority to convert the present horse lines for electric traction, and also for power to construct additional tramways. The Chairman (Mr. C. H. Low) said that they had been formally invited by the City Council to discuss proposals for the purchase of their undertaking, but they had declined the offer. The various clauses having been explained to the meeting, a resolution approving the Bill was unanimously passed.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LIMITED).—The Directors of this Corporation recommend a dividend for the half-year ended Dec. 31 at the rate of 8 per cent. per annum, making (with the interim dividend for the half-year to June 30) a dividend payable for the year 1897 of 7 per cent. on the Ordinary share capital. This compares with a dividend of 6 per cent. for the year 1896.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for October were £2,885, against £4,314 in the corresponding month last year.

GUTTA-PERCHA CORPORATION (LIMITED).—The first ordinary general meeting of the shareholders of this Company was held on Tuesday, the Right Hon. Sir E. Thornton presiding. This was the statutory meeting, and the Chairman stated that after the Company went to allotment certain claims were made in connection with patent rights (if any) in British North Borneo, the Kingdom of Brunei, and the Dutch Governments of Borneo, by a Mr. Abrahamson. These claims were of no value to the Company at all, but concerned Mr. Serullas and Mr. Abrahamson. Owing to the extreme heat the Company's process could not be worked there, and the markets of the world were secured under the patents already granted and assigned to the Company. This Company's patent (said the speaker), like many a good thing, has been lying idle for some time in inexperienced hands, and a number of enterprising men in France, thinking it would not be worked by others, put up a factory and had worked it profitably on a commercial scale since 1894. They had been producing as much as 1401b. weight of gutta-percha in one day, which, according to the Directors' estimate, would give a profit of about £30 per day. Our manager succeeded in persuading the French folks that it would be beneficial to all parties that they should hand over their factory, freehold land, covering an area of about 20,000 sq. ft. and having a splendid frontage on a well-known canal, together with their plant, machinery, buildings, manager's residence, electrical installation, water rights, goodwill, lock, stock and barrel, as a profitable and going concern on a very satisfactory basis, and payable as to one half in cash, and one half in shares of this Company, taken at par, and this arrangement is to be confirmed at the meeting of the private Company owning this factory to be held to-morrow. Although we are looking out for a suitable site to put up works in London I am sure this arrangement of taking over this established business, although its factory is in France, will be considered by you as eminently satisfactory. It is an absolute proof to you that the process is thoroughly commercial and profitable, and that pending the time it will necessarily take to get our London factory into thorough working order we shall be in possession of an establishment already in working order, and actually paying at the present time, and the earning powers of which can be increased indefinitely by doubling, trebling, or quadrupling the machinery as we think fit. With reference to two questions that have often been asked: Can we get the leaves, and if so why not manufacture on the spot? And the answers to both are exceedingly simple. The leaves we can get in any quantity, the Company already owning more than 200 tons which were included in the purchase, and having besides offered to it on sale a further similar quantity and the Company's agents in the East inform us that they are prepared to supply thousands of tons per annum. As to the second question we have gone very thoroughly into the matter, and we find that it would be much cheaper to manufacture here than on the spot. It is always difficult to consign chemicals and acids to the East, while the only extra cost of manufacturing here might be the freight of the leaves from Borneo and Singapore to Europe, and that outlay is covered by the fact that, after the gutta has been extracted from the leaves, the used leaves can be sold for paper pulp at a price far exceeding the cost of transport, so that there is no loss on freight at all.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY (LIMITED).—Official notice is given in our advertisement columns that a petition has been presented to the Chancery Division of the High Court of Justice for confirming the special resolution passed on the 17th ult. (and confirmed on the 28th ult.) reducing the capital of this Company by cancelling the whole of the Founders' shares. The reduction will be from £200,000 (in 40,000 shares of £5 each, of which 27,900 are Ordinary, 12,000 Preference, and 100 Founders' shares), to £199,500 (in 39,900 shares of £5 each, of which 27,900 are Ordinary and £12,000 Preference shares). The petition will be heard before Mr. Justice Romer on Feb. 5. Messrs. Neve and Beck, 21, Lime-street, E.C., are solicitors for the Company.

LONDON ELECTRICAL CAB COMPANY (LIMITED).—This Company announce the issue of the balance of 86,388 shares of £1 each at a premium of 2s. 6d. per share. The money is required for the immediate increasing of the number of the Company's vehicles, and the prospectus contains a satisfactory report from Messrs. Kincaid, Waller and Manville. The Company has acquired the sole license for the use of the Johnson and Lundell motor with series parallel controller patents for hackney carriages in London.

MUNICIPAL ISSUE.—The Leicester Town Council have decided to issue new Corporation 2½ per Cent. Redeemable stock to the extent of £450,000, at the minimum price of 95. Of the new issue £33,719 is to be used for electric lighting purposes.

NATIONAL TELEPHONE COMPANY (LIMITED).—The Directors of this Company have resolved (subject to a final audit) to recommend the following dividends for the half-year ended Dec. 31:—At the rate of 6 per cent. per annum (less income tax) on the amouuts paid up on the First and Second Preference shares; at the rate of 5 per cent. per annum (less income tax) on the amounts paid up on the Third Preference Shares; at the rate of 6 per cent. per annum (free of income tax) on the amounts paid up on the Ordinary shares; carrying £40,000 to reserve and about £9,000 forward. With regard to the 130,766 Third Preference shares issued in June last, the dividends thereon will be calculated from the dates fixed for payment of the various instalments.

SOCIETE FRANCAISE D'ELECTRO-METALLURGIE (PARIS).—New Four per Cent. Mortgage Bonds to the extent of 4,000,000fr. are to be issued by this Company, in order to pay off the existing Six per Cent. Bonds.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the further issue of 10,000 Ordinary shares of the City of London Electric Lighting Company (Limited), the Four per Cent. Perpetual First Mortgage Debenture stock, and the further issue of 8,657 Seven per Cent. Cumulative Preference shares of the Electric Construction Company, and to grant a quotation to the further issue of 832 Five per Cent. Perpetual Preference shares (Nos. 8,420 to 9,251) of the City and South London Railway. The Committee have appointed Feb. 2 a special settling day in £194,023 Four per Cent. Debenture stock of the Edison and Swan United Electric Light Company (Limited), and £100,000 Five per Cent. First Debenture stock of the Sulphide Corporation (Ashcroft's process) Limited. The Committee have also ordered a further issue of £264,711 Sterling Four per Cent. 500-year Debenture stock of the Commercial Cable Company, £194,023 (part of 200,000) Four per Cent. Debenture stock of the Edison and Swan United Electric Light Company (Limited), and £100,000 Five per Cent. First Debenture stock of the Sulphide Corporation (Ashcroft's process), Limited, to be quoted in the Official List.

TOTTENHAM AND EDMONTON GAS LIGHT AND COKE COMPANY.—A meeting of the shareholders will be held on Feb. 5 for the purpose of considering the provisions of the Company's Bill for powers to generate and supply electricity in Tottenham and Edmonton.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY (LIMITED).—Coupon No. 15 of the Five per Cent. Mortgage Debentures of this Company, due 31st inst., will be paid at the Capital and Counties Bank, 39, Threadneedle-street, E.C., and at Messrs. Westendorp and Co.'s, Amsterdam.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Jan. 21 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,011.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Jan. 22	3,517	+617	...	...	...
Bristol Trams & Carriage	„ 21	2,381	+654	3	7,209	+ 1,556
City & South London Ry.	„ 23	1,075	- 39	4	4,334	- 53
Dover Tramways	„ 22	107	...	20	2,265	...
Dublin United (Southern)	...	...	...	...	...	...
Liverpool Overhead Rly.	„ 23	1,354	+137	4	5,510	+ 376
Sheffield Tramways	„ 23	986	+211	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Jan. 19.	Price Wednesday, Jan. 26.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 29. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	3/0	Central London Ordinary	9¾ 10¼	9¾ 10¼	2 13 6	June and December	10¼	9¾
143,106	10	1/9¾	Do. (£6 paid)	5¼ 6	5¼ 6	3 0 0	„ „	5⅝	5¼
£680,000	Stock	2½	City and South London Railway Con. Ordy.	69 71	69 71	2 14 10	January and July	70½	70
8,419	£10	5%	Do. 5% Perpetual Preference	15½ 16	15½ 16	3 2 6	„ „	15⅞	—
£135,701	Stock	4½	Do. 4½ Perpetual Debenture	138 140	138 140	2 17 2	May and November	..	—
54,000	10	2/6⅔	Waterloo and City Ordinary	12¼ 13	12¾ 13¼	2 5 3	June and December	13⅛	12⅝
27,500	10	3%	Liverpool Overhead Railway Ordinary	11⅜ 11½	11⅜ 11½	2 12 2	February & August	—	—
10,000	10	5%	Do. 5% Preference	16 16½	16 16½	3 0 7	„ „	—	—
125,000	Stock	4½	Do. 4½ Debenture	108 110	108 110	3 11 5	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Jan. 19.	Price Wednesday, Jan. 26.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 22. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£923,960	Stock	14/0	Anglo-American	61 63	61 63	4 12 0	Feb., May, Aug., Nov.	62¼	61¼
£3,038,020	Stock	28/0	Do. Preferred	111 112	111 112	5 3 7	" "	112	111
£3,038,020	Stock	5/0	Do. Deferred	13½ 13¾	12¾ 13½	..	" "	13¼	13¼
£137,400	£100	4%	*African Direct Telegraph (Red)	100 104	100 104	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	6 7	6 7	..	..	..	..
130,000	10	3/0	Brazilian Submarine	16½ 16¾	16½ 17	4 2 4	Mar., June, Oct., Dec.	17	13¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112 116	112 116	4 6 2	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	185 190	187 192	4 3 6	Jan., Apr., July, Oct.	..	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105 107	105 107	3 14 9	" "	107	106½
16,000	10	8/0	Cuba Submarine	8 9	8 9	8 17 10	February and August	8½	..
6,000	10	10%	Do. Preference 10 per Cent.	18 19	18 19	5 5 3	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	10½	..
£20,000	£50	4½%	Do. 4½ per Cent. Debentures	103% 106%	103% 106%	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10½ 10¾	10½ 11	5 13 7	Jan., Apr., July, Oct.	10¾	10¾
400,000	£10	2/6	Eastern	17¾ 18¼	18 18½	3 10 3	" "	18⅝	17¾
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18½ 19½	19 20	3 0 0	" "	19½	18¾
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131 134	131 134	2 19 11	May and November	133½	—
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	102 105	102 105	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension	18¾ 19½	18¾ 19½	3 13 8	Jan., Apr., July, Oct.	19½	18¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	132 136	132 135	3 0 2	February & August	134	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99 103	99 103	4 17 3	January and July	101	—
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99 103	99 103	4 17 3	" "	—	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	104 107	104 107	3 16 2	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108% 111%	108% 111%	3 12 1	May and November	—	..
180,227	10	1/9	Globe Telegraph and Trust	11½ 12½	12 12½	3 14 0	Jan., Apr., July, Oct.	12½	11⅞
180,042	10	6%	Do. 6 per Cent. Preference	17¾ 18¼	17¾ 18¼	3 5 9	" "	18¼	17⅛
150,000	10	5/0	Great Northern of Copenhagen	27 28	27 28	3 11 5	January, April, July	27½	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	101 104	101 104	4 17 7	March & September	..	..
17,000	25	12/6	Indo-European	52 55	52 55	4 10 11	May and November	54½	53½
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	108 111	108 111	5 10 1	March & September	109½	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105 108	105 108	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October	8½	8
3,381	£100 Cert.	6%	Submarine Cables Trust	136 141	138 143	4 4 6	" "	143	141½
15,609	10	6/0	West African Telegraph	4 5	4 5	5 0 0	.. ..	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103 106	103 106	4 14 4	March & September	103¾	—
30,000	10	..	West Coast of America	¾ 1½	¾ 1½	..	..	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	105 107	105 107	3 14 9	June and December	..	..
88,321	10	1/0	West India and Panama	⅜ ⅝	⅜ ⅝	..	May and November	—	—
24,563	10	6/0	Do. 6 per Cent. 1st Preference	7 7½	7 7½	8 0 0	" "	7½	7½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5 7	5 7	8 11 5	" "	—	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105 108	105 108	4 12 2	January and July	—	—
64,256	15	3/0	Western and Brazilian	9¾ 10½	9¾ 10½	2 18 5	May and November	10½	..
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½ 8	7½ 8	3 15 2	" "	7⅞	..
33,129	7½	1/6	Do. Deferred Ordinary	2¾ 3½	2¾ 3½	..	" "	..	..
£382,250	—	4%	Do. 4 per Cent. Debenture Stock	104 107	105 107	3 14 1	June and December	105	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105 110	105 110	6 7 10	Feb., May, Aug., Nov.	—	..
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	—	..
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	3 3½	3 3¼	5 14 4	August	—	—
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16 1/16	1/16 1/16	..	July	..	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2 2½	2 2½	8 0 0	October	..	—
484,597	5	3/0	National	6⅜ 6¾	6⅜ 6¾	4 7 3	February & August	6¾	6⅜
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15 17	15 17	3 10 7	" "	16⅜	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14 16	14 16	3 15 0	" "	..	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6 6½	6 6½	3 16 11	" "	6⅜	6½
1,829,471	Stock	8½%	* Do. Debenture Stock, 3½% (red.)	102 107	102 107	3 5 0	June and December	106½	105½
171,504	1	0/4	Oriental	1/16 1/16	⅜ ⅜	6 13 4	April and October	1/16	—
£8,000	5	5/0	United River Plate	4 4½	4 4½	5 11 1	July	4⅛	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101 106	101 106	4 14 6	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.						
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	10¾	13¼	—	March	..	—
£50,000	5	..	Do. (New Issue) £3. 10s. paid	..	..	—	..	..	—
50,000	£10	14/0	City of London Electric Lighting (fully paid)	27 28	29½ 30½	2 5 11	February & August	28½	27⅛
40,060	10	6%	Do. 6% Cumulative Pref. (fully paid)	17 18	17 18	3 6 8	January and July	17⅞	17⅛
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129 134	129 134	3 14 3	June and December	..	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	12½ 13½	14 15	2 3 6	February & August	13⅜	13⅛
20,000	5	2/3	Do. 4½ per Cent. Preference	6¼ 6¾	6½ 6¾	3 6 8	" "	6⅞	6¼
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	January and July	..	—
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	10½ 11	10¾ 11¼	3 6 8	March	10⅞	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	112 114	112 114	3 14 7	June and December	—	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	13⅝ 14½	14¾ 15½	..	..	14⅜	14
20,000	£10	6/0	Do. 6% Cumulative Preference	15½ 16	15¾ 16½	3 13 10	March & September	15⅞	15¾
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9 10	9½ 10½	..	..	9½	9¼
10,000	£5	7%	Do. 7 per Cent. Preference	11 11½	11¼ 11¾	2 10 7	March & September	—	..
111,000	£5	..	London Electric Supply Ordinary	3 3¼	3¼ 3½	..	..	..	..
48,050	£5	..	Do. Preference	6⅝ 6¾	6⅝ 6¾	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	18 19	19 20	2 15 0	April and October	19	18⅝
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	18 19	19 20	..	" "	..	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117 121	117 121	3 13 6	June and December	..	—
6,452	10	8/0	Notting Hill Electric Ordinary	17½ 18½	18 19	2 2 1	March	—	..
275,000	1	..	Rand Electric	1/16 1/16	1/16 1/16	..	..	..	—
£125,000	Stock	5%	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90 95	90 95	5 5 3	..	93½	..
150,000	$100	$2	Royal Electric Company of Montreal Shares	145 147	145 147	..	..	⅛	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105 107	105 107	4 4 1	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	17 18	18 19	3 0 6	February & August	18¾	17½
20,000	5	3/6	Do. 7 per Cent. Preference	10 11	10 11	3 3 6	" "	10½	10⅜
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	101 104	101 104	3 16 0	June and December	..	..
67,500	5	4/0	Westminster Electric Supply (fully paid)	16 17	16½ 17½	2 17 2	March & September	17⅜	16½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	£3	5%	Brush Electrical Engineering	1⅞ 2⅛	2½ 2⅝	—	—	2⅛	2 1/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2½ 2⅝	2½ 2⅝	5 1 1	—	2¼	2¼
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109 113	109 113	4 0 9	February & August	112	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102 105	102 105	4 6 2	June and December	104½	—
10,000	£10	..	British Aluminium Ordinary	..	—	—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference	..	—	—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7½ 8½	7½ 8½	5 17 8	June and December	—	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	107 112	107 112	4 0 6	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2 2½	2 2½	—	—	—	—
£>2,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	86 91	86 91	5 6 5	January and July	—	—
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 3	2½ 3	5 10 0	February & August	—	—
17,139	5	2/9½	Do. (£5 paid)	4½ 5½	4½ 5½	5 0 0	" "	—	—
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	100 102	103 105	3 16 2	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅜ 2⅞	2⅜ 3	3 10 0	February & August	2⅞	2½
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½ 3⅝	3½ 3⅝	4 3 4	August	3 1/16	—
91,146	1	10/0	Elmore's Patent Copper Depositing	⅜ ½	⅜ ½	..	..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	21 22	21 22	4 10 11	February & August	22	21¾
3,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 12 0	" "	—	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 10	" "	..	—
£50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	23½ 24½	23 24	4 3 4	" "	23½	23⅜
£50,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103 107	103 107	3 14 9	March & September	..	..
£7,350	12	12/0	Telegraph Construction and Maintenance	38 41	39 42	4 2 5	March and July	41	40
£100,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102 105	102 105	4 15 3	January and July	103¼	—
£22,500	£5	3/6	Williams and Robinson Ordinary	7⅜ 8½	7⅜ 8½	4 4 10	April and October	—	..
£22,500	£5	3/0	Do. 6% Cumulative Preference	6¾ 7¼	6¾ 7¼	4 2 9	" "	7⅜	..
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	105 107	105 107	—	—	—	—

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IMPERIAL OR BOARD OF TRADE STANDARD WIRE GAUGE.

Table of Relative Dimensions, Lengths, Weights, and Resistances of Pure Copper Wire.

By H. G. CHEESMAN, Eastern Telegraph Company.

No. of B.T.W. Gauge.	DIAMETER. Inchs	Millms.	SECTIONAL AREA. Circular mils. (d^2) 1 mil. = ·001in.	Circular mm. (d^2).	Square in. ($d^2 \times$ ·7854)	Square mm.	WEIGHTS AND LENGTH.—Sp. gr. 8·90. Grains per foot.	lbs. per 1,000 feet.	Grmms. per metre.	Feet pr. lb.	Yards per lb.	Metres per gramme.	RESISTANCE AS PURE COPPER AT 15·5° C. OR 59·9° F. Ohms per 1000 feet.	Feet per Ohm.	Ohms per metre.	Metres per ohm.	Ohms per lb.	Ohms per kilogm.	No. of B.T.W. Gauge.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0000000	0·500	12·700	250000·	161·290	·196350	126·68	5294·0	756·28	1127·4	1·3223	0·44076	0·000887	0·04079	24515·0	0·00012433	8043·2	·000053937	·0001189	0000000
000000	·464	11·785	215296·	138·890	·169093	109·19	4559·2	651·31	970·9	1·5354	0·51180	·001030	0·047367	21112·0	·00014437	6926·7	·000072727	·0001608	000000
00000	·432	10·973	186624·	120·400	·146574	94·562	3952·0	564·57	841·6	1·7713	0·59043	·0011382	0·054644	18300·0	·00016655	6004·2	·000096790	·0002133	00000
0000	·400	10·160	160000·	103·230	·125664	81·072	3388·2	484·03	721·54	2·0660	0·68866	·0013859	0·063737	15689·0	·00019426	5147·6	·00013168	·0002903	0000
000	·372	9·4487	138384·	89·278	·108657	70·119	2930·4	418·68	624·06	2·3887	0·79623	·0016024	0·073693	13569.5	·00022461	4452·2	·00017603	·0003880	000
00	·348	8·8391	121104	78·130	·095115	61·363	2564·5	366·26	546·18	2·7296	0·90996	·0018311	0·084208	11875·5	·00025666	3896 2	·00022985	·0005067	00
0	·324	8·2295	104976·	67·725	·082448	53·191	2223·0	317·57	473·41	3·1489	1·0496	·0021123	0·097146	10293·8	·00029609	3377·3	·00030590	·0006743	0
1	·300	7·6209	90000·	58·064	·070686	45·603	1905·8	272·27	405·87	3·6729	1·2243	·0024630	0·11331	8825·8	·00034536	2896·5	·00041618	·0009175	1
2	·276	7·0103	76176·	49·145	·059928	38·598	1613·1	230·44	343·82	4·3394	1·4464	·0029110	0·12387	7469·7	·00040803	2450·8	·00058098	·0012807	2
3	·252	6·4008	63504·	40·970	·049876	32·178	1344·8	192·11	286·38	5·2054	1·7351	·0034919	0·16059	6227·1	·00048946	2043·1	·00083592	·0018429	3
4	·232	5·8927	53824·	34·725	·042273	27·273	1139·5	162·83	242·72	6·1415	2·0471	·0041199	0·18947	5277·9	·00057748	1731·6	·0011636	·0025653	4
5	·212	5·3847	44944·	28·996	·03·299	22·773	951·74	135·96	202·68	7·3550	2·4516	·0049339	0·22691	4407·1	·00069158	1445·9	·0016688	·0036792	5
6	·192	4·8768	36864·	23·783	·02·953	18·679	780·64	111·52	166·24	8·9670	2·9890	·0060153	0·27664	3614·8	·00081317	1186·0	·0024806	·0054687	6
7	·176	4·4703	30976·	19·984	·024329	15·695	655·93	93·708	139·69	10·671	3·5570	·0071587	0·32942	3037·5	·0010034	996·58	·0035183	·0077454	7
8	·160	4·064·)	25600·	16·516	·020106	12·972	542·12	77·445	115·44	12·913	4·3043	·0086620	0·39836	2510·3	·0012141	823·62	·0051438	·011340	8
9	·144	3·6576	20736·	13·378	·016286	10·507	439·11	62·730	93·511	15·941	5·3136	·010694	0·49181	2033·4	·0014989	667·13	·007840	·017284	9
10	·128	3·2512	16384·	10·570	·012868	8·3018	346·95	49·565	73·886	20·176	6·7253	·013534	0·62243	1606·6	·0018971	527·12	·012558	·027686	10
11	·116	2·9463	13456·	8·6811	·010568	6·8182	284·95	40·707	60·681	24·566	8·1886	·016480	0·75787	1319·5	·0023099	432·91	018618	·041045	11
12	·104	2·6416	10816·	6·9779	·008495	5·4804	229·04	32·720	48·776	30·562	10·1873	·020502	0·94286	1060·6	·0028737	347·98	·028816	·063527	12
13	0·092	2·3368	8464·	5·4605	·006648	4·2887	179·24	25·606	38·170	39·055	13·0183	·026199	1·2048	829·97	·003·723	272·31	·047056	·10374	13
14	·080	2·0320	6400·	4·1293	·005026	3·2429	135·53	19·361	28·862	51·650	17·2166	·034648	1·5934	627·57	·0048566	205·90	·082301	·18144	14
15	·072	1·8288	5184·	3·3445	·004071	2·6267	109·78	15·688	23·378	63·765	21·255	·042775	1·9672	508·33	·0059958	166·78	·15792	·34815	15
16	·064	1·6256	4096·	2·6426	·003217	2·0755	86·733	12·391	18·471	80·703	26·901	·054138	2·4897	401·65	·0075884	131·78	·20093	44297	16
17	·056	1·4224	3136·	2·0232	·002463	1·5890	66·408	9·4569	14·142	105·41	35·136	·070710	3·2519	307·51	·0099115	100·89	·34278	·75569	17
18	·048	1·2192	2304·	1·4864	001809	1·1675	48·790	6·9700	10 390	143·47	47·823	·096245	4·4262	225·93	·013491	74·125	·63504	1·4000	18
19	·040	1·0160	1600·	1·0323	0012567	·81072	33·882	4·8408	7·2154	206·60	68·866	·13859	6·3737	156·89	·019426	51·476	1·3168	2·9030	19
20	·036	0·91439	1296·	·83611	·0010179	·65668	27·444	3·9206	5·8445	255·06	85·020	·17110	7·86e9	127·08	·023983	41·696	2·0070	4·4247	20
21	032	·81280	1024·	·66063	0008042	·51886	21·684	3·0978	4·6179	322·51	107·603	·21655	9·9590	100·41	·030354	32·945	3·2149	7·0875	21
22	·028	·71119	784·	·50580	·0·0061575	·39725	16 602	2·3717	3·5355	421·63	140·543	·2s284	13·007	76·878	·039646	25·224	5·4845	12·091	22
23	·024	·60960	576·	·37161	00045239	·29186	12·198	1·7425	2·5975	573 89	191·296	·38496	17·705	56·481	·053963	18·532	10·161	22·400	23
24	·022	·55880	484·	·31225	·000380·13	·24524	10·249	1·4642	2·182b	682·98	227·66	·45816	21·070	47·460	·064219	15·571	14·891	31·725	24
25	·020	·50400	400·	·25803	·00031416	·20268	8·4705	1·2100	1·8039	826·40	275·46	·55437	25·495	39·223	·077706	12·869	21·069	46·419	25
26	·018	·45720	324·	·20903	00025446	·16417	6·8611	0·98016	1·4611	1020·3	340·10	·68441	31·475	31·771	·095938	10·424	32·112	70·794	26
27	·0164	·41656	268·96	·17352	·00021124	·13628	5·6955	·81365	1·2129	1229·0	409·66	·82447	37·916	26·371	·11557	8·6531	46·600	102·73	27
28	·0148	·37592	219 04	·14131	·00017203	·11099	4·6384	·66263	0·98779	1509·1	503 03	1·0123	46·558	21·479	·14190	7·0471	70·261	154·89	28
29	·0136	·34544	184·96	·11933	·00014527	·093719	3·9167	·55954	·83410	1787·2	595·73	1·1989	55·136	18·137	·16805	5·9506	98·539	217·24	29
30	·0124	·31496	153·76	·09918	·00012076	·079100	3·2561	·46515	·69340	2149·8	716·60	1·4422	66·324	15·077	·20215	4·9469	142·59	314·34	30
31	·0116	·29464	134·56	·086811	·00010569	·068181	2·8495	·40707	·60682	2456·6	818·86	1·6480	75·787	13·195	·23099	4·3292	186·18	410·45	31
32	·0108	·27432	116·64	·075250	000091609	·059102	2·4700	·35286	·52600	2834 1	944·70	1·9012	87·431	11·437	·26648	3·7526	247·78	546·25	32
33	·0100	·25398	100·00	·064515	·000078540	·050670	2·1176	·30252	·45096	3305·6	1101·86	2·2175	101·98	9·8059	·31082	3·2172	337·11	743·18	33
34	0·0092	·23368	84·64	·054605	·000066476	·042887	1·7924	·25605	·38169	3905·5	1301·83	2·6199	120·48	8·2997	·36723	2·7231	470·56	1037·4	34
35	·0084	·21336	70·56	·045521	0000055417	·035752	1·4942	·21346	·31820	4684·8	1561·60	3·1427	144·53	6·9190	·44051	2·x701	677·09	1492·7	35
36	·0076	·19304	57·76	·037264	·000045865	.029267	1·2231	·17473	·26047	5723·0	1907·66	3·8391	176·56	5·6639	·53813	1·8583	1010·3	2227·6	36
37	·0068	·17272	46·24	·029831	·000036317	·023430	0·9792	·13988	·20853	7148·8	2382·93	4·7956	220·55	4·5343	·67219	1·4877	1576·6	3475·8	37
38	·0060	·15240	36·00	·023225	·000028274	·018241	·7623	·10891	·16235	9182·2	3060·73	6·1597	283·28	3·5300	·88340	1·1582	2601·1	5734·4	38
39	·0052	·13·08	27·04	·017444	·000021237	·013701	·5726	·081800	·12194	12225·	4075·0	8·2008	377·14	2·6515	1·1495	0·86995	4610·5	10164·	39
40	·0048	·12192	23·04	·014864	·000018095	·011674	·4879	·069700	·10390	14347·	4782·3	9·6245	442·62	2·2592	1·3491	·74125	6350·4	14000·	40
41	·0044	·11176	19·36	·012490	·000015205	·0098097	·40997	·058567	·087306	17074·	5691·3	11·454	526·75	1·8984	1·6055	·62286	8994·0	19828·	41
42	·0040	·10160	16·00	·010322	·000012566	·0081072	·3388	·048402	·072154	20660·	6886·6	13·859	637·37	1·56s9	1·9427	·51476	13163·0	29031·	42
43	·0036	·09144	12·96	·008361	·000010179	·0065668	·2744	·039206	·058445	25506·	8502·0	17·110	786·88	1·2708	2·3984	·41696	20071·0	44247·	43
44	·0032	·08128	10·24	·0066063	·0000080425	·0051886	·2169	·030978	·046179	32281·	10760·0	21·655	995·90	1·0041	3·0354	·32945	32149·0	70875·	44
45	·0028	·07119	7·84	·0050·58	·0000061575	·0039725	·1660	·023717	·035355	42163·	14054·3	28·284	1300·8	0·76878	3·9645	·25224	54845·0	120910·	45
46	·0024	·06096	5·76	·003716	·0000045239	·0029186	·12198	·017425	·025975	57389·	19129·6	38·498	1770·5	·56482	5·3962	·18531	101609·0	224000·	46
47	·0020	·05080	4·00	·002581	·0000031416	·0020268	·08470	·012100	·018039	82640·	27546·6	55·437	2549·5	·39273	7·7706	·12869	210690·0	464490·	47
48	·0016	·04064	2·56	·001652	·0000020106	·0012972	·05421	·0077445	·011545	129130·	43043·3	86·621	3983·6	·25103	12·141	·082362	514380 0	1134000·	48
49	·0012	·03048	1·44	·(00·9292	·0000011310	·00072965	·03049	·004356	·0064939	229560·	76520·0	153·99	7082·0	·14120	21·585	·046328	1625700·0	3584008·	49
50	·0010	·02540	1·00	·0006451	·0000007854	·00050670	·0211761	·9030252	·0045096	330560·	110186·6	221·75	10198·0	·098058	31·083	·032172	3371090·0	7431800·	50

The resistances in the above Table are calculated from Dr. Matthiessen's standard foot of soft copper wire weighing one grain, equalling 0·2064 B.A. units at 32°F., and are corrected for temperature to 60°F. for the standard ohm 10^9 C.G.S. units represented by 106·3 centimetres of pure mercury of one square millimetre section, weighing 14·4521 grammes at the temperature of melting ice, legalised by an Order in Council on August 23rd, 1894.

To convert standard ohms into B.A. units multiply by 1·01351.

To convert B.A. units into standard ohms multiply by 0·9866.

The resistance of pure copper wire increases as the temperature rises about 0·38 per cent. for each degree Centigrade, and 0·21 per cent. for each degree Fahrenheit.

The Diameter (D) in mils. of any copper wire equals the square root of its weight (W) in grains per foot, multiplied by 6·872.

$$D = 6{\cdot}872\sqrt{W} \text{ . . . mils.} \quad \text{Or } D = 0{\cdot}37824\sqrt{w} \text{ . . . mm., where } w \text{ represents the weight in grammes per metre.}$$

The Weight (W) of any copper wire per foot in grains equals the square of its diameter D (mils.), divided by 47·22.

$$W = \frac{D^2}{47{\cdot}22} \text{ . . . . grains per foot.} \quad \text{Or } W = \frac{d^2}{{\cdot}01436} \text{ . . . grammes per metre, where } d^2 \text{ represents the diameter in millimetres squared.}$$

The Resistance (R) of any pure copper wire per mile at 60° F. equals the square of its diameter D (mils.) divided into 53845·5.

$$R = \frac{53845{\cdot}5}{D^2} \text{ . . . standard ohms per statute mile at 60° F.} \quad \text{Or } R = \frac{20{\cdot}0535}{d^2} \text{ . . standard ohms per kilometre at 60°F., where } d^2 \text{ represents the diameter in millimetres squared.}$$

The Conductivity (C) of any given length and diameter of copper wire is obtained by multiplying its calculated resistance (R) by 100 and dividing the product of its measured Resistance (r).

$$C = \frac{R \times 100}{r} \text{ . . . . conductivity per cent.}$$

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NOTES.

THE Council of the Institution of Civil Engineers has resolved that the Engineering Conference, inaugurated with such marked success last May, shall be a biennial event. It was decided during the first meeting that the Conference should not be a peripatetic one, but should regularly be held in London, a very general impression prevailing at the time that the Conference would be held annually. According to the recent decision of the Council it will next be held in London in the spring of 1899. That there was "infinite variety" provided during the first Conference most of those who were present will readily agree; possibly the Council fears that too frequent recurrence would be a custom likely to stale it. At any rate, in deciding not to make the Conference an annual institution the Council has ensured for it enhanced importance on those rarer occasions when it will be held.

ON Thursday next the adjourned discussion on Mr. PHILIP DAWSON'S Paper on "The Mechanical Features of Electric Traction" will be resumed by the Institution of Mechanical Engineers. The Paper was read and the discussion on it commenced on November 4th last, and now, after an interval of three months, the broken thread of the discussion is to be taken up, and the author's reply is to be heard. It is held by some to be advantageous for a considerable period to elapse between the reading and discussion of a Paper, the interval giving time for criticisms and suggestions to mature in the minds of intending speakers; but we think very few people can believe that so long a time as three calendar months would do anything but efface all recollection of the gist of the Paper. For our own readers who are interested in Mr. DAWSON'S valuable communication we have done our best to minimise the evil effect of the lengthy interval by reserving our illustrated reprint of the Paper until the eve of the adjourned discussion.

WHAT is the hitch in the plans for working the Inner Circle by electric traction? What is really "the problem exciting the minds of the electricians"? According to the Chairman of the Metropolitan Railway Company, while "there would be no difficulty about pulling trains of 200, 250, or 300 tons," the question to be solved was how to have "a sufficient reserve of energy on the Circle in the event of two, three, four, or more trains wanting to start at the same time." But is there really any difficulty here, or reason for delay? Broadly speaking, the question is whether the "sufficient reserve of energy" can be obtained without the use of storage batteries, or whether these will be necessary. Assuming storage batteries are requisite, surely the best makers of such plant have already acquired sufficient experience in their manufacture to suit the requirements of electric traction. Assuming, on the other hand, that it is decided to dispense with electric storage plant, surely the provision of sufficient reserve power is only a well-determined matter of the design of feeders, generating plant and boilers. There is also no small amount of direct experience to draw upon. The Chicago system of overhead electric railways has been running a heavy service of trains for some time past, and no difficulty of the kind anticipated by the Chairman of the Metropolitan Railway Company has been met with. In fact, even in the times of heaviest load the starting acceleration of the trains is surprisingly high, while the power house engines appear on such occasions to have no difficulty in keeping full pressure on the line. Provided the Directors of the Metropolitan Railway will lay out money for a power station of ample capacity, and will lay down feeder cables sufficiently large to convey the full power without excessive drop, we do not anticipate any difficulty in regard to promptly starting the trains, even should it happen that several are required to start simultaneously.

BRADFORD is taking the lead, among cities possessing a municipal system of electric supply, in the matter of systematically hiring out motors and arc lamps, and supplying electrical heating and cooking apparatus, &c., to consumers.

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A well-arranged pamphlet has been published, in which the advantages and cost of these things are clearly set forth. The first section deals with motors, power for which is supplied at 2½d. per unit. Rent for these ranges from £1. 10s. per annum for ½ B.H.P. to £5 per annum for 6 B.H.P., the electric supply department delivering the motor free of cost to the ground floor, the customer having to pay for any subsequent vertical movement necessary, and for foundations, wiring from the mains, &c. The next section relates to the hire of arc lamps, current for which is supplied at 5d. per unit. Single carbon 100-hour enclosed lamps are offered at £1. 1s. each per annum, and open arc lamps at £1. 1s. per annum for double-carbon, and 10s. 6d. per annum for single-carbon lamps, the current ranging for 5 or 6 to 10 or 12 amperes. The customer is required to supply the carbons and to do the necessary retrimming, but an inspector is periodically sent round to see that the hired-out lamps are in order. We suggest that the department might find it advantageous to offer to undertake the cleaning and recarboning of lamps, where these are placed out of doors, such, for instance, as in front of shops. For current for cooking and other heating purposes the charge is the same as for motive power, the prices for purchase outright of apparatus ranging from a guinea for a water-boiler, or two guineas for an egg boiler, up to £14 for a complete electric oven, or £37 for a hot cupboard. A copper bronchitis kettle costs £3. 15s., which is more than an average doctor's bill for curing an attack of the complaint alluded to.

The enterprise which has characterised the go-ahead municipality of Bradford from the first, in regard to electrical matters, is thus maintained. Bradford was the first city to adopt municipal electric supply, and it did so at a time when the uncertainties of the venture were more formidable than they are to-day. Confident of ultimate success, the plucky Yorkshire borough—for it was a borough at that time—"bravely put it to the touch, to win or lose it all." With quite different feelings must we regard the recently-developed inclination of the Corporation of London to start an electric supply business on its own account. No pioneer work is this that it contemplates; for, however much within its legal right it may prove to be, it must not be forgotten that a joint-stock company has been allowed to bear the heat and burden of the toilsome part of the day, patiently developing a business of which the Corporation would now endeavour to reap the benefits.

If the Corporation of London wishes to own an electric supply works, either of two courses are open to it, viz., to purchase the works and business of the existing concern at a fair price, or to seek powers to start an independent and rival business. There can hardly be any doubt as to which of the two courses would be the wiser and more prudent. It is scarcely probable that a Provisional Order would be granted to enable it to adopt the latter course unless it could be shown that current could thereby be supplied cheaper and with advantage to the ratepayers. There is vague talk of combining the projected supply station with a dust-destructor works, the proximity of Shoreditch with its dual works seeming to have attracted the minds of the Corporation to this problematical mode of working. We very much doubt if the dust-destructor part of the scheme, when reduced to exact figures, will assist the Corporation to show either Parliament or the Board of Trade that the creation of a rival electric supply business in the City is well advised; but even should such a conclusion be arrived at by the powers that be, the Corporation cannot overlook the fact that its existing rival is now a decidedly healthy one.

Apropos of Shoreditch and its combined dust-destructor and electric supply works, we note that at a meeting of the Vestry on Tuesday last, Mr. H. E. Kershaw, the Chairman of the Electric Lighting Committee, made the following statement:—

"That owing to the unprecedented success of the Vestry's efforts in the combined scheme of the generation of electricity from the steam supplied by the dust destructor, the Committee recommend the Vestry to reduce the charge for electricity from 6d. per unit for the first two hours, and 4d. per unit for the surplus, to 6d. per unit for the first hour and a-half, and 2d. per unit afterwards. This will work out to consumers of electricity using the light for three hours per day at 4d. per unit, four hours per day at 3½d. per unit, six hours per day at 3d., and so on, reducing the cost in proportion to the number of hours the light is in use. This, I believe, is a record in municipal electric light undertakings. After existing for six months only we are supplying electricity, within a little, as cheaply as any municipal installation in the country. During the past quarter we have sold 95,000 units of electricity, and the engineer's estimate for the current quarter is 150,000 units. The Committee feel extremely gratified that their efforts have been attended with such marked success, fully justifying what has been repeatedly termed a most expensive and dangerous experiment, and for the benefit of the many municipalities who are watching this scheme, though we do not feel called upon to issue our statistics until the end of the first financial year (June 30th), we are satisfied that our expectations will be more than realised, and the success of the joint scheme most thoroughly established."

With the wisdom of obvious common sense the Vestry resolved to pospone their decision in regard to these recommendations until after they had had an opportunity to examine the first financial year's accounts, which are to be placed before them later on. We sincerely hope it will turn out to be feasible to adopt the recommendations, and should such prove to be the case the circumstance will undoubtedly tend to justify the adoption of the combined scheme at Shoreditch. But even though this happen, as in the specially favourable circumstances it may, it must not be taken to justify the establishment of similar works in other places—not even in the City of London. What is destroyed at the Shoreditch "dust" destructor works is not, strictly speaking, *dust*, and the mixture has a much higher calorific value than is usual with town refuse. Only to places abounding to the same extent as Shoreditch in cabinet factories or similar works can the success of the Shoreditch scheme offer any encouragement to imitate it.

Returning to Bradford, where a scheme has been floated for constructing a light electric railway between that city and Leeds, some misunderstanding seems to have arisen in regard to the nature of the scheme, and the promoters have issued recently a pamphlet explaining matters in a lucid and intelligible manner. The interurban light railway is designed to form a connecting link between the tramway systems of the two cities, "whereby a passenger may be carried from any point in one city to any point in the other, for a single fare, the amount of such fare to be divided in agreed and just

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proportions between the two Corporations and the interurban line; and also, that goods, parcels and mails should be carried." As the existing tramways in either city do not extend to the city limits, the promoters of the interurban line are compelled to seek additional powers, to construct lines within the city limits in each case, in order that the system might be rendered complete. It is to be hoped that no unreasonable obstruction may be put in the way of this part of the scheme, and that the corporations owning the two tramway systems will perceive it to be to the advantage of the public for such a connecting line to be built. Interurban roads, similar to that projected for construction between Leeds and Bradford, form one of the most important features in the future development of electric traction in this country, possibly not even second to town tramways.

INTERURBAN electric railways, somewhat similar to the proposed Leeds and Bradford line, abound in America, especially in the United States; but many of these possess features we hope will be omitted from British lines. The pamphlet referred to in our last note cites the electric railways between Minneapolis and St. Paul as examples of well-arranged interurban lines, and certainly these are free of many defects inherent in other systems. In numerous instances, as, for example, the lines running from Cleveland to Akron, Bedford, Painesville, Berea, &c., separate fares are collected within the town limits and on the intermediate lines, the usual 5 cent fare conveying only to the town limits in either case. In some cases, *e.g.* the cars labelled "Lachine Rapids" that parade the streets of Montreal, the cars do not go to the place indicated by the label; and, after paying the city fare, the luckless passenger is dumped down at the city boundary beside a rudely-constructed light railway, where he must await the arrival of a "connection" car. In the system of electric lines extending from Fort Niagara on Lake Ontario to Buffalo, on Lake Erie, a through passenger must change cars some three or four times ere he may reach the desired point on the Buffalo tramway system. Such things may be the delight of trippers, but they are an annoyance to business people, especially if burdened with baggage, and, in a sense, the American interurban line lays itself out for the conveyance of baggage. The absence of a regular railway station, with its porters and baggage room, and the pernicious habit of interurban baggage cars of loading and unloading in the middle of a wide street or public square, make travelling with baggage over these lines highly undesirable. In order to test this we travelled recently over the Cleveland and Akron interurban electric line; we have lively recollections of being planked down in the centre of a busy street in Akron, and having to drag our baggage over the badly made "dirt" road to the nearest "express" office. They may be used to that sort of thing in America, but it is not likely to prove attractive on this side of the Atlantic.

CARBON, in the prepared form in which it is generally known to electrical engineers as "carbons," plays so important a part in such a variety of departments of electrical industry that technical information as to its manufacture, and the influence of the various processes of manufacture upon the ultimate quality of the material itself, cannot fail either to interest or usefully to instruct electrical engineers and electricians of the present day. Essential as carbon is to the production of the arc light, and vitally dependent as the quality of the light must be upon the perfection of manufacture of the material, this specially prepared carbon claims the attention of the electric light engineer, who should also remember that the same material is extensively used for dynamo brushes, as well as to some extent in rheostatic regulators and other minor apparatus of the power station. Telegraph and telephone electricians will recognise the material as forming an essential part of many common forms of primary battery, while the latter will remember that no better material than carbon has yet been found for telephonic and microphonic transmitters. Nor do these common uses of carbon exhaust the range of its electrical applications; thus, for example, in electro-chemical operations, both under wet and dry processes, carbon electrodes have largely and advantageously been employed. Having these facts in view, our readers will welcome, we are sure, the series of articles on "Carbons for Electric Lighting and other Purposes," which is commenced in our issue this week. The author, Mr. FRANCIS JEHL, is an engineer who has the advantage of much practical experience in the manufacture of carbons under various processes, and who is therefore able to invest with authority his practical treatment of the subject.

LAST Monday saw the completion of the Direct West India all-British submarine cable route to the West Indies. Hitherto cable messages have had to be sent *viâ* Nova Scotia and the United States; but in future by the completion of the cable between Jamaica and Bermuda, connecting with the existing cable between Halifax and Bermuda, messages between this country and Jamaica will be conveyed over an all-British route, not forgetting that Britain rules the waves. The event has been made the occasion of great rejoicings in Jamaica.

THE Directors of the Newcastle-upon-Tyne Electric Supply Company (Limited) in acknowledgment of their indebtedness to the Durham College of Science, of that town, for assistance in scientific questions from time to time, have sought the authority of the shareholders to make an annual subscription not exceeding £50 to that college. This laudable action on the part of an electric supply company would be, we believe, unique, and it is to be hoped that the shareholders will comply with the recommendation of their Directors.

German Electrical Standards.—The *Frankfurter Zeitung* announces that, during the present session of the Reichstag, the draft of a Bill regulating electrical standards will be presented for consideration.

On Starting a Municipal Electrical Department.—An interesting Paper entitled "Some Practical Hints on Starting a Municipal Electrical Department" was read yesterday at the Falcon Works Engineering Society, at Loughborough, by Mr. J. J. Steinitz.

The Municipal Electrical Association.—At a meeting of the Council of the Municipal Electrical Association, held at the Westminster Palace Hotel on Friday last, Mr. A. H. Gibbings, the electrical engineer to the Corporation of Bradford, was

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unanimously elected President for the forthcoming session. Mr. Gibbings, it will be remembered, has been a member of the Council of the Association since its formation. The next convention of the Association will be held in London, and will take place in June next.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Ceara—Maranham	Dec. 23, 1897	—
Curaçao—La Guayra	Jan. 5, 1898	—
Para—Cameta	Jan. 13, 1898	Jan. 27, 1898.
Para—Maranham	Jan. 22, 1898	—
Bolama – Bissao	Jan. 28, 1898	—

Destruction of Overhead Wires in Boston, U.S.A.—The blizzard which swept across the northern part of the United States during the past week has done enormous damage to the various systems of overhead wires. It is reported that at Boston, Mass., the fire alarm system was completely wrecked, while telegraph, telephone and trolley lines were brought down, greatly impeding traffic and hampering business communications. Telegraphic communication with Boston, on the land side, was restored on Wednesday afternoon by the repair of one of the lines.

British Control of Submarine Cables.—*Elektricität*, of Leipzig, in its issue of January 22nd, is responsible for the following effusion:—

Notice has lately been repeatedly called to the fact that almost all of the ocean cables are in English hands. England, in the course of the last 50 years, has encircled the world with a veritable net of cables, which has done much to secure its commercial supremacy. The possession of so comprehensive a cable system, together with the enormous sums which the companies earn, have greatly assisted to make London the trade centre of the world, and other great cities of Europe are beginning to realise that it is time to alter this state of affairs. France has lately been making considerable efforts to free itself from the English cable monopoly, and the first great step in this direction was the opening last summer of the cable between Brest and the United States, which broke through the English monopoly in the Atlantic. The fact that the German line to Spain has met with such success and been so largely patronised, not only by Germany, but also by Holland, Denmark, Norway, Sweden and Russia on the one hand, and the United States, Africa, Asia and Australia on the other, is a sufficient argument for an early extension of the German ocean cable system. The extensive use made of the existing lines speaks well for the prospects of success of a German line to North America. German industry and German trade are now beating England in every market in the world, and this is all the more reason for Germany to learn to dispense with English mediation altogether. Germany can stand on its own feet, Germany can itself work an ocean cable to America, and it is to be hoped that this important work will soon be commenced.

Patents Expiring.—A patent, interesting if only from a historical point of view, will expire next Sunday. It was granted to Lucien Gaulard and John Dixon Gibbs on February 6, 1884, for "Improvements in Means for Producing and Utilising Electric Currents in Secondary Circuits." Referring to the system of producing secondary currents now embodied in all transformers, but then practically unknown, the inventors state that they have discovered it to be necessary, in order to produce practical results, to keep the current and the "vibrations of the current" in the primary circuit constant, and to make the variations of the electrical energy required by varying "the tension of the current at its source." They refer to the self-induction of the coils of such induction coils, and, imagining that this causes a loss of energy, and a consequent loss in efficiency, they endeavour to counteract it by a peculiar method of construction. A concentric conductor is used to form the primary and secondary. The core is a single conductor carrying the primary current, and round this are laid a number of wires insulated from one another, and from the central conductor. The cable thus formed is wound on a bobbin, which may be provided with an iron core, and the insulated wires surrounding the central conductor are connected together in multiple arc and form the secondary. The iron core may be surrounded by a copper cylindrical envelope, the introduction or withdrawal of which varies the current developed in the secondary. An alternate form of conductor is suggested, in which the primary is a flat copper ribbon, and is surrounded by insulated conductors connected in multiple arc as above. "The result of this novel system of induction," says the specification, "is that by separating from one another the spirals of the inductor, and surrounding it with a secondary circuit, the reaction of the induction of the spirals of the primary circuit on one another is wholly or in part avoided. A considerable resistance due to counter electromotive force on the primary current is neutralised, thus preventing a transformation into heat of a great part of the transmitted energy. . . ." A document such as this, representing the state of electrical knowledge only 14 years ago, brings forcibly to us the strides made in recent years by the systematic study of the theory of electricity and its practical applications.—Another patent, No. 3,034. 1884, granted to Charles Hodgson, will expire on the 9th of this month. It relates to improvements in apparatus for electrically controlling railway signals, and describes an electromagnetic arrangement by means of which a semaphore worked mechanically from one point can be electrically restored to or locked in the danger-position from other points.—On the 11th inst. Joseph Boguski's aluminium-bronze patent expires, a patent broadly claiming the production of aluminium-bronze from melted kryolite or from other compound of aluminium and a flux, in presence of copper, brass or other metals, by means of the electric current.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 4th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Paper to be read: "Electro-Magnetic Brakes and their Capabilities," by L. H. Walter.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on "Some New Studies in Cathode and Röntgen Radiations," by A. A. C. Swinton.

SATURDAY, February 5th.

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' visit to Messrs. Siemens' Works, Woolwich. Train from Fenchurch-street at 10.5 a.m. Applications to join the party should be made at once to the Students' Hon. Secretary (Mr. S. Grant, 28, St. Mary Abbott's-terrace, W.), as the number will have to be limited.

CHESTERFIELD AND MIDLAND COUNTIES INSTITUTION OF ENGINEERS and MIDLAND INSTITUTE OF MINING, CIVIL AND MECHANICAL ENGINEERS.

2.30 p.m. Joint Meeting in the large room of the Literary and Philosophical Society, Leopold-street, Sheffield. Papers for discussion: (1) "Latest Developments and the Practical Applications of Alternating Multiphase Machinery for Electric Power Transmission," by Walter Dixon; (2) "On Some Dangers Attending the Use of Steam Pipes," by A. L. Steavenson.

MONDAY, February 7th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7.30 p.m. First Ordinary Meeting at the Royal United Service Institution, Whitehall. Presentation of Premiums for Papers read during the past year. The President for the year 1898, Mr. W. W. Beaumont, will deliver his Inaugural Address.

WEDNESDAY, February 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Conclusion of discussion on Major-General Webber's Paper: "Notes on the Electro-Chemical Treatment of Ores Containing the Precious Metals." Paper to be read: "An Electrolytic Process for the Manufacture of Parabolic Reflectors," by Sherard Cowper-Coles.

SOCIETY OF ARTS.

8 p.m. Ninth Ordinary Meeting. Paper to be read: "Compensation to Workmen," by A. D. Provand.

THURSDAY, February 10th.

INSTITUTION OF MECHANICAL ENGINEERS.

7.30 p.m. Adjourned discussion on Mr. P. Dawson's Paper on "Mechanical Features of Electric Traction."

FRIDAY, February 11th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting, in the rooms of the Chemical Society, Burlington House. Address by the President. Paper to be read: "On Electromagnetic Induction in Plane Cylindrical and Spherical Current Sheets, and its Representation by Moving Trails of Images," by G. H. Bryan.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "The Protection of Power Transmissions from Lightning," by J. T. Morris

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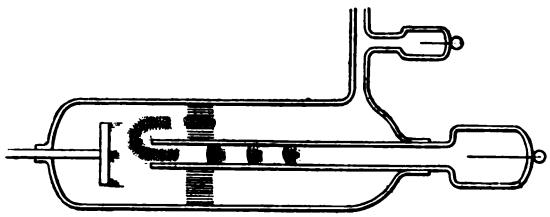
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Vacuum Discharges in a Magnetic Field.—A. Paalzow and F. Neesen have examined the influence of a magnetic field, not so much upon the luminous phenomena as upon the current strength of the vacuum discharge. This they were enabled to do by the constant high-potential battery in their possession. The characteristic difference between this constant discharge and the induction-coil discharge is that the former can sometimes be prevented by the magnetic field, the latter never. To examine the influence of the field both when its lines of force where parallel and when they were perpendicular to the axis of the tube, the authors employed a compound tube in the form of a cross, with an electrode in each of the four branches. In the "equatorial position," with the lines of force acting across the path of the current, the latter was always enfeebled and sometimes broken altogether. In the axial position, with only the space between the electrodes exposed to the uniform magnetic field produced by an enveloping coil or by perforated pole-pieces, the current was weakened at the higher pressures at which the discharge begins to set in. At the maximum intensity of discharge there was no perceptible influence, but when the exhaustion reached the limiting pressure the current was strengthened. The magnetic field acted, in fact (unless the cathode itself was exposed to the field) like an increase of pressure of the gas. No difference was observed in the behaviour of paramagnetic oxygen and diamagnetic hydrogen.

[Paalzow and Neesen, *Wied. Ann.*, No. 13, 1897.]

Resistance of the Cathode Space.—Eilhard Wiedemann has made some interesting experiments to determine the cause of the increase of resistance of a rarefied gas when the anode is brought very near the cathode. Some time ago he showed that if a wire anode is brought into the dark cathode space the positive light bends back until it reaches the negative glow light. To find whether this is due to an effect upon the



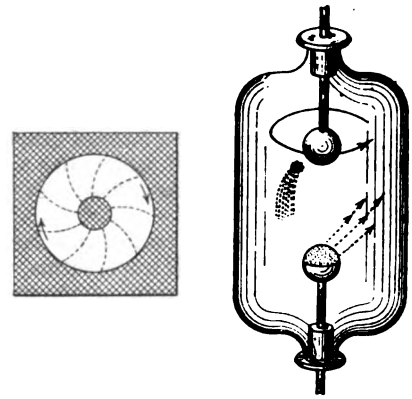
anode itself or upon the positive light he constructed the tube shown in the diagram with two anodes, one of which is enclosed in a narrow tube. When the latter anode is used the positive strata are seen to bend back, as shown, until they merge into the negative glow. When the other anode is used the positive glow penetrates into the narrow tube. In every case, therefore, the discharge proceeds from the positive light to the negative glow, and thence through the dark space.

[Wiedemann, *Wied. Ann.*, No. 13, 1897.]

Simple Demonstration of the Zeeman Effect.—W. König corrects the assertion of Egoroff and Georgiewsky that the partial polarisation of the light of a magnetised candle-flame is an illustration of the Zeeman effect. The latter implies a difference in the vibration periods of the luminiferous particles, but not a resultant change of direction of vibration. He has, however, devised a means of effectively exhibiting the phenomenon which is of remarkable simplicity, and will probably do much to make it better known. One sodium flame will absorb the light from another flame if the temperatures are suitably regulated, as may be done by a piece of wire gauze. But when the emission flame is in a magnetic field, different periods of vibration are produced in it, and the dark flame lights up when seen through the absorbing flame. This does not apply to the case in which the flames are viewed in the direction of the lines of force, since the magnetised flame consists of two portions of circularly-polarised light in opposite directions. But across the lines of force the two portions have the same plane polarised condition. The simple absorption of the light of one flame by another may be demonstrated by throwing the shadow of the absorbing flame upon a screen of obscured glass. When the emission flame is fed with a lithium or thallium salt, as well as sodium, the shadow appears red or green, showing that the new vibrations are not absorbed. To observe the Zeeman effect the emission flame is viewed through the absorption flame and through a dichroiscope, or through a doubly-refracting prism, which gives two images of the emission flame side by side. If the flame was colourless to begin with, then on making the field only one of the images lights up, that being the one whose vibrations take place in a vertical direction. If the emission flame is coloured with another salt the effect is obtained as a kind of dichroism of the flame, the two images being differently tinted on magnetisation. If well regulated the polarisation of the light is complete and well distinguished from the partial polarisation above mentioned. If the magnetised flame is observed with a Savart polariscope, and the absorption flame is then interposed, the feeble interference fringes become distinct and perfectly dark. If the emission flame is coloured with lithium, the dark fringes appear in the red colour of the lithium. The phenomenon observed by Egoroff is probably a partial development of this effect, due to the self-absorption of the flame.

[König, *Wied. Ann.*, No. 13, 1897.]

Magnetic Wind.—The explanation of the phenomenon of "electric wind," meaning the discharge from points accompanied by a blast of air, has taxed the successive theories of



electric discharge to the utmost. That air can be electrified has been generally denied by the more recent workers, and the effect upon air has, since Helmholtz, been attributed to a dissociation of the gaseous molecules. Unless a higher than atomic dissociation is assumed, this hypothesis meets with serious difficulties in the case of monatomic gases. There remain the wave theories sketched out by Hertz, Goldstein, and others, which embrace all vacuum discharges. But O. Lehmann has recently carried out an investigation of the phenomena of electric and "magnetic" wind, which tend to put these theories out of court. It appears that the air currents between two opposed points, made visible by tobacco smoke or by a heavier gas, can be explained by the projection of two opposed currents of particles or ions, which produce a motionless layer in the middle. If for any reason a layer of air acquires a different dielectric capacity from the rest, partial discharge takes place within it, which gives the appearance of a stratified discharge. Electric wind is the cause of the unsymmetrical shape of the arc, which is blown away from the negative pole. If the electric wind occurs in a strong magnetic field the stream lines of the ions, and hence also of the air, must be changed in obedience to the electromagnetic forces, since a moving ion is equivalent to an electric current. This may be well shown by means of the arc, which rotates in a magnetic field originally devised by Andrews. One of the poles is a plate with a circular perforation, the other is a carbon rod with its end in the centre of the circle. The arc playing between the rod

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and the inner edge spins ronnd rapidly in a magnetic field with its lines of force parallel to the rod. If an alternate current with 100 reversals per second is used, it often happens that the arc spins round 50 successive times in the same direction between every two reversals. The spiral paths of the carbon particles show that it is a case of magnetic wind, and not an influence upon an ether phenomenon. In a large highly exhausted "electric egg" the author recently noticed a curious phenomenon in this connection. It was an appearance resembling a comet, consisting of negative glow light and a brush or tail, which projected from the cathode in an eccentric direction. On approaching a magnet to it from the outside it began spinning round the axis of the vessel, the rate increasing with the proximity of the magnet, and reversing on reversing the poles. The author seeks an explanation in the eccentric impact of a stream of air upon the cathode.

[LEHMANN, *Wied. Ann.*, No. 13, 1897.]

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

PART I.—PHYSICAL PROPERTIES OF CARBON.

Before I proceed with a description of the modern process by which electric light carbons, electrodes and battery plates, &c., are manufactured, I shall consider some of the peculiarities and facts that are known to exist concerning the interesting element (carbon) from which they are made.

Carbon (Symbol C), combining weight 11·97, is one of the most important of all the elements, without which no animal or vegetable body could exist. We find it in Nature in the form of the diamond, of graphite, of various varieties of coal, and, in fact, it exists in enormous quantities in combination under a variety of forms. In its purest and rarest form it is found as the diamond, which has a density varying from 3·30 to 3·55. Less pure it occurs in the form of graphite or plumbago and anthracite, the former of which has a density varying from 2·15 to 2·35, while the density of the latter is between 1·4 to 1·6.

Allotropic Forms.—The most remarkable fact concerning carbon is that it exists in three allotropic forms, which forms, as we shall see, have in appearance or physical properties nothing in common. In fact, we see that their densities vary greatly, also that they differ in colour and hardness, while chemically they are all identical. These three allotropic forms are: (1) the diamond, (2) graphite or plumbago, and (3) charcoal. In the form of the diamond carbon is crystallised in forms which belong to the "regular system" of crystallography. Its origin in nature seems to be unknown. It has been found that when the diamond is burned in oxygen gas it leaves a minute yellowish ash, having a cellular structure. When inserted between the poles of a strong arc it soon swells up, becomes opaque, conducts electricity, the density becoming diminished, and at the same time it is transformed into a mass resembling coke. All these facts, together with the recent experiments made by M. Henri Moissan with the help of the electrical furnace, affords, we think, sufficient and conclusive proof that its formation was or is due to crystallisation after fusion, under great pressure, which conditions Nature can and has fulfilled in its past periodical evolutions. Diamond, when polished, has a very brilliant lustre, it possesses the standard coefficient of hardness, and it is a non-conductor of electricity.

All these facts show how totally different it is from form (2). Graphite occurs in Nature either in massive, or six-sided crystalline plates of the "rhombohedral system." In commerce it is known either as the amorphous or foliated plumbago. It has a sort of metallic lustre, grey and black, can be easily broken, crumbled, and reduced to powder, and when rubbed on paper it leaves traces, on account of which property it is used in the manufacture of lead pencils, &c. It is a fair conductor of electricity, and burns or oxidises more readily than the diamond.

The third allotropic modification is charcoal, and includes lampblack made from vegetable or mineral oils, coal, coke, animal charcoal, &c. This form, it may be mentioned, under ordinary conditions does not crystallise, and has received the name of "amorphous carbon." In general it is an excellent conductor of electricity, oxidises or burns readily, much more than either of its two other forms already mentioned above. It is to this class of carbon that we shall turn our attention, as it is the only kind that is at present suited practically and commercially for the manufacture of carbon used in connection with electrical purposes. It may be mentioned, however, that when cast iron is melted in contact with a large amount of charcoal a large proportion of it is taken up, and on cooling it slowly the carbon crystallises into six-sided plates that resemble those of graphite. By means of the arc, or electrical furnace, all kinds of carbon undergo this transformation. From what has been shown above it is clear that the transformation from one to either of the two other allotropic forms of carbon simply depends upon the functions of heat and pressure.

We shall now take a retrospective glance at what has been done by early investigators, who worked and experimented in order to attain the manufacturing of practical electric-light carbons.

PART II.—HISTORICAL NOTES.

Sir H. Davy was no doubt the first to employ carbon electrodes in connection with the arc. His electrodes were simply made out of charcoal—that is, points or rods cut out of carbonised wood—and were neither dense nor homogeneous. It is self-evident that these carbons were very rapidly consumed, a fact which is not surprising when we consider the current and voltage he employed. He used the great battery of the Royal Institution, which consisted of 2,000 pairs of plates, constructed after Wollaston's design, with which he obtained an arc about 10 centimetres (4in.) long. No doubt if we would take some of our modern carbons and subject them to an arc of 4in. length they would not last long.

Foucault was one of the first to make use of deposited carbon, or the coke that condenses on the inside of the retorts used in the manufacture of gas, We find, however, as early as 1846 *Staite* and *Edwards* patented a process of making carbon electrodes by mixing pulverised coke with sugar, which mixture was moulded and subjected to a high pressure and baked until it attained a white heat. It was then again dipped in a concentrated solution of sugar, in order that the sugar might enter the pores and make the whole more dense. The electrodes were then subjected to a second baking.

In 1849 *Leonolt* patented carbons which consisted of two parts of retort coke, two parts of wood charcoal, and one part of liquid tar, the whole being worked in a paste, well kneaded, moulded, pressed, covered with sugar or syrup, and then subjected to a high temperature for about 30 hours. Leonolt also tried to purify his carbons after they were baked by immersing them in different acids.

Messrs. *Watson* and *Slater*, in 1850, experimented on similar basis to those described above. *Lacassagne* and *Thiers*, in 1857, tried to purify carbons by immersing them in fused caustic soda or potash, their object being to change the silica which the carbons contained into soluble silicates. The carbons were then steeped in hot water, and afterwards exposed to a current of chlorine gas which passed through a heated porcelain tube in which the carbons were placed. They wanted to convert the various earths that were not acted upon by the soda or potash into volatile chlorides of silicium, calcium, &c. Not long after these experiments, which were of no practical value, *Curmer* conceived the idea to make carbons out of a mixture of lampblack, benzine and turpentine. This mixture, after being kneaded, pressed and baked, left a porous coke, as the benzine and turpentine in a large measure volatilised during the baking. *Curmer* took these porous carbons and saturated them with resin or syrup and then baked them again.

Jacquelain, who was formerly a chemist at the Ecole Central of Paris, made carbons by using the carbides of hydrogen obtained in the distillation of coals, turf, &c.; also from the products obtained by the carbonisation of these materials, which were placed in sealed vessels. It may be mentioned

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that he obtained fair results, but would never venture, or was unable, to work out a practical mode of operation.

Gauduin also worked upon carbons which he made out of lampblack; the price of this material, however, was so high at the time that he was obliged to seek some other substance or source. He heated resin, pitch, tars, and oils in closed vessels, and, after decomposition, these left sufficiently pure carbon. It may be mentioned that the volatile products of the above substances were conducted from the closed vessels by means of worm-tubes and condensed, and were used again in mixing. *Gauduin* proceeded by pulverising the carbon which was left after decomposition, afterwards mixing it with a certain percentage of lampblack, using as the binding material the carbides of hydrogen which he obtained, as mentioned above, as a secondary product arising from the decomposition of the resins, pitch, oils, &c. He then kneaded the mixture and moulded the same with the use of steel moulds, which were then subjected to the pressure of a powerful hydraulic press. These carbons after being baked were considered as superior to those met with in commerce at the time.

Carré, however, seems to have had the greatest success in the production of carbons, which were considered perfect from a commercial and scientific point of view, and we may justly consider him as the founder of the present carbon industry. No doubt the undevoloped state of electric lighting at the time when those early investigators worked upon the problem had a great influence upon their work, and we shall see hereafter that some of them were not far out of the way, and that the modern practice differs from their's only in that the system has since been worked out in a more and perfect mechanical method. When M. Carré studied the problem, the Gramme machine had just appeared, and a host of inventors were struggling to construct a good arc lamp. There were demands for a good carbon, and one that was practical in every respect, so that on the whole the time was very favourable to the founder of the commercial arc lamp carbon industry. Carré gives an account of his experiments and work in the *Comptes Rendus de l'Académie des Sciences*, February 19, 1877, as follows:—"The superiority of artificial carbons for various experiments, and the possibility of purifying by alkalis, acids, *aqua regia*, &c., the carbonaceous powders that enter into their composition, then led me to seek for some means to produce them economically. By moistening the powders either with syrups of gum, gelatine, &c., or with fixed oils thickened with resins, I succeeded in forming pastes sufficiently plastic and consistent to be forced into cylindrical rods through a draw-plate placed at the bottom of a powerful compression apparatus of about 100 atmospheres. Carbons are now manufactured by this process, and I have at various times presented some of them to the Académie des Sciences and to the Société d'Encouragement.

"These carbons have three or four times the tenacity, and are much more rigid than retort coke carbons, and cylinders of 10mm. diameter and 50cm. long may be used without any danger of splintering during a break in the circuit, which often happens with others. They may be as easily obtained of the slenderest diameters (2mm.) as of the largest. Their chemical and physical homogeneity gives great steadiness to the arc; their cylindrical form, combined with the regularity of their composition and structure, cause their cones to continue as perfectly shaped as if they had been turned in a lathe, and therefore there are no occultations of the point of maximum light like those produced by the projecting and comparatively cold conners of the retort coke carbons. They are not liable to the inconvenience of flying into splinters when first lighted, as the others are, in consequence of the great and sudden expansion of the gas contained in their cellular spaces, which are sometimes 1 cubic mm. in capacity. By giving them one and the same uniform density they are consumed by the same amount for an equal section; they are much better conductors, and, without the addition of any substance other than carbon, they are even more luminous in the proportion of 1·25 to 1·00."

Carré's Carbon Mixture.—The mixture which Carré preferred, and patented on January 15, 1876, is as follows:—

Very pure coke, finely pulverised	15 parts.
Calcined lampblack	5 "
Syrup of sugar	7 to 8 "

This whole mixture was well pounded together, kneaded and worked into a sort of hard paste. Afterwards, it was pressed through a draw-plate by means of a hydraulic press, and the carbon rods were piled into retorts and baked at a high temperature.

From that period up to the present time improvements have mainly consisted in the perfection of the machines that are used in connection with the raw material, and in the process of baking. The modification of the core which the positive carbon contains is an invention of Siemens. Carré also found that when soda or potash was introduced into the carbons these substances had a tendency to double the arc, render it silent, and, by combining with the silica, which is always present in retort coke, they eliminated it in transparent, glassy globules at about 6mm. or 7mm. from the points. The light was also said to be increased in proportion of 1·25 to 1·00. Lime, magnesia, and strontia increased the light in proportion of 1·30 or 1·50 to 1·00, while giving at the same time different colours according to the substance introduced into the carbon. Boric acid increased the life of the carbons by covering them with a glassy coating, which protected its surface somewhat from lateral combustion, while there were no indications of an increased effect in light. Iron and antimony brought up the increase to 1·60 and 1·70 as regards light.

It was *E. Reynièr* that noticed that a large percentage of the carbon in an arc lamp was consumed by wasteful combustion—that is, by combustion that did not contribute its share of light. He found this combustion going on at the lateral surface of the carbon around the heated points, and that there was a great draught of air continuously washing the lateral surface of the heated points, which thus consumed the carbon. He thought it would be advantageous to thus cover the carbons with a metallic covering. From the experiments which he made at the workshops of Sautter and Lemonnier, Paris, he obtained the following results: 9mm. diameter carbons covered with nickel increased 50 per cent. in life, while 7mm. carbons were lengthened in life up to 62 per cent. Carbons covered with copper also received a lengthened life intermediate between the naked and the nickellised carbons. It may be mentioned that the metals were deposited galvanically. Reynièr also noticed that carbons with metallic covering did not modify the amount of light they gave, there was neither an increase or decrease. This question of increasing the life of the carbons has occupied the minds of men from that time up to the present date. Some inventors cover the carbons first with zinc and then with copper, and thus produce a sort of brass covering which increases the life to a certain extent. The writer patented a contrivance some years ago by which the lateral combustion was to a great extent prevented, and the increase in life amounted to 100 per cent. and over. This contrivance consisted of a protecting tube made of steel and lined with refractory clay, which was suspended by means of a wire frame that admitted of adjustment. The frame also carried a small glass cylinder of about 4in. length and 3in. diameter. The bottom part of the frame had a ring made of nickel which had three projecting platinum claws. This whole apparatus is placed on the lower carbon of an arc lamp. This lower carbon (continuous-current lamp) burns, as is well known, always with a sort of a conical point or peak, and on this point the platinum claws rest at about 9mm. or 10mm. from the tip. As the carbon consumes the ring with the claws and the whole apparatus descend, but keep their relative position with respect to the arc constant. The whole apparatus is adjusted so that the upper carbon projects about 5mm. out of the protecting tube. It will be seen that by this arrangement there can be none, or at least very little, air-washing, and the upper carbon burns away with a flat end instead of a conical one, as in ordinary lamps.

Enclosed Arc Lamps.—The Jandus, Stewart, and General Electric lamps are other devices in order to do away with this lateral combustion. In these lamps the whole arc is enclosed in a glass globe into which very little air can penetrate. The openings at the top and bottom of these globes are just large enough to allow the carbons to pass freely. These openings consist generally of metal rings that are free to move and yet prevent the air entering the globe. The carbons generally

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used in these kind of lamps are solid for both upper and lower, and generally last from 100 to 150 hours. It is interesting to note the fact that Sir H. Davy enclosed his carbons when experimenting with the arc in a glass globe similar to the arc lamps mentioned above. We find in Ganot's "Physics" the following lines relating to Davy's experiments:—"As charcoal rapidly burns in the air, it was necessary to operate in vacuo, and hence the experiment was for a long time made by fitting the two points in an electric egg." The electric egg is described as: "This consists of an ellipsoidal glass vessel with metal caps at each end." From this we see that the modern enclosed arc lamp can trace its origin back to Davy's time.

All these contrivances, whether the writer's apparatus in which the arc was partly enclosed, or as in the Jandus, Stewart and General Electric lamps in which the arc is wholly enclosed, take higher voltage and less current than in the ordinary lamps. The watts remain at about the same value. In fact an enclosed arc under ordinary conditions takes about 80 volts and 5 amperes, whereas the lamp, or rather arc, without being enclosed would take 40 volts and 10 amperes.

(*To be continued.*)

NOTES ON SYNCHRONISING ALTERNATORS.

BY H. E. M. KENSIT.

The first question that presents itself in the parallel running of alternators is to ascertain whether the synchronising transformers are so connected that the alternators are in phase when the lamp is bright, since if they should accidentally be so connected that the transformer on the incoming machine is opposed to that on the loaded machine, then the lamp will be full bright when the machines are dead out of phase, and the result will, of course, be that they will be paralleled out of phase.

Many central station engineers still solve this question by the "trial and error" method of paralleling through light fuses in the first case, and risking blowing them with 4,000 volts across the terminals, not to mention the strain on the alternators.

Yet the arrangements necessary for avoiding this are so exceedingly simple that it is surprising they are not in universal use. They are also frequently required, as, in the case, say, of a newly-installed machine, or one that has been dismantled for cleaning or repairs, it is always better to settle this point before paralleling the machine on to the 'bus.

The usual arrangements are to have the synchronising transformers either across one coil of the armature or across the alternator terminals.

First taking the case where the transformers are across only one coil, and referring to the diagrammatic sketch in Fig. 1, let A A represent double-pole switches for connecting machines to 'bus. Take No. 1 to be a machine connected to the 'bus, and No. 2 to be the incoming machine, of which it is uncertain whether the synchronising connections are correct. It is required to find, before paralleling, that the machines are in phase when the lamp is bright. In other words, the transformers must be so connected that when both 'bus plugs are in the lamp will be bright. Before starting No. 2 trace the lead from the switchboard terminal connected to B' to the alternator terminal, and see that the lead from the other side of the adjacent coil is connected to C'. Disconnect at B and C, and run up alt. 2 to speed. Then take leads from B' and C', and apply to terminals B and C respectively—B, for the purpose of paralleling, being taken to be the red or positive side of the 'bus, and C the black or negative. If the lamp is then bright, it is obvious that if B and B' are both connected to the positive sides of the 'bus, and C and C' to the negative sides respectively, the coils of the transformers will always be in phase and the lamp bright when the alternators are in phase. If not, then the leads of B' C' must be reversed.

Next, take the case when the transformers are connected direct across the alternator terminals. This arrangement is shown in Fig. 2, and is even simpler than the preceding. Take A_1 A_1 to be double pole switch plugs as before, and No. 1 to be the loaded machine, while No. 2 is the incoming. Then take out the fuses of No. 2 or raise the brushes at the alternator and insert the 'bus plug at A. If, then, the lamp is bright, all is right for paralleling. If not, the leads to the synchronising transformer of No. 2 must be reversed.

Another case that often occurs in practice is where it is necessary to parallel a machine, of which the synchronising transformer is fed off only one coil with a machine of which the synchronising transformer is across the alternator terminals. In this case it will be seen that neither

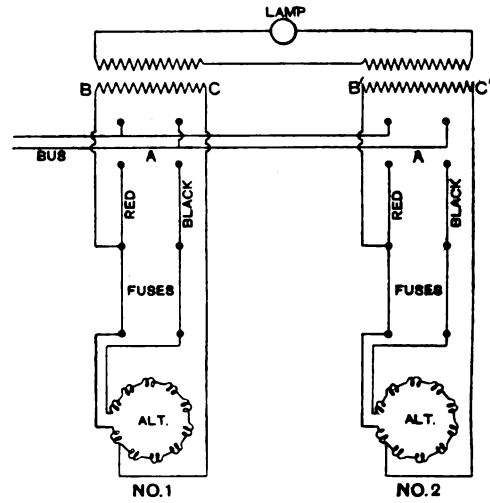

Fig. 1.

methods 1 nor 2 are applicable, and that the temporary use of another transformer is necessary. Referring to Fig. 3, let A, A, as before, represent double-pole 'bus switches, No. 1 the running machine, and No. 2 the incoming. Connect up a transformer temporarily, as shown by dotted lines. Disconnect leads B' C' D' and E', and connect D' to F and E' to G. Then run up No. 2 alternator to speed. If the lamp is not now bright reverse the H.T. leads to the temporary transformer. Then disconnect leads D' and E' from F and G, and secure them in their proper places, and connect up

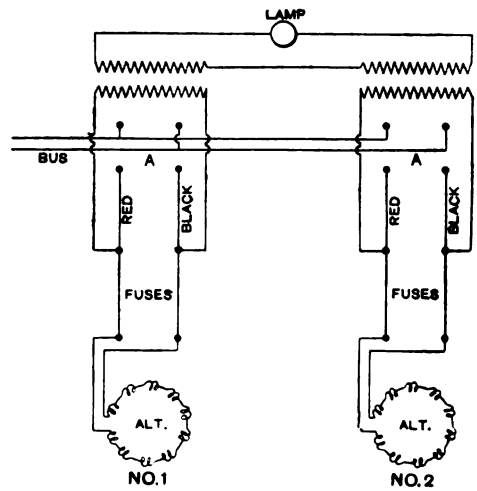

Fig. 2.

B' C'. Next disconnect at D and E and connect D to F and E to G. If the lamp is not bright reverse the leads at B' C', and replace the leads at D and E.

We have now, in the first place, proved that No. 2 is right for paralleling by means of the temporary transformer, and we have then made the transformer on the one coil correspond with the temporary transformer—the latter can now be removed and the alternators paralleled by means of their own switchboard transformers with every confidence. In the converse of this case, *i.e.*, if No. 2 was the loaded machine and No. 1 the incoming, it would only be necessary to withdraw

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No. 1 fuses and close the 'bus switch, as in case No. 2. The importance of using some such methods as these, especially in the case of alternators possessing little or practically no self-induction, is obvious, and they will give but little more trouble than wiring and changing the fuses.

An inspection of Figs. 1 and 2 will show that the second method is decidedly the simplest and best. With the synchronising transformer across the alternator terminals, should any doubt arise as to whether any connections have been changed, it can be immediately settled before paralleling, by simply withdrawing the fuses and closing the 'bus switch. It will also be seen that with this arrangement no subsequen changing of the alternator leads can in any way affect the conditions for paralleling ; and, furthermore, it gives greater uniformity, all the transformers being wound in the same ratio, and having the same voltage applied to them.

In the first method, using only one coil, confusion is apt to be caused by getting different readings from each machine on the paralleling and hospital voltmeters, and special connections must be made if it is necessary to see that all is right before paralleling.

It is often stated that alternators can be better synchronised when the speed is being raised than when it is being decreased. In a somewhat extended experience with various types of alternators the writer has never been able to detect that this makes the slightest difference. A Cardew voltmeter, with its dead-beat action and open scale, is a most satisfactory instrument for the purpose of synchronising. In fact, so clear and deliberate are its indications that it is hardly possible to be far

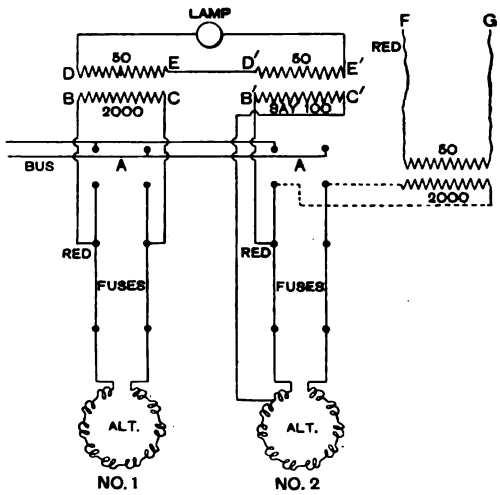

FIG. 3.

out if a slight allowance, say two volts, is made for the lag of the instrument. If this is not done, the machines may have started to drop out of phase before the switch is actually closed, and to be too late is undoubtedly worse than to be too soon.

To parallel with a lamp or two lamps is somewhat trying, since, if the first and perhaps second opportunities are not good enough, the staring at the fluctuating light is apt to have a dazzling and confusing effect that does not conduce to the use of the deliberate judgment necessary to secure a successful result. With a gravity voltmeter, again, the swing is deceptive, but with a hot-wire instrument, and engine-drivers who understand their business, there would certainly seem to be but little need for automatic devices for paralleling alternators.

With machines of the E.C.C., Leeds and London, Ferranti disc armature, and Parsons steam turbo types, the writer has not found that the very different amounts of self-induction possessed by these machines has caused any difficulty in distributing the load amongst them in any proportions desired. Usually the load on any machine can be adjusted by varying the excitation only, and this appears to be done with greater ease in stations where each machine is independently excited. When, however, the needle of the alternator ammeter develops an abnormal amount of swing, it is usually caused by a tendency to difference of speed, and therefore of alternations, and is best remedied by adjustment of the steam at the stop valve. In some cases, of course, adjustment of both steam and excitation is necessary.

As the result of a large number of observations, the writer has found it possible, where the plant runs well in parallel and the ammeters are suitably damped, to read the current given by several alternators of different types in parallel to within an average of 3 or 4 per cent. In one set of readings taken the largest error (comparing the readings with the sum of the circuit readings) was 6 per cent., and many coincided. This does not imply that very little or no synchronising current was passing, as a certain amount of swing of the needles is always present, and represents this ; but if the parallel running is good, it will be a steady swing, easily averaged, and allowing the load on the machines to be read with sufficient accuracy almost at a glance.

THE POST OFFICE ELECTRIC MAIL VAN.

Since about the 24th ult. the London Electrical Cab Company, under contract with the Post Office, have been daily running a mail van between the General Post Office and Paddington.

Post Office Electric Mail Van.

Between these terminal-points two calls have to be made, one at the West Central Office, and the other at the Western District Office. Six journeys per day are made, representing a total distance of 35 miles. The total weight of mails carried is, of course, very variable, but it frequently exceeds a ton.

The cells used are of the E.P.S. Faure-King type, specially made for this purpose. Each cell is 6¼in. square in plan, and 10in. high, and contains 11 plates which have a capacity of 172 ampere hours at a discharge rate of 30 amperes. Forty such cells are used, always in series, giving a pressure of about 80 volts. The cells are carried in a single tray, which is slung under the bottom of the van by four suspension links supported from the body of the van by helical springs under compression. The total weight of the battery is about 13cwt. Through hinged doors in the floor of the interior of the van the motor is easily accessible. The latter is of the Johnson-Lundell two-pole iron-clad type, in which the field winding surrounds the armature. This type of motor the company find to be more efficient than the four-pole type hitherto used in their cabs.

There are two armature windings, two commutators, and two series field windings on each motor. The brushes are of carbon, fed end-on to the commutator by a simple flat spring. The capacity of the motor is about 3½ H.P., and the mean working current about 30 amperes. On the armature spindle

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is a raw-hide pinion having 20 teeth, which gears into the central wheel of the differential gear, this wheel being provided with 62 teeth. To provide for the different speeds of the driving wheels in negotiating curves, the countershaft is in two halves, each half being driven by the differential gear illustrated in Fig. 3 of *The Electrician*, Vol. XXXIX., p. 540. These countershafts run in self-aligning bearings, and each carries a sprocket-wheel having 18 teeth. Sprocket-chains connect these with the larger sprocket-wheels fixed to the driving wheels, and bearing 120 teeth. Finally, the diameter of these rear or driving wheels is 8ft. 6in. The many difficulties encountered in the tyres have been met by the use of solid round rubber tyres of small cross-section. The controller admits of five combinations, which secures different speeds and tractive force: (1) All the windings on the motor, together with a resistance, in series; (2) the same, but with the resistance cut out; (3) the two field windings in parallel and the armature windings in series; (4) the fields in series and armature windings in parallel; and (5) the two field windings in parallel, connected in series with the two armature windings in parallel. The motor may be reversed at the slow speed by placing the regulator handle back of the neutral or top notch. The action of putting on the brakes also puts the motor out of circuit, so that the latter never works against the brake.

A key is provided by which alone the cells are connected to the regulator, and by which the driver is enabled to leave the van "out of gear." The turntable, to which the front two wheels are attached, is provided with a toothed wheel; this gears into a pinion on a vertical spindle, on the upper end of which is fitted a worm-wheel gearing into a worm operated by the driver's steering wheel. It may be added that the laminated type of sprocket-chain hitherto used on the cabs is being replaced by a chain closely resembling the ordinary bicycle sprocket-chain.

The accompanying illustration gives a view of the mail van. The daily service of six journeys is performed with one battery charge, and has, so far, been characterised by perfect punctuality—an essential feature in a mail service. The maximum speed of the van is from 10 to 11 miles per hour on the level road. We have to express our appreciation of the courtesy and kindness extended to us by Mr. Walter C. Bersey on the occasion of our recent visit to the works of the London Electrical Cab Company in Lambeth.

MECHANICAL FEATURES OF ELECTRIC TRACTION.*

BY PHILIP DAWSON.

(Concluded from page 451.)

The demand for this special class of work brought out a host of devices, of which 10 years' experience has sifted the useful from the useless; and it may be fairly stated that the chief principles involved in the design of a thoroughly good motor-truck, fulfilling all or most of the conditions imposed by electric traction, have now been fully recognised, with the result that the electric motor-truck has been matured to a standard form. Truck building has become an independent business in America, although many car works still make some form of truck for themselves. Rigid frames had been employed in trucks for cars driven by gas, steam, compressed air, or cable grip; but in all of these the conditions are entirely different from those in electric motor-cars. This experience was dearly bought by some of the earlier electric tramways, as was testified by many a scrap-heap composed of trucks which, after running but a few miles, had to be discarded. The quality of the motor trucks may mean the success or failure of an electric tramway; and to secure a good truck is quite as indispensable as to use a well-constructed and efficient motor. A motor truck comprises many parts, the most important of which are the side frames, springs, wheels, axles, boxes, bearings, motor bearings and suspension, sand-boxes, brakes, and safety appliances. The following are the essential conditions which must be fulfilled by a truck in order that it may be suitable for electric traction:—

1. The truck must be as light as possible, consistently with rigidity and strength.

2. It must be thoroughly braced, so as to keep it stiff and square without having to depend in any way on the car body. The strains on a motor car in rounding curves, and when passing a change of gradient, are extremely severe; much more so than with horse-cars, where the horses pull the car round on curves, and go slower at a change of gradient.

3. The journal boxes must be self-lubricating, must require but little attention, and must be dust-proof.

4. The brake action must be simple, effective, and easily adjustable; and the brake shoes must admit of being replaced at a moment's notice, and must be mounted in such a way as not to be influenced by the vertical motion of the car.

5. The truck must be constructed in such a manner as to render access easy to all parts; and to admit of motors, wheels and axles, journal-boxes, brake-gear, and other parts, being easily removed, without having to dismember the truck. Cross strains on bolts should be avoided as much as possible.

6. The car body must be attached to the truck in such a manner as to be readily removed on loosening a few bolts.

7. Springs must be arranged so as to render the running of the car as smooth when empty as when fully loaded, and to prevent the pitching and rolling motion to which street cars are so liable on sharp curves and rough roads. This is a highly-important point, not only for the comfort of the passengers, but also to prevent rapid deterioration of the car wiring and car bodies; deterioration of the wiring is likely to cause grave results to the motors by producing short circuits.

8. An appropriate choice of wheels is most important.

There are three different kinds of trucks: the rigid four-wheel, the radial six-wheel, and the four-wheel bogie for eight-wheel cars. Of these three, however, only the first and third are generally used, the radial truck not having given the satisfactory results which were expected.

Four-wheel Truck.—In the rigid four-wheel truck, where the wheel-base is naturally restricted, it is of the greatest importance to have an arrangement whereby the car body is supported as far outside the wheel-base as possible; and to diminish as much as may be, by the judicious use of springs, the destructive effect of jolting, both upon the car body and upon the motor equipment. The best modern truck, which has been employed on all the latest and best-equipped British and colonial tramways, is the "Peckham," of which models are exhibited. It has been adopted by Bristol, Dublin, Guernsey, Clontarf, Coventry, Isle of Man, North Staffordshire, Dover, Leeds, Birmingham, Brisbane, Sydney, and other places, and in all cases has given the utmost satisfaction. The support selected as the model for a truck frame is the standard cantilever bridge truss, which experience in bridge building has shown to be the strongest form of construction. This truss principle has been closely followed in the construction of the Peckham truck; and, while various modifications in detail have been made to adapt trucks to the various conditions occurring in street-tramway practice, the characteristic bridge form of truss has been strictly adhered to in all of them. The cantilever truck has now come to be regarded as the standard for the best work in the United States, inasmuch as 15,000 are now in use in that country.

As the length of the car body grows greater, the difficulty increases of supporting it properly at the ends, without increasing the height of the car platform above the ground. The resistance offered by any truss to bending varies directly as the cube of its depth. If, therefore, the car platform were raised high enough above the street level, it would be an easy matter to support the sills of any car effectually so that it should be impossible for them to droop at the ends under heavy loads. It is an entirely different thing, however, so to support them, when the height from the rail to the lower edge of the sill is limited, as it must be in street tramways. Beyond 27in., or at most 30in., every inch that the car platform is raised above the level of the street makes it so much the more difficult for ingress and egress. This is, therefore, practically the limit in height to which the car body used for city service can be raised. This problem has been solved by the use of extension rods, in a way never before applied in street tramways. A second bridge truss is constructed by employing the extension rod as a lower member, and the car sill as an upper member; and this truss is supported flexibly upon the main truck truss. The truss extension rods, instead of terminating, as heretofore, at the extremity of the truck frame, are carried below and around its lower member, and are stayed to the car sill by bolts passing through the truck pedestals and end springs. The angle of the truss extension rods has not been changed in any way to secure a longer support, but as they are dropped bodily lower they give a wider base of support to the car body than would otherwise be possible. By this method it has been found practicable to carry upon single trucks, with a wheel-base of only 7ft., cars as long as 35ft.

Other important improvements include the flexible gear, which is so constructed that it allows the cantilever extension truss to be built in sections, so that the portion under the journal-boxes can be removed when necessary for taking out the wheels and axles, but when in place it makes a continuous truss. This gear also allows of introducing in its upper portion coil springs for supporting the truck frames flexibly upon the journal-boxes, thereby relieving the

* Paper read before the Institution of Mechanical Engineers.

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truck frames as well as the car body from the rigid metal contact with the rail, and also relieving the rail from the hammer-blow which would attend a rigid connection between the rail and the car body.

Swivel Truck.—The rapid growth of inter-urban lines, upon which the tendency is to use long cars, and the desire on many tramways to use long cars for city work, have resulted in the swivel truck, shown in Fig. 9. This is the result not only of railway experience, but also of many years' experience of electric tramway needs. A truck so constructed runs exceedingly easy, the weight being doubly cushioned by the two elliptical springs and spiral springs over each axle-box. The brake gear is simple, and the shoes are applied with a powerful leverage. The centre of gravity of the trucks has been brought down as low as possible ; with cars having straight sides, the body of the car need not be more than 27½in. above the rail. The wheel-base has been kept short, and the space between the axles kept clear, so that it is possible to mount two motors on the truck without difficulty. The arrangement of the springs on the trucks renders it possible to remove the bolster and elliptic springs quickly and easily whenever it becomes necessary to examine and overhaul the motors. When this has to be done, the car body is simply jacked up with the bolster, and the truck frame can then be run out from under the car. The rivets used in the construction of all these trucks are driven in hot by means of pneumatic riveters under 30 tons pressure.

Motors.—In the early days the motors were all used with double-reduction gearing, with consequent great waste of power in a double transformation of the high armature-speed to the low speed of the car axles, an efficiency of 60 per cent. being rarely obtained. At present good design, workmanship and materials have brought about such a change for the better that under most conditions an efficiency of 80 per cent. is attained, which remains constant with widely-varying loads. When the application of electricity for propelling street cars was first practically attempted it was endeavoured to apply the existing stationary motor to the existing running gear. The motor and axle were connected by means of belts, sprocket chains, friction clutches, and other mechanical devices, all of which, with few exceptions, have now been abandoned, on account

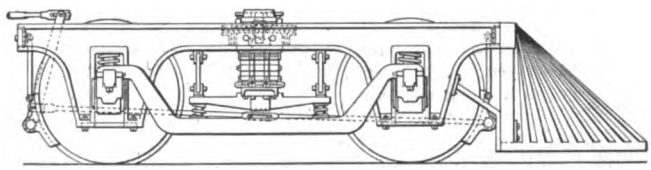

Fig. 9.—Swivel Truck.

of the great expense of maintenance and their low efficiency. Double-reduction spur-gearing was first introduced on the experimental line at Woonsocket, Rhode Island, which was jointly equipped in 1886 by the Thomson-Houston and Bentley-Knight companies ; and the advantages of a specially constructed and self-contained motor-truck were there demonstrated. The high speed and comparatively cumbersome construction of motors at that time necessitated a double reduction in gear between armature and axle, each reduction being about 9 to 1. Thus an armature speed of about 1,500 revolutions per minute gave a car-speed of about 15 miles per hour. The later makes of double-reduction motors, of which a great many have been employed both in the United States and in Europe, have done excellent work ; but more recent and keener competition in electric traction has resulted in more advanced designs being developed. The electric motor having demonstrated its ability to do the required work, the next problem was so to improve it as to reduce the working expenses as low as possible. This was partially effected by improving the design of the double-reduction motor, and to a much greater extent by the introduction of single-reduction gearing. The success of single-reduction stimulated still further improvement in design, and motors mounted direct upon the driven axles, and devoid of all gearing, were developed. These, however, have not yet come into practical use for street cars, on account of their increased weight, and also of their rapid deterioration owing to the absence of any spring support, in consequence of which the motors receive all the shocks due to the comparatively rough tramway lines. The increased weight and rapid deterioration, and consequent increase in original cost and maintenance, have prevented their competing on even terms with improved single-reduction motors.

Single-reduction Motors.—The maturing of the design of single-reduction motors marks a distinct epoch in the construction of tramway motors. The practical experience of many years' use has proved them reliable and efficient, and they have fairly fulfilled the following essential requirements of a motor for tramways :—

1. The motor must be as light in weight as possible, having due regard to strength and simplicity in its mechanical and electrical construction.

2. It must be completely closed in, and protected from dirt, moisture, &c.

3. Its capacity must be ample, and it should be able to run continuously for at least two hours at its rated capacity without heating beyond 90° to 135° F. It should be capable of developing at least 50 per cent. more than its rated capacity without injurious sparking or other damage, and the starting torque must be great.

4. All the external and internal parts of the motor must be thoroughly accessible, and easily taken apart.

That motor is the best which enables the line to be worked at the lowest cost for fixed charges as well as for running expenses. The relation between weight of motor and expense of working is forcibly shown by the maintenance of way on various tramways at present working. A motor entirely protected from dirt, moisture,

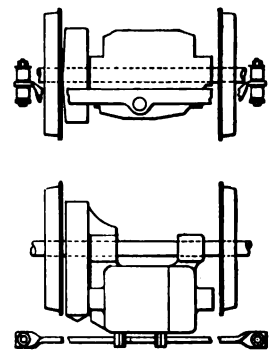

Fig. 10.—Nose Suspension.

&c., needs far less repairs, and so diminishes the cost of working. If a motor does not keep within a certain limit of heating and sparking, renewals of parts will obviously become numerous and costly. Difficulty of access to the wearing parts means higher charges for maintenance and labour.

Gearing.—More than one reduction in gearing between armature and axle means too high speed of the armature, and, consequently, too great wear in the teeth. Any decrease in number of parts and bearings diminishes the cost of maintenance. Large teeth must be used, and the gearing must run in grease. Experience has proved the greater economy of steel over cast-iron gearing for tramway motors. A recent careful investigation of 66 tramways in 49 cities, using over 7,000 motors, has demonstrated that the average life of cast-iron gearing is somewhat over 30,000 miles, while that of steel gearing is nearly twice as great. Apart from the advantages of

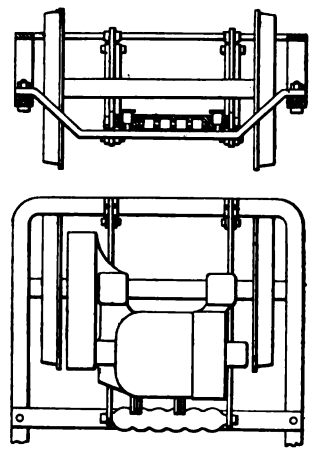

Fig. 11.—Side Bar Suspension.

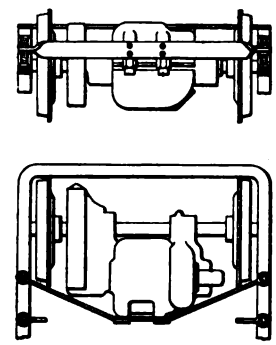

Fig. 11a.—Yoke Suspension.

longer life and higher efficiency, there is much less danger of breakage in steel than in cast-iron gearing, and of consequent springing or breaking of shafts and frames. The teeth are cut out of a solid rim by finely-made cutters of the best known shape, as determined by exhaustive experiments. Motor pinions should be made from the best hammered steel forgings, and the teeth should be formed by accurate cutters and specially-designed machinery with the same care as is used in the manufacture of the gearing, and they should all undergo the same rigid inspection and tests as the gearing.

Power.—The average horse-power exerted by a tramway motor at the car-wheel probably does not exceed 20 per cent. of the maximum power it is expected to exert in starting the car under the various conditions encountered. In order to get the best efficiency out of such a motor it is necessary that its point of highest

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possible efficiency should coincide with the development of the power at which the greatest amount of work is to be done.

Suspension of Motors.—There are three principal ways in which the motors can be suspended from the trucks; they are known as "nose," and "side-bar," and "centre" suspension. In the first method, shown in Fig. 10, one end of the motor rests on the axle through its bearings, while the other is hung from the truck by a cross-bar and springs. An advantage claimed for this method is that the gearing wears more evenly. In "side-bar" suspension the weight is nearly all taken off the axles. As shown in Fig. 11, a side frame resting entirely on springs carries the motor by two lugs, one on either side, which are so placed that the motor is suspended from its centre of gravity. This plan has not proved as successful as was anticipated, and the first, or "nose" suspension, is still much in use.

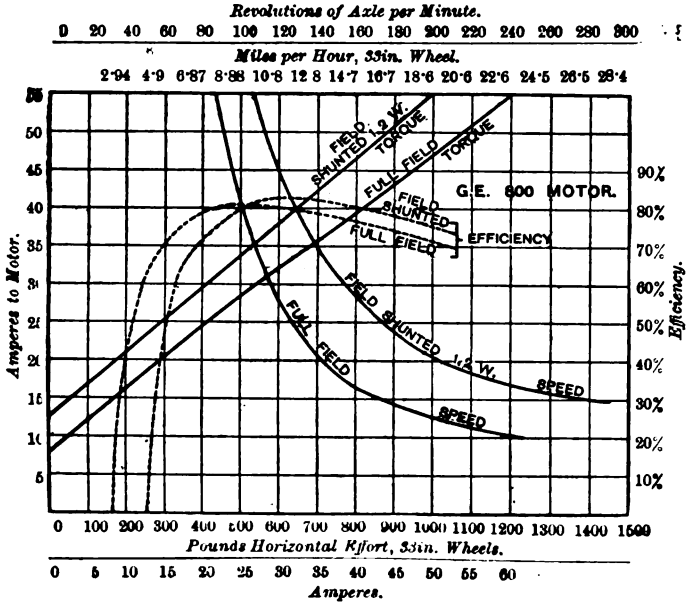

Fig. 12.

Rating of Motors.—This is rather a difficult question, because there are so many variable factors. At present nearly every manufacturer has a different method of rating, and a motor which would be called 15 H.P. by one is called 30 H.P. by another. A tramway motor works intermittently, and therefore can exert for brief periods a much larger power than it could continuously. Motors may be rated either by the torque, which when making a given number of revolutions per minute they exert upon a wheel of a given diameter, that is to say, by their tractive effort; or else by the horse-power which they can develop. In both cases, however, care must be taken to state the length of time during which the motors are to exert their rated power; and also the rise of temperature permitted in that time. The General Electric Company, which is the largest manufacturing establishment in the United States, rates its motors by the torque which they can exert

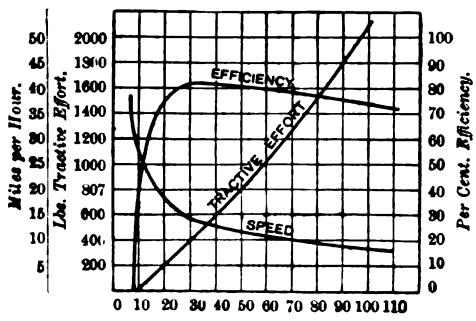

Fig. 13.

for one hour at the circumference either of a 30-in. or of a 33-in. wheel, at the speed for which they have been constructed, with a limiting rise in temperature of 135°F. after a run of one hour. Such a rating fairly represents the maximum conditions of ordinary working, and leaves sufficient margin to meet emergencies without injury to the motor. Instead of expressing the power of the motor by the torque, the tractive effort which the motor can give out at the normal speed may be stated. Motors may also be rated by the horse-power which they can safely give out temporarily, while they are so designed that they can run continuously at half that rated power without their temperature rising by more than 90°F. to 135°F. Inasmuch as all the insulation used in the construction of tramway motors is practically fire-proof, they can stand a far greater amount of heating than ordinary stationary motors. It is unnecessary to go into the electrical details of the devices used for controlling the speed with tramway motors; they can now be considered practically perfect, and they are so designed mechanically that it is impossible for an attendant to make a mistake in handling them. Figs. 12 and 13 have been kindly furnished by the British Thomson-Houston Company. Fig. 12 shows the commercial efficiency, the torque at the circumference of a 33-in. wheel, and the speed, both with full and with shunted fields, of a General Electric 800 motor with a four-turn armature, that is, a General Electric motor having a torque of 800lb. This motor was originally constructed for American lines, and is designed for average speeds of 12 to 15 miles an hour. Fig. 13 gives the efficiency, speed, and tractive effort of a General Electric 1,000 motor with full field. Fig. 14, furnished by the kindness of the Westinghouse Company, gives the efficiency, the torque on a 30-in. wheel, and the horse-power developed, of a No. 46 motor, which

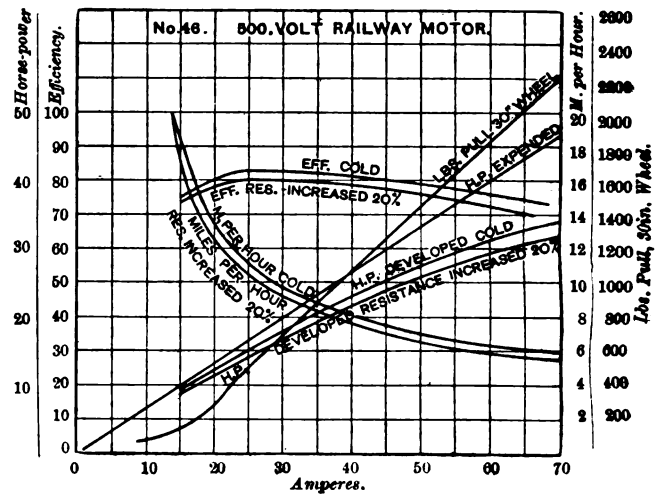

Fig. 14.

is nominally rated at 25 H.P. The temperature tests of this machine were as follows:—amperes, 38; electromotive force applied, 500; duration of test, one hour; draw-bar pull on 30-in. wheel, 1,000lb.; rise in temperature of commutator 54°F., of field 115°F., and of armature 72°F. For higher currents than the above the temperature will rise approximately as the square of the increase in current. But for lower currents the temperature will not fall according to the square of the decrease, because the element of iron loss is practically a constant, and is therefore of greater relative value at light loads.

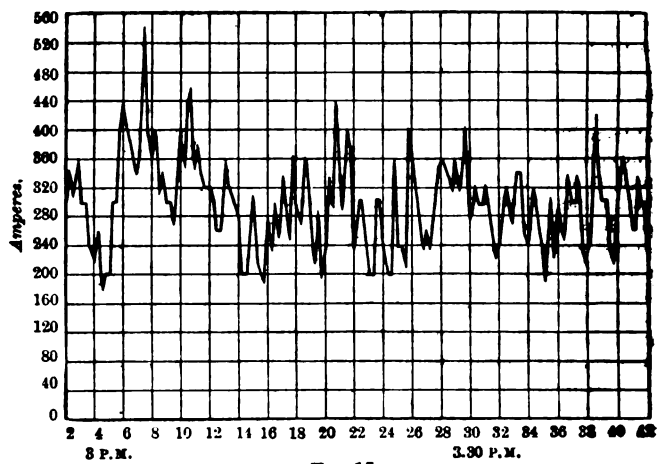

Fig. 15.

Power Station.—The success or failure of an electric line depends to no small extent upon the situation and design of the power station. The conditions which govern its erection are in many ways entirely different from those which have to be considered in the construction of an electric-lighting station. The load is constantly varying, and the variations are large and unexpected. Breakdowns are more serious than in electric lighting; and such precautions must be taken as will render a suspension of service practically impossible under any circumstances. In many instances the station must be in continuous operation

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for several consecutive days. In large American power-stations certain of the engines have frequently been running for eight and ten days continuously. In Fig. 15 is shown a diagram of the results obtained in a series of readings taken on an English tramway; and in Table IX. are given the sizes of engines recommended for use in power stations.

Table IX.—*Sizes of Engines recommended for use in Power Stations.*

Maximum power required.	Number of engines.	Power of each engine.
I.H.P.		I.H.P.
200	2	200
400	3	200
600	3	300
1,000	3	500
1,500	4	500
2,000	4	750
5,000	6	1,000
10,000	6	2,000

In early days the engines employed were far too small and weak. At the present time dynamos for tramway work are so constructed that accidents to them are quite as rare as to the driving engines themselves. Countershafts have been abandoned as wasteful in power and useless. Large reserves of power were also provided on the earlier electric lines; this practice has been abandoned, and Table IX. shows the reserve power which should be allowed; it will be seen that a sufficient number of engines are provided to furnish the maximum horse-power required for working the line, with a surplus of one engine in reserve. With this reserve the machinery can be kept in perfect adjustment and repair, one engine being at all times stationary. In case of a breakdown this extra engine is ready to take the place of the one disabled.

Driving.—A great diversity of opinion used to exist as to whether the engines should drive the generators by belts or ropes, or be directly coupled. The great objection advanced against direct coupling was the want of elasticity, which in the event of sudden and heavy overloading might cause a breakdown of the engine itself. It is said that belts and ropes act as a spring, and prevent sudden shocks from damaging the engine. It seems, however, to be beyond doubt that, for large stations having direct-coupled engines of 500 H.P. and upwards, slow-speed compound condensing engines, horizontal or vertical, are preferable. Direct coupling is steadily gaining ground, and should always be used for units of 100 kilowatts and upwards.

Stations should always be built as compact as possible; but space, light, and, above all, ventilation, should never be grudged in the engine room. Whether vertical or horizontal engines are adopted seems to depend primarily upon the available space; and secondly, and to a large degree, upon the fancy of the designing engineer.

Power.—Tramway work being of such a character that even in the largest stations the average load rarely exceeds two-thirds of the maximum, it becomes necessary, in order to have an economical engine, for it to be so constructed that at its most economical cut-off it will give out two-thirds of its maximum power. Thus, supposing an engine at its most economical cut-off of 28 per cent. will give 350 H.P., at its maximum cut-off of 80 per cent. it will give 520 H.P. When, therefore, an engine of 350 H.P. is ordered it is expected to be able to run at 50 per cent. overload, the generators being constructed to stand the same strain All bearings must be of such ample dimensions as to run perfectly cool when the engine is working at 50 per cent. above its rated power.

Engines.—In consequence of the difference of conditions between a lighting and a traction station, all engine builders who have had experience in tramway work now build an entirely different kind of engine for traction from that which they supply for lighting stations, as far as dimension and weights are concerned, as indicated in Table X. The conditions under which a tramway engine works are if anything more onerous than those of a rolling-mill engine. A slight variation either in number of revolutions per minute or in angular velocity per revolution is of the greatest importance in a traction station, whereas it is of small importance in a rolling mill. A traction station should always be so arranged that, if the normal load be suddenly thrown on or off an engine, the speed shall not vary more than 2 per cent. In some cases a maximum variation of $1\frac{1}{2}$ and $1\frac{1}{4}$ per cent. is all that is allowed. Where polyphase currents are used constant speed is of even greater importance; and a guarantee should be required that under no circumstances shall the angular velocity during one revolution vary more than three-quarters of 1 per cent., and in some cases not more than half of 1 per cent. With heavy flywheels, and governors properly designed for tramway work, especially when the governors are of the flywheel kind, it is quite practicable to fulfil the above conditions. A shaft governor is undoubtedly far more satisfactory in every way than any ball governor driven by belt or gearing from the engine shaft.

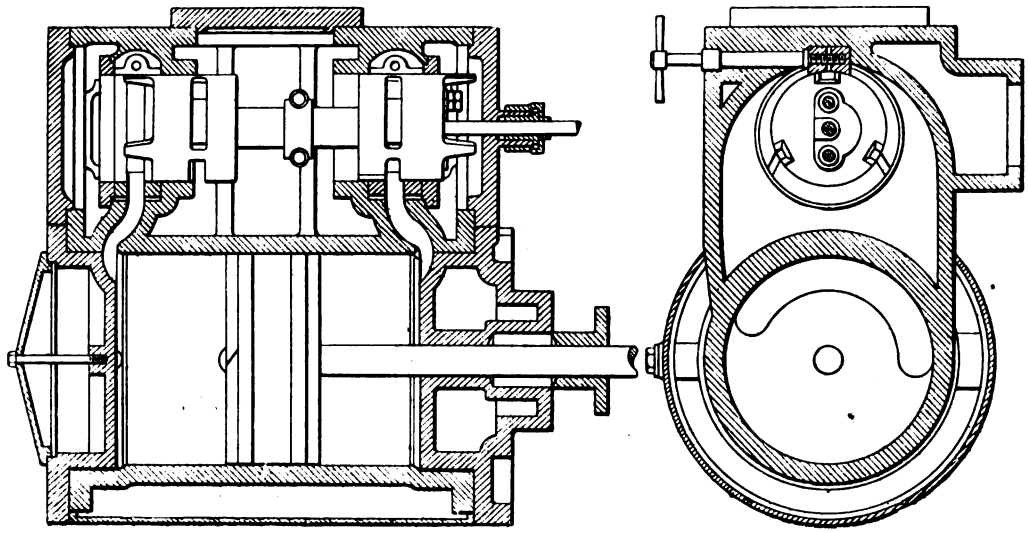

FIG. 16.

Table X.—*Comparative Weights of Engines for Lighting and for Traction.*

Power of engine.	Weight of engine.		
	For lighting.	For traction.	Difference.
I.H.P.	lb. tons.	lb. tons.	lb. tons.
90	13,000 = 5·8	15,000 = 6·7	2,000 = 0·9
115	15,000 = 6·7	17,000 = 7·6	2,000 = 0·9
140	21,000 = 9·4	23,000 = 10 5	2,500 = 1·1
215	33,000 = 14·8	37,000 = 16·6	4,000 = 1·8
325	46,000 = 20·5	50,000 = 22·3	4,000 = 1·8
400	53,000 = 23·7	50,000 = 25·9	5,000 = 2·2
500	74,000 = 33·0	80,000 = 35·7	6,000 = 2·7

Governing.—During the last few years there have been several flywheel accidents in tramway stations in America. Respecting these accidents and flywheels in general, more is said later on. Most flywheel accidents have occurred with engines employing a releasing valve-gear and a delicate ball governor. When the load is suddenly thrown off, and when they have to work with no load and a vacuum, ball governors are too uncertain. They generally act, but occasionally the valve gear, owing to wear or bad adjustment, prevents the engine controlling itself. To obviate this, a second governor is put in engines of this class, which governs some 10 revolutions slower than the main governor, and which, when it exceeds the speed it is set for, causes a stop-valve to trip, whereby the steam is entirely shut off from the engine. This seems to be an admission that such engines are liable to run away. With powerful shaft-governors connected directly to the cut-off valves by

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Table XI.—*Weights of Engines and Flywheels for Electric Traction.*

Description of governor		Flywheel	governor		
Power of engine	at economical load I.H.P.	583	1,070	500	800
	maximum I.H.P.	911.	1,650	1,000	1,600
Weight of engine	lbs.	106,000	177,000	186,000	325,000
	tons	47·4	79·0	83·1	145·0
Flywheel diameter	feet	11	15	15	20
Flywheel weight	lbs.	25,000	45,000	60,000	100,000
	tons	11·2	20·1	26·8	44·6
Bearings diameter	inches	13	15	18	20
Bearings length	inches	25	30	34	36
Ratio of length to diam. of bearings		1·92	2·00	1·89	1·80

Table XII.—*Proportions of Bearings in Rolling-Mill and other Continental Engines.*

Cylinder diameter	inches	17·7	23·6	23·6 35·4	23·6 39·3	25·6	27·5	49·2
Cylinder stroke	inches	27½	43	41	39	25½	39	49
Revolutions per minute		66	75	60	120	105	100	85
Bearings diameter	inches	6·7	12·6	8·6	9·8	9·6	10·2	17·1
Bearings length	inches	10·8	24·4	14·2	14·5	15·7	16·5	23·6
Ratio of length to diam. of bearings		1·61	1·93	1·65	1·48	1·63	1·62	1·48

Mean ratio of length to diameter of bearings, 1·63.

means of positive mechanism, it is impossible for engines to run away.

Table XI. gives the standard dimensions of bearings and flywheels, and the weights, of typical engines now successfully working large tramway stations; the first two examples are engines with flywheel governors. The smaller engines are fitted with single or double piston-valves, Figs. 16 and 17, and the larger with grid-iron valves. In small engines the governor acts only on the high-pressure cylinder; but in large engines it is so arranged as to act on both cylinders. Table XII. gives the dimensions of some standard Continental engines, most of which are driving rolling-mills. On comparing the dimensions of the bearings in this table with those of the tramway engines, it will be seen that the ratio of the length of the bearing to its diameter in the tramway engines is generally somewhere near 2 to 1, Table XI.; whereas in the engines not designed for tramway work it is nearer 1½ to 1, Table XII. The main bearings are usually provided with cylindrical shells, which can be taken out by simply jacking up the shaft to take the weight off the bearings. The shells are made hollow for water circulation,

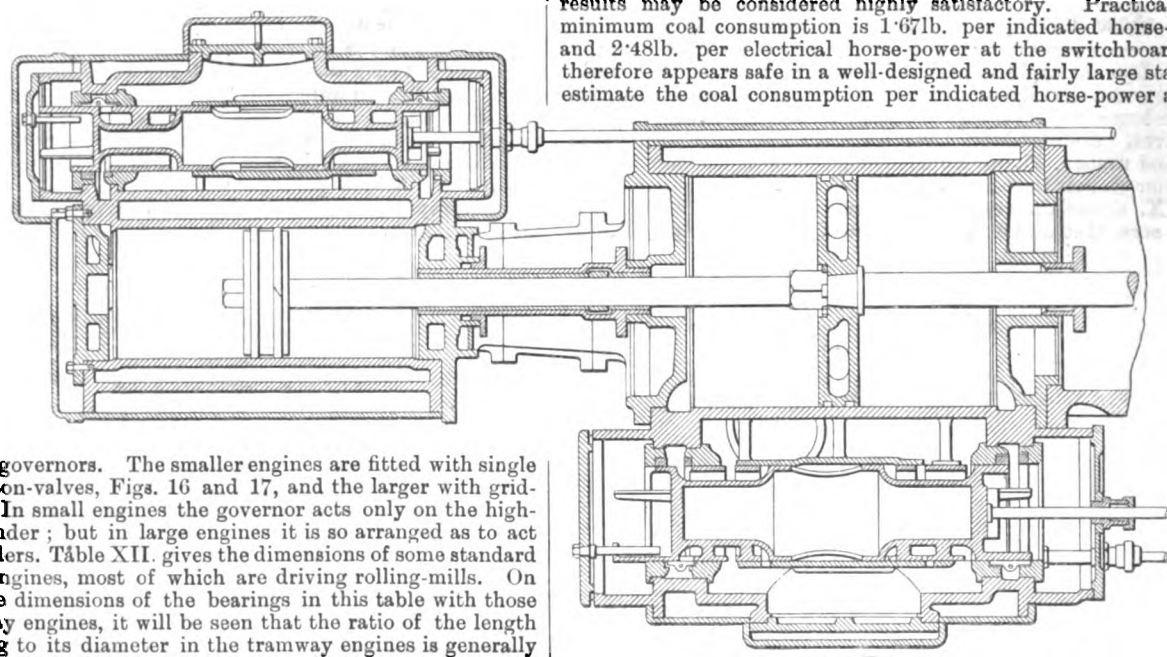
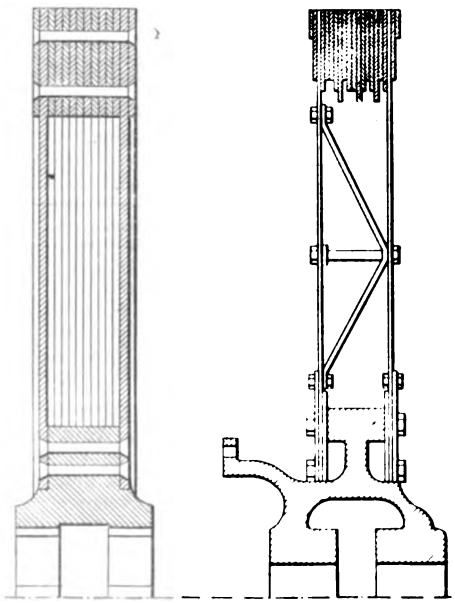


Fig. 17.



Figs. 18 and 19.

which can be used in case the bearings should heat from dirt or other cause; by this means the engine can be enabled to complete its run.

Tests.—Table XIII. gives the results of tests recently made in a large American station. There are four tandem compound condensing engines: high-pressure cylinder 20in. in diameter, low-pressure 36in., stroke 36in.; initial pressure 125lb. per square inch, economical cut-off $\frac{5}{16}$ths of stroke in high-pressure cylinder; vacuum 24in. of mercury; revolutions 103 per minute. These four engines each drive by belt a 500-kilowatt generator; and there is one direct-coupled engine, with cylinders 15in. and 23in. diameter, and 17in. stroke, driving a 200-kilowatt generator. The results may be considered highly satisfactory. Practically the minimum coal consumption is 1·67lb. per indicated horse-power, and 2·48lb. per electrical horse-power at the switchboard. It therefore appears safe in a well-designed and fairly large station to estimate the coal consumption per indicated horse-power at 2lb., and per electrical horse-power at not more than 2·66lb., so that the coal consumption per Board of Trade unit will not exceed 3·3lb.

Flywheels.—The use of flywheels in electric traction stations is important. Owing to the need of keeping the angular velocity as constant as possible, especially in large stations where, owing to Board of Trade regulations, polyphase transmissions become a necessity, the flywheels have to be much heavier than for ordinary lighting work. The strains they may be called upon to bear occasionally are enormous. The dynamos for tramway work are now constructed with such an amount of copper, and with such fire-proof insulation, that they can stand short-circuiting without serious damage. Circuit-breakers are, of course, supplied, and are generally prompt in action; but it may happen, and has occasionally occurred, that something goes wrong with the circuit-breaker, and it will not immediately break the line when a short circuit occurs. It may therefore happen that an engine may be practically stopped dead, and enormous strains may thus be put on the flywheel. Moreover the moment the flywheel has stopped, the circuit-breaker may happen to act, and the full power behind the piston may be applied to rotate the wheel, thereby again subjecting it to great strains. The utmost care has therefore to be taken in the design of flywheels. Accidents cause terrific havoc, and as far as the damage done is concerned are nearly as bad as boiler explosions, if not worse. In America the circumferential speeds allowed, even with cast-iron wheels, are much in excess of those to be met with in this country or on the Continent; over 90ft. per second is frequently allowed, as seen from some of the tables, whereas in English practice it is not considered safe to go beyond 80ft. This may possibly be owing to the better quality of cast-iron in America.

Flywheels built up of rolled plates, and constructed more like a boiler or a bridge, have been adopted to some extent in electric tramway stations in America. In Figs. 18 and 19 are shown plate constructions of different kinds; and also the construction of a cast-iron wheel 15ft. in diameter, and weighing about 49,000lb. or 22 tons. These built-up wheels generally have a cast-iron centre, or hub, with brackets to which the armature is bolted, so as to take some of the strain off the two keys that hold the armature on the shaft. To the centre of the hub are connected segmental web-plates, extending to the extreme outside diameter of the wheel.

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Table XIII.—*Tests of Pratt-street Electric-Power Station, City and Suburban Railway, Baltimore.*

	Date of test, 1895.				Average.
	Aug. 14.	Aug. 16.	Aug. 17.	Aug. 21.	
Average I.H.P. for 20 hours	1,860	1,873	1,773	2,000	1,876·5
Average E.H.P. for 20 hours	1,395·5	1,405	1,330	1,499	1,407·4
Coal used, total ..... lb.	75,678	70,885	72,885	74,511	73,490
Coal used per I.H.P. per hour, engines only ..... lb.	1·83	1·70	1·85	1·67	1·76
Coal used per I.H.P. per hour, other machinery ... lb.	0·20	0·19	0·21	0·19	0·20
Coal used per I.H.P. per hour, entire station ..... lb.	2·03	1·89	2·06	1·86	1·96
Coal used per E.H.P. per hour, entire station ..... lb.	2·71	2·52	2·74	2·48	2·61

Coal Consumption.—The above consumptions are based on the total amount of coal actually used in the station for the above electrical output, no deductions being made for ash, clinker, or moisture.

Load.—The heaviest load was 731 I.H.P., the lightest 366, and the average during four hours 553 I.H.P.

Generators.—Four 500 kilowatt, by General Electric Company, of 670 E.H.P. each, making 2,680 E.H.P.; and one 200 kilowatt, of 268 E.H.P.; total 2,948 E.H.P.

Boilers.—Campbell and Zell water-tube, four sets of 700 H.P., making 2,800 H.P. total.

Engines.—Four compound, by McIntosh and Seymour, cylinders 20in. and 36in. diameter by 36in. stroke, of 750 economical I.H.P. each, making 3,000 I.H.P.; one compound, by same makers, cylinders 15in. and 23in. diameter by 17in. stroke, of 250 economical I.H.P.; stoker, hoisting and conveying engines of 50 I.H.P.; total 3,300 I.H.P.

Two Blake vertical twin air-pumps and condensers, each 1,800-H.P. capacity, making 3,600 H.P.; one horizontal ditto, 250 H.P.; total 3,850 H.P. capacity.

Two Blake duplex feed-pumps, 14in. and 8½in. diameter by 12in. stroke, each 2,800 H.P. capacity, making 5,600 H.P.; two combined pumps and receivers, 6in. and 4½in. diameter by 7in. stroke, each 4,500 H.P. capacity, making 9,000 H.P.; total 14,600 H.P.

Hunt's coal and ash-conveying apparatus. Roney mechanical stokers.

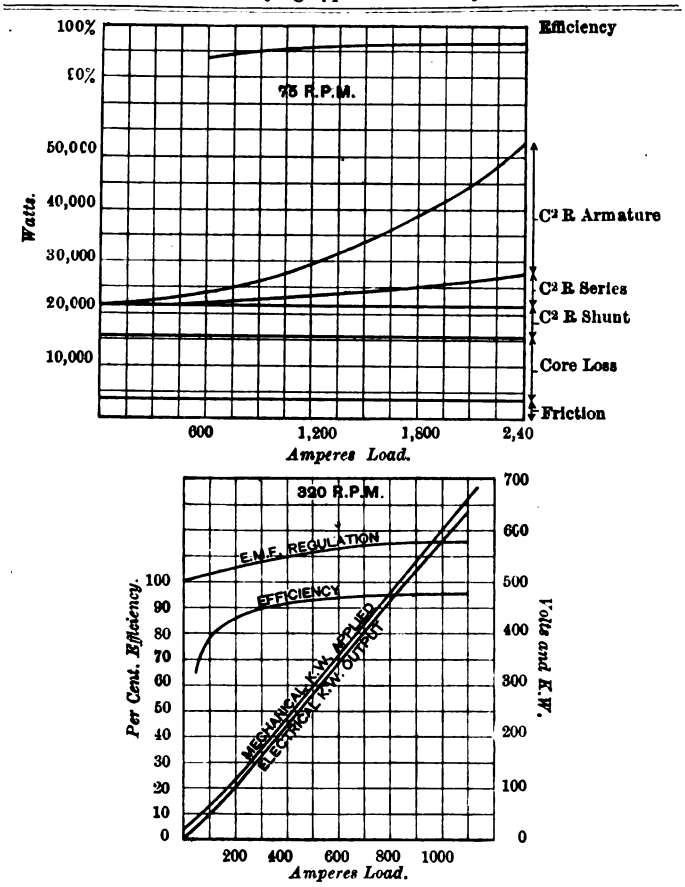

FIG. 20.

The plates are faced along their edges, so as to form a good joint. Outside of these segments are two circular plates, bolted through each segment and through both plate and hub. The segments are generally braced by truss pieces, held in the centre by cross bolts which act as struts. Outside the web plates surrounding the rim is a strip riveted through the rim; and outside of this is a second strip also riveted through. The rims of these wheels are usually turned down after the wheels have been riveted up and fixed on the shaft. Accidents to flywheels may generally be attributed to three chief causes:—firstly, poor castings or internal strains; secondly, faulty design and construction; thirdly, excessive speed. In designing a flywheel it is easy to calculate its parts so that it shall be perfectly safe to bring it to a stand-still within a given angle. Investigation of some of the best flywheels for tramway stations shows that their design permits of their being stopped in less than one revolution, with factors of safety varying from 17 to 18.

Generators.—The kind of generator to be used for electric traction is an important question. As in the case of the engines, tramway generators, Table XIV., must stand heavy overloading without damage. Moreover, as one pole is earthed, the greatest care must be taken that the best insulation is used throughout. Since the loads to which they are subject are extremely variable, dynamos as usually constructed for lighting work would require the position of the brushes to be constantly altered. To obviate this heavy magnetic inductions are allowed for in designing tramway generators, thus rendering it unnecessary to shift the brushes, and also avoiding sparking. It is the universal and best practice to use toothed armatures in tramway work. As to the kind of field winding which should be adopted, it would seem from tests made on a large scale with separately excited, shunt-wound, and compound-wound machines, that the best suited to tramway work from every point of view is the over-compounded generator. The usual pressure of current employed on trolley lines is 500 volts; and for this tension dynamos are so designed that the pressure between their terminals is 500 volts at no load, and is increased to 550 volts when the full load comes on. The over-compounding can be regulated up to 10 per cent. by varying a german-silver shunt placed on the series coil. The curves represented in Fig. 20, for which the author is indebted to the British Thomson-Houston and Westinghouse Companies, show the high efficiency of tramway generators with large variation of load.

Table XIV.—*Electric Tramway Generators.*

Rated power.	Total weight of generator.	Diameter of shaft.	Armature.	
			Diameter.	Weight.
kilowatts.	lb. tons.	inches.	inches.	lb. tons.
150	13,100 = 5·8	7 to 9	45	6,000 = 2·7
225	37,000 = 16·5	9 to 11½	59½	14,520 = 6·5
	34,300 = 15·3	9 to 11½	59½	13,920 = 6·2
	21,000 = 9·4	9 to 10½	45	7,000 = 3·1
300	60,400 = 27·0	14 to 16	59½	20,720 = 9·3
	43,900 = 19·6	14 to 16	59½	16,650 = 7·5
	39,100 = 17·4	14 to 16	59½	15,500 = 6·9
400	74,250 = 33·1	15 to 18	72	31,480 = 14·0
	71,440 = 31·9	15 to 18	72	30,580 = 13·6
	64,300 = 28·8	15 to 18	72	28,740 = 12·8
	59,700 = 26·6	14 to 16	65½	24,900 = 11·1
500	87,150 = 38·9	16 to 18	88½	35,800 = 16·0
	76,000 = 34·0	16 to 18	88½	32,000 = 14·3
	71,300 = 31·8	16 to 18	88½	30,500 = 13·6
	64,300 = 28·8	16 to 18	88½	27,100 = 12·1
800	110,000 = 49·1	19 to 22	94½	49,440 = 22·1
	100,900 = 45·0	19 to 22	94½	45,520 = 20·3
	94,400 = 42·2	19 to 22	94½	41,170 = 18·4
1,300	158,930 = 71·0	24 to 27	126	69,910 = 31·2
1,500	163,200 = 72·5	24 to 27	126	73,100 = 32·6
250	40,000 = 17·8	12 to 14	60	15,000 = 6·7
400	60,000 = 26·8	16 to 19	75	25,000 = 11·2
500	90,000 = 40·2	18 to 21	80	30,000 = 13·4
800	125,000 = 55·8	21 to 23	90	40,000 = 17·8
1,200	195,000 = 87·1	23 to 25	115	65,000 = 29·0
1,500	240,000 = 107·0	24 to 27	130	70,000 = 31·3

Number of Poles.	Revolutions per minute.	Commercial Efficiency.		
		Full-load.	Half-load.	Quarter-load.
	Revolutions.	Per cent.	Per cent.	Per cent.
6	200	95½	92½	89
6	120			
6	150	93¾	93	89½
6	200			
6	100			
6	150	94	93	89½
6	200			
8	80			
8	100	94	93	89½
8	120			
6	150			
10	75			
10	90	94	93	89½
10	100			
10	125			
10	80			
10	100	94½	93¾	90
10	120			
12	80	95	94	90½
12	75	95	94	90½

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POLYPHASE MOTORS FOR ELECTRIC TRACTION.

From time to time we read in editorial articles, principally in American journals, that in electric traction the commutating machine is drifting into disuse, and that it is soon to be replaced by the polyphase alternator and the induction motor. In a recent article it has been argued that soon the induction motor will supersede the continuous-current motor for this class of traction work. It would appear that articles coming from America must be considered academic in that country, since the Americans are, above all other people, willing to experiment on a large scale, and thus far, not a single tramway installation is in operation on a polyphase system using induction motors, nor have any of the American traction engineers that we have met professed to believe that such a system of tramway operation is likely to come into operation there. We read that the polyphase motor in traction work can give the same results as to speed control and torque as a continuous-current motor. An examination, however, of the means by which it is proposed to obtain these results makes this in no way clear to us, neither do the reasons given as to why the induction motor has not been more generally used in traction systems seem sufficient. We are of the opinion that the great objection to a double overhead wire system and the difficulties of limiting the drop in voltage in the earth return, with alternating currents, are not given due weight by the advocates of polyphase traction systems. In Europe generally the objections to an overhead system have been the chief cause of retardation of electric traction. The opposition to even a single wire has been most strenuous, but in all cities that we are acquainted with the double trolley wire system, with its attendant complications, is out of the question. What we saw of it in Cincinnati, and what we heard when there as to its vagaries, have convinced us that the double trolley is an intolerable nuisance. Continuous-current traction systems have caused some trouble from induction at varying loads. How much more would this be the case with a polyphase system, one conductor of which would be some 20ft. from the other two? The advocates of the induction motor, whilst stating that the absolute efficiency of the induction motor is much the same as that of a continuous current motor, do not seem to consider that at full load such a motor would not have a power factor much above 0·85, or in other words the transmission efficiency for a given amount of energy delivered to the motor would be 73 per cent. of that for a continuous current motor at full load.

In a traction system the average power of the motors, while they are taking current, is not more than a third of the rated power, in which case the energy factor or apparent efficiency would be as low as 0·7 or 0·8, and the transmission efficiency for a given amount of energy delivered to the motor would be about one-half or two-thirds of that in a continuous-current system. In this country, where the drop in the earth return is restricted to seven volts as a maximum, frequent transforming sub-stations would become necessary. For since, with

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alternating currents, the distance of transmission in an earth return is much less than that with a continuous current, these sub-stations would necessarily each require to have a capacity to meet the maximum load that would be likely to occur on a given section; consequently the fixed losses in transmission of such a system would become considerable, whereas in an equivalent continuous-current system there are no fixed losses in the transmission.

Then, again, referring to the various means of control for the motors, we find advocated such a method as rheostatic control. This method makes the use of collector rings necessary, and these are to some extent as objectionable as commutators, for the collecting brushes require about the same amount of inspection. The maximum efficiency in this case is only realised at full speed; half-speed gives only half-efficiency, a condition highly unfavourable for most lines that run from suburban districts into the centre of cities. The controller for such a method would be quite as complicated as a continuous-current controller, and there would be great difficulty in dealing with the arcs formed at the contacts, since magnetic blow-outs are unreliable for dealing with alternating-current arcs. The current at starting is the same for the same torque as at full speed, or, neglecting the energy factor, it would be double that of continuous-current motors with series-parallel control. This method of control is, therefore, out of consideration. We are cognisant of certain experiments made with two induction motors connected in series, the armature of the first being connected with the field magnets of the second. This increases the total torque per ampere, but on account of the increased self-induction in the circuits the maximum torque per ampere is limited to 38 per cent. of that of the same machine running in multiple. In this case, therefore, increased torque per ampere is obtained at the expense of maximum torque. One of the disadvantages of the induction motor is that the speed varies as the square of the voltage.

A second method that has been proposed, which to some extent lessens this defect, is to put a variable ratio transformer on each car, so that the impressed voltage on the motors may be varied at will. In starting up, however, and at low speeds, the chief dissipation of energy takes place in the motor armature, which unsuits the method for city work where long runs have to be made at slow speeds. There would be a loss in efficiency at full speed of 5 or 6 per cent. in the controlling transformer, and at half-speed the efficiency of the motor would be less than 50 per cent. The controller being in the general nature of a transformer, but with numerous contacts and terminals, it is more complicated and expensive than the ordinary continuous-current controller, and is more likely to burn out and give trouble. Motors designed for this method of control would in general be somewhat heavier than continuous-current motors, according to the current at starting, indeed, in all the cases we have examined with the same range of conditions this has been found true with the induction motor. Our observations in general lead us to the opinion that the induction motor usually is only suited to those traction systems in which long runs can be made at a constant speed, in which also there is no objection to a double conductor system, and where lenient regulations exist as to the voltage drop in the earth return. Moreover, for polyphase motors, the efficiency of transmission in the circuit must necessarily be kept very high; first, on account of the torque of an induction motor falling off as the square of the voltage; secondly, on account of the small voltage drop permissible in the earth return. The transforming stations would then have to be frequent, and with each one having a capacity capable of meeting the maximum load liable to occur in a given section the fixed losses would become as great, if not greater, than in a system employing rotatory converters and distributing by continuous currents. With the advantages, therefore, due to the continuous-current system of distribution, that the energy factor is unity, and, at the same voltage and cost, a higher efficiency in the consuming circuit is obtainable; and with the objection to the double overhead system and the liability to trouble from induction of such an arrangement, we see only a very limited field for the induction motor in electric traction work. The commutator of an ordinary street car motor costs but £5 or £6, and will travel some 100,000 miles before requiring any renewal of the bars. Having reference to practical experience with trolley wires, it appears that the maintenance of an additional overhead wire will exceed that of the commutators of the motor used on a corresponding length of line. And, as we have already stated, the commutator would not be completely superseded, in that it would have to be replaced by a collector and brushes. We are unable to see, therefore, on what reasonable grounds it is to be supposed that the induction motor will soon take a prominent place in traction systems, and the commutating machine be relegated to obscurity. On the contrary, we expect to see immediately a greater development of the continuous current system.

OBITUARY.

LORD SACKVILLE ARTHUR CECIL.

We regret to record the death of Lord Sackville Arthur Cecil (half-brother to the Marquis of Salisbury), which occurred at Holwood, Beckenham, Kent, the seat of his mother, Mary, Countess of Derby. His lordship had been ill for some weeks, but was recovering when pneumonia supervened on pleurisy. Born in 1848, he was a son of the second Marquis of Salisbury, and was educated at Wellington College and Trinity College, Cambridge, where he took his B.A. degree in 1869, and his M.A. degree in 1872. He early showed signs of that scientific turn, which in the case of his more distinguished half-brother developed in the direction of chemical and electrical research. In his own case it took a more practical and mechanical turn. While at Cambridge he travelled much on the engines of local trains and expresses, studying the duties of the engine-driver and stoker with characteristic keenness. The steam engine, with its complex details, had great attraction for him, and frequently he made the run to Wisbech, Peterborough and London on the footplate. It was not long before he was at work in the Stratford shops of the Great Eastern Railway, where much interest was excited among the men by the sight of one with some of the bluest blood in Britain in his veins, dressed in the regulation mechanic's overalls, gaining knowledge and acquiring practical experience like themselves.

Lord Sackville Cecil was afterwards engaged in the Doncaster carriage department of the Great Northern Railway. The scientific attainments he displayed as an engineer and electrician were of no mean order. He subsequently joined the traffic department of the Great Eastern Railway, and again showed a lively appreciation of the details of the working of a great railway system. From 1878 to 1880 he held the post of Assistant General Manager of the line. In 1880 he was appointed General Manager of the Metropolitan District Railway, and continued in that post for five years.

He then became associated with submarine telegraphy, and at the time of his death was a Director of the Eastern, the Brazilian Submarine, and the Pacific and European Telegraph Companies, and of the Globe Telegraph and Trust Company.

Lord Sackville Cecil was a man of the simplest habits, of unvarying courtesy to all, of the keenest intelligence, doing all he undertook with the utmost thoroughness and conscientiousness. He will be greatly missed and widely regretted.

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Owing to his extensive knowledge and determination to exhaustively understand every question with which he had to deal, combined with sound judgment, his death will be a great loss to the companies with which he was associated. The body was cremated at Woking on Wednesday. A communion service for the family was held yesterday in Hayes Parish Church, at 9 a.m., and by 9:45, when the funeral service began, the church was filled with those who had come to pay their last tribute of respect. Amongst those present were Lords Lionel and Arthur Cecil, Lady Margaret Cecil, Lord Stanley, the Earl of Galloway, the Right Hon. A. J. Balfour, M.P., the Right Hon. W. St. John Brodrick, M.P., Mr. H. C. Fischer, C.M.G., representing the Post Office, Mr. J. Denison Pender, representing the Eastern and Associated Telegraph Companies, Mr. W. H. Axworthy, representing the Brazilian Submarine and the Pacific and European Telegraph Companies; Mr. W. Hibberdine, representing the Deutsche See Telegraph Company; Mr. G. Draper, Secretary of the Eastern and the Eastern and South African Telegraph Companies; Mr. S. Collett, Secretary of the Globe Telegraph and Trust Company; Mr. W. King, Secretary of the Exchange Telegraph Company; Dr. Muirhead; Mr. W. H. Burman; Mr. Estell, representing the District Railway Company; Mr. C. Swarbrick, late of the Great Eastern Railway Company; Mr. Macdonald, Mr. Macmillan, Mr. J. L. Verne, and others. A large number of very beautiful wreaths had been sent.

CHARLES WILLIAM STRONGE.

We regret also to record the death, from pneumonia, at 2, Whitehall-court, London, on Sunday last, of Mr. Charles William Stronge, C.B. Mr. Stronge, who had attained his 81st year, was the third son of the late Sir James Matthew Stronge, of Tynan Abbey, Armagh, and entered the Treasury at the age of 17. He remained in that Department for 50 years, during which time he acted as private secretary to different Ministers, including the Earl of Derby when he was Prime Minister. The Companionship of the Bath was conferred upon him in 1880 by Lord Beaconsfield. In recognition of his services he was in 1879 appointed official Director of the Eastern and the Eastern and South African Telegraph Companies. Of these Companies, on his retirement from the Treasury, he became an ordinary Director, and continued to be so until his death. He was also a Director of the Castle Mail Packet Company. A gentleman of the old school, and of genial presence, he won the respect of all who were brought in contact with him. The funeral took place on Wednesday last at Kensal Green.

THE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

BY F. CHARLES RAPHAEL.

VII.—The Manchester Exchange System.

The exchange system at Manchester merits a full and detailed description, as it combines the much discussed call-wire system with a typical network of underground metallic circuits. Another feature of the Manchester system is that, as a necessity of the call-wire system, the majority of the subscribers are directly connected to one central exchange—in fact, 3,800 out of a total of about 5,000 subscribers within the Manchester district.

The fundamental idea governing call-wire working is that the operator's duties are to be simplified by slightly adding to the number of operations to be performed by the subscriber in requisitioning a connection. In addition to the two wires connecting his instrument with the exchange, each subscriber is connected to a call-wire circuit common to some 40 or 50 subscribers, and connected permanently to the operator's head-gear receiver at the exchange. The ordinary subscribers' set, described in Article III. of the present series,* is modified by the addition of what is known as a call-wire key. When this key is in its normal position the subscriber's instruments are connected to his line in the usual way, and his call-wire terminals are insulated. But when the switch is depressed the instruments, with the exception of the magneto and bell, are connected to the call-wire circuit in bridge. The call-wire circuit is used only for communicating with the exchange, the subscriber's own line exclusively for conversations with other subscribers. In the exchange the latter line ends in a plug in front of the operator serving the group of subscribers on the same call-wire circuit. To obtain com-

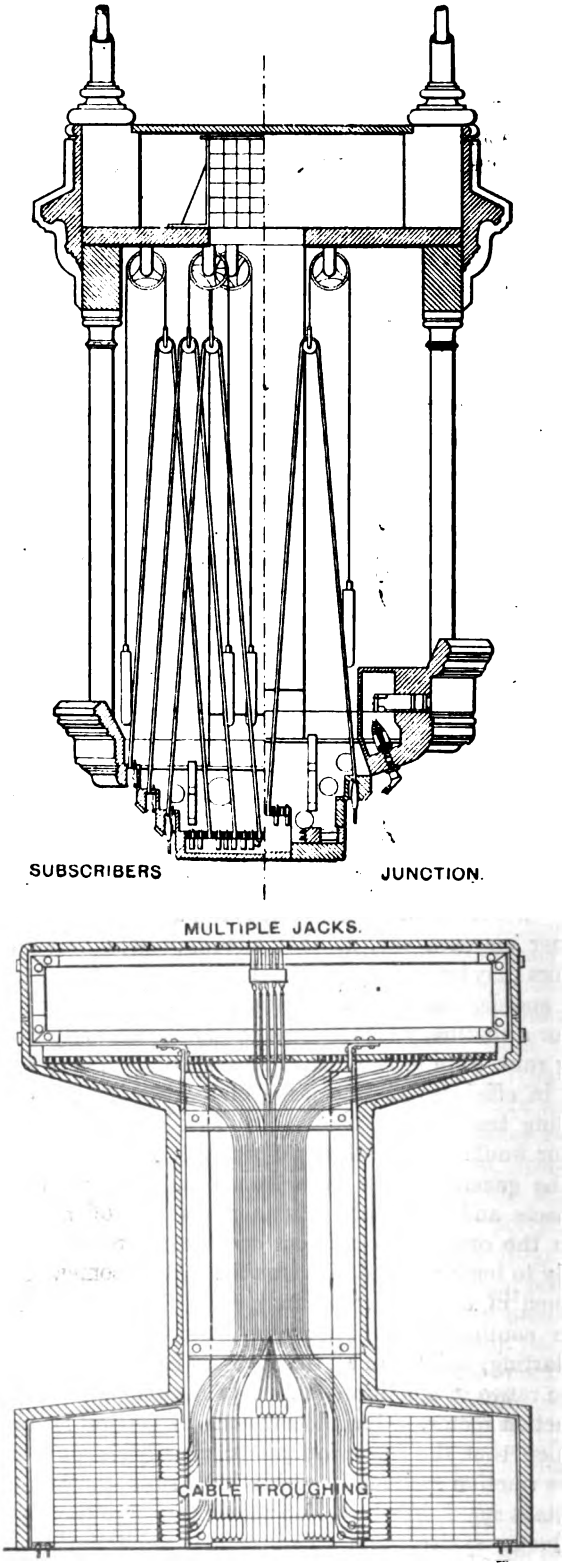

Fig. 54.—Section of Manchester Switchboard.

* All Rights Reserved. For Articles I., II., III., IV., V. and VI., see *The Electrician*, July 2, 9, 30, August 13, 27, September 17, October 1, November 5, and December 10, 1897.

* See *The Electrician*, Vol. XXXIX., p. 448.

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munication with another subscriber, the calling subscriber removes his receiver from the hook and depresses the call-wire key. If he hears another subscriber's voice speaking on the call-wire to the operator, he waits until the wire is silent, and then gives his own number and the number wanted. The operator, who is always listening, immediately makes the engaged test. If the wanted subscriber is engaged she replies to that effect; if not, she immediately inserts the calling subscriber's plug into the wanted subscriber's jack, at the same time repeating the two numbers. The originating subscriber, knowing then that the connection is made, releases the call-wire key, hangs up his receiver again, and rings. On the termination of his conversation he again makes use of the call-wire and tells the operator to "clear" his number.

It is thus seen that the calling subscriber does a certain amount of the operating himself, and the exchange operator is saved the trouble of ringing up and obtaining a reply from the wanted subscriber.

Subscribers' Switchboard.

The subscribers' switchboard at the exchange is greatly simplified by the use of the call-wire system, no answering jacks being required, no ring-off indicators and only a small number of keys. Fig. 53 is a general view of the switch-room, the small board on the left of the illustration being the junction board, and the long board one of the two lines of subscribers' boards. The second lines of subscribers' board is on the right and is not seen in the figure. The small board at the end is the call-wire board, this being shown in greater detail in Fig. 58; its function will be explained later.

In Fig. 54 the table is shown in section as well as the two forms of canopy used for the subscribers' and junction boards respectively. The distance between the top of the table and

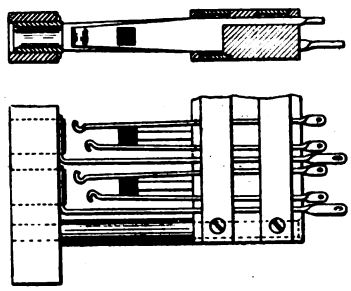

Fig. 55.—Three-point Branching Call-wire Jacks (half actual size).

the bottom of the canopy is about 18", being somewhat greater than in the figure. The plugs in which the subscribers' lines end are situated in sockets in the canopy, and this permits a construction of table somewhat different from that of the flat boards on the branching system with self-restoring indicators, described in Article V. of the present series. The modification allows the operators to get much nearer to the jacks, as no key-shelf with cords and counter-weights underneath is necessary. The cables of the subscribers' wires and test-wires, each cable containing 21 sets of three wires (the two-line wires and the test wire), are carried straight through from end to end of the board in troughing on the floor level, and the wires from the jacks are T'd from the straight cable. To insulate these T-joints long narrow strips of vulcanised fibre are used, with a row of holes punched in them at short distances apart. Each jointed wire is merely forced into one of these holes, here being thus no need to use rubber or tape as insulation.

The subscribers' jacks are three-point jacks, specially made for call-wire boards. Fig. 55 is a half-size drawing of one of these. The plugs are of the 3-way type. The tip makes contact with the short spring, and the ring with the longer spring; these are the two line contacts. The sleeve of the plug makes contact with the barrel of the jack and connects it and the barrels of all the other jacks of that subscriber to an earthed battery. This is clearly seen in Fig. 56, where the connections of the subscribers' board are shown diagrammatically. It is seen that in addition to the battery connection made through the sleeve of the plug the barrels of the jacks are connected to the battery through a spring contact in the socket in which the plug rests as soon as the latter is drawn down. This latter contact "engages" the calling subscriber's line also. The engaged test is made by means of a metal-pointed vulcanite thimble worn by the operator, the metal point being connected by a flexible cord to one terminal of her head-gear receiver. The receiver is, as usual, differentially wound, and the middle terminal is connected to earth.

The underground lines entering the building end in "cable-heads," whose construction will be indicated presently. From the terminals of these cable-heads wires are led across a cross-connecting field to the test-jacks, where the lines are arranged in numerical order according to the subscribers' numbers. There is an intermediate cross-connecting board between the test-board and the switch-board, and this is necessary for the following reason: If a subscriber changes his office or residence, it is usually necessary to connect him to a different underground cable and to a different call-wire. As the subscriber retains his number, the connection between the line and the jacks of the multiple must be altered, for the latter must remain in numerical order. This alteration is made at the first cross-connecting field. The plug to which the line is connected must, however, be opposite the operator who

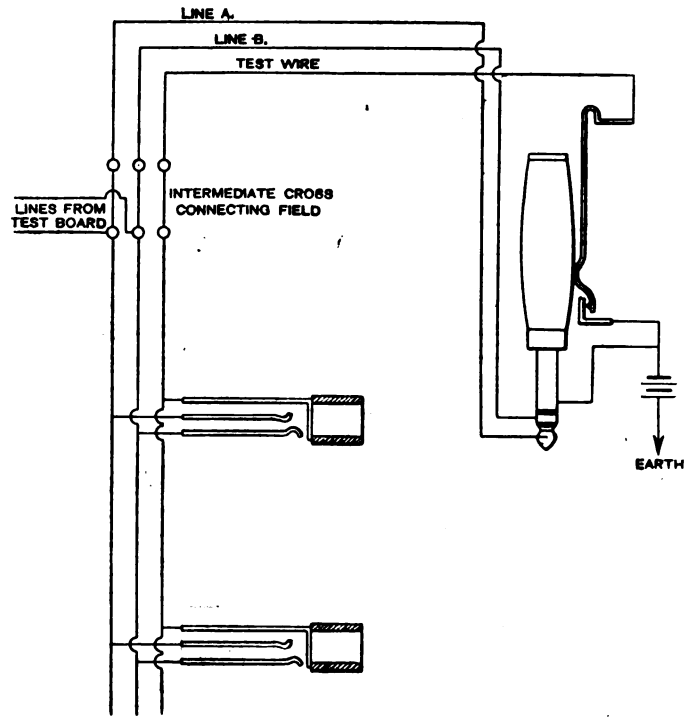

Fig. 56.—Connections of Subscribers' Switchboard.

serves the call-wire. Thus the three pairs of wires—from the line, from the jacks of the multiple, and from the plug—are all led to the intermediate cross-connecting board, where the connections between the plug and the jacks are changed if a subscriber gets a new line.

As already stated, there are from 40 to 50 subscribers connected to each call-wire circuit, every such circuit being served by an operator. There are four call-wire circuits to a section of the board, which therefore provides for up to 200 subscribers, and is served at the busiest times of the day by four operators. The usual operators' keyboard being unnecessary on the call-wire system, each operator is provided only with a "service-plug" connected through a ringing key to her speaking set. This plug and key are only used when it is necessary for her to connect her instrument to a subscriber's line to ring him up or to break in upon a conversation for some cause.

Call-Wire Board and Operators' Connections.

The call-wire circuits are treated quite independently to the subscribers' lines. Each subscriber's microphone and receiver circuit is connected through his call-wire key to the call-wire circuit, this connection only being made while the key is depressed. The instruments are then connected in parallel, or as a bridge to the call-wire lines. The call-wire circuits, which are all metallic, are brought to test-jacks in a special

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call-wire test-room. Each call-wire circuit is then divided on the cross-connecting field into three branches. These can be traced out on Fig. 57, where the connections of the call-wire circuit within the exchange building are shown diagrammatically.

The first branch, marked AA in the diagram, goes to the operator's speaking and listening set, so that the operator's microphone and receiver is thus perpetually connected to the circuit. To this branch is shunted the service plug and ringing key mentioned above. When the plug is inserted in any jack the corresponding subscriber's line is connected in parallel with the operator's set and the call-wire circuit. On depressing the ringing key, however, a ringing current is sent from the generator to that line only. The thimble worn by the operator, and used for making the engaged test, is also shown in the diagram.

The second branch BB goes to a jack on the chief operator's table, so that this lady can plug into any call-wire circuit with a plug connected to her writing-table set, and overhear the conversation on the wire.

The third branch CC from the tab of the cross-connecting field runs to the call-wire board. This board, a general view of which is given in Fig. 58, performs a most important part in the Manchester system. The board is capable of dealing with 144 call-wire circuits. The branch CC runs straight to contacts DD on a drum switch, shown diagrammatically in Fig. 52. From here a branch is taken to the two outer springs of a four-point series jack, called the operators' service jack, and another to the inner springs of the similar jack to the left of this one. Each call-wire circuit has its own drum switch and its own four-point jack. The former are actuated by the levers on the four white panels of the board, seen in Fig. 58, while the jacks are in the central panel of the upper part of the board, between the two panels of indicators. When the lever of the drum switch is in its central position the springs DD are left insulated, as in the diagram Fig. 57. Normally also all the plungers are inserted in the operators' service jacks, so that the inner and outer contacts are insulated from one another. Then the branch CC of the circuit is entirely insulated, and each call-wire is served by its own operator. At luncheon time and at other less busy times when it is not necessary to have an operator for each call-wire circuit, the superintending operator, on giving a girl permission to leave, goes to the call-wire board and removes the plunger corresponding to the call-wire in question. This connects the outer springs of the jack with the inner springs branching the call-wire circuit to the one on the right of it, and the operator to the right of the one who is leaving then serves both circuits. It is thus seen that the call-wire circuits can, during the less busy hours, be divided in any way among any number of operators by a proper arrangement of the plungers on the call-wire board.

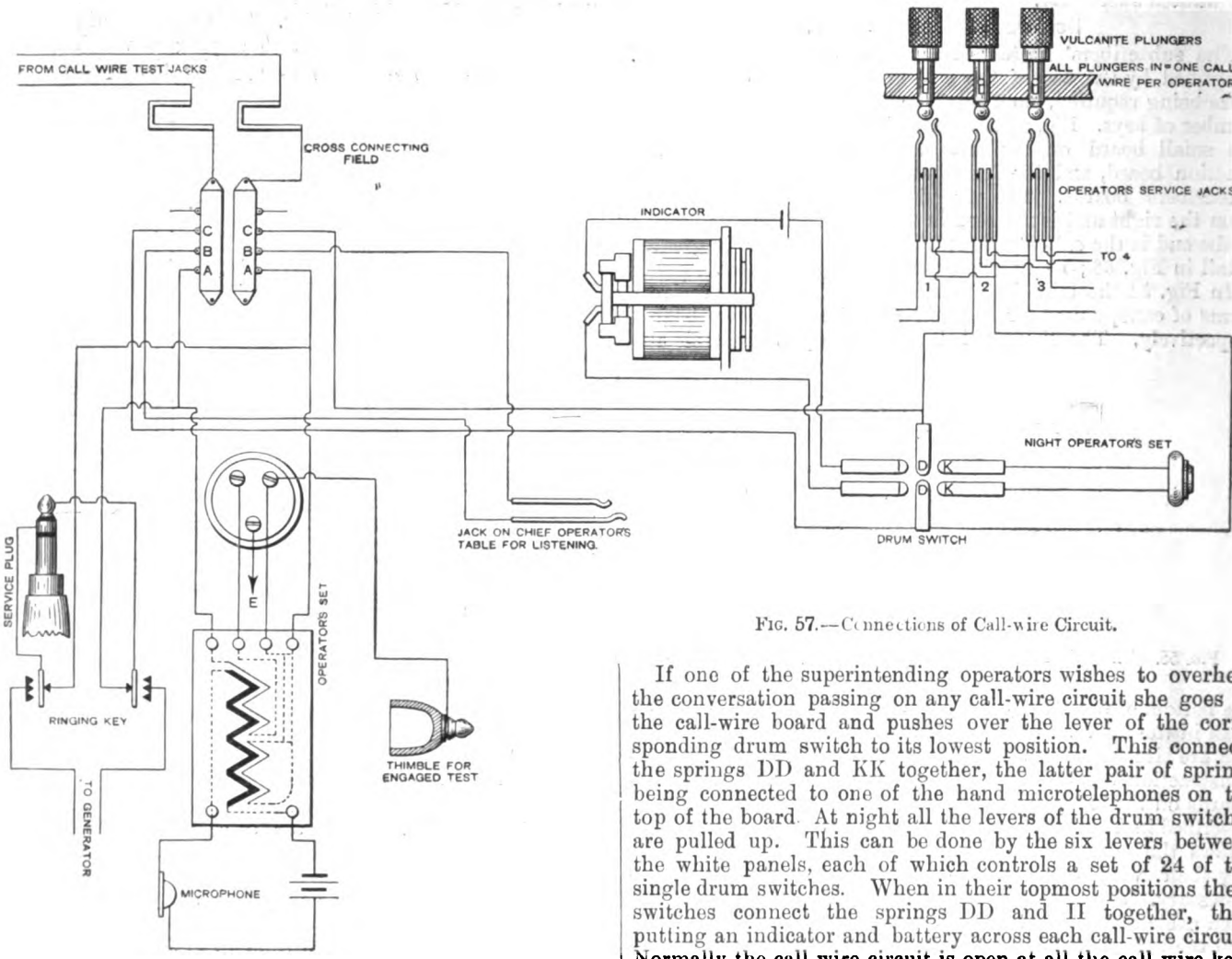

FIG. 57.—Connections of Call-wire Circuit.

If one of the superintending operators wishes to overhear the conversation passing on any call-wire circuit she goes to the call-wire board and pushes over the lever of the corresponding drum switch to its lowest position. This connects the springs DD and KK together, the latter pair of springs being connected to one of the hand microtelephones on the top of the board. At night all the levers of the drum switches are pulled up. This can be done by the six levers between the white panels, each of which controls a set of 24 of the single drum switches. When in their topmost positions these switches connect the springs DD and II together, thus putting an indicator and battery across each call-wire circuit. Normally the call-wire circuit is open at all the call-wire keys on the subscribers' instruments, but, as soon as a subscriber removes his receiver and depresses this key, the circuit is closed and the battery sends a current through the indicator, causing it to drop. On seeing this signal, the night operator pulls the corresponding drum switch over to the lowest position of the lever, thus connecting his telephone to the call-wire in question, and receives instructions from the subscriber. He then takes down a loose double plug cord from a hook, and makes the desired connection on the nearest multiple.

There are two night operators on duty from 11 p.m. to 6 a.m., and three from 8 p.m. to 11 a.m. and 6 a.m. to 8 a.m. By means of a simple switch the bells on either side of the board are switched on to a local circuit ending in contact points under the hinge of the indicator-flap, so that the bell rings as soon as an indicator drops. The photograph from which Fig. 58 was prepared was taken at a slack time on Saturday afternoon, when some of the subscribers' boards (those corresponding to the business-office district) could be left

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FIG. 57.—General View of the Manchester Telephone Switchroom.

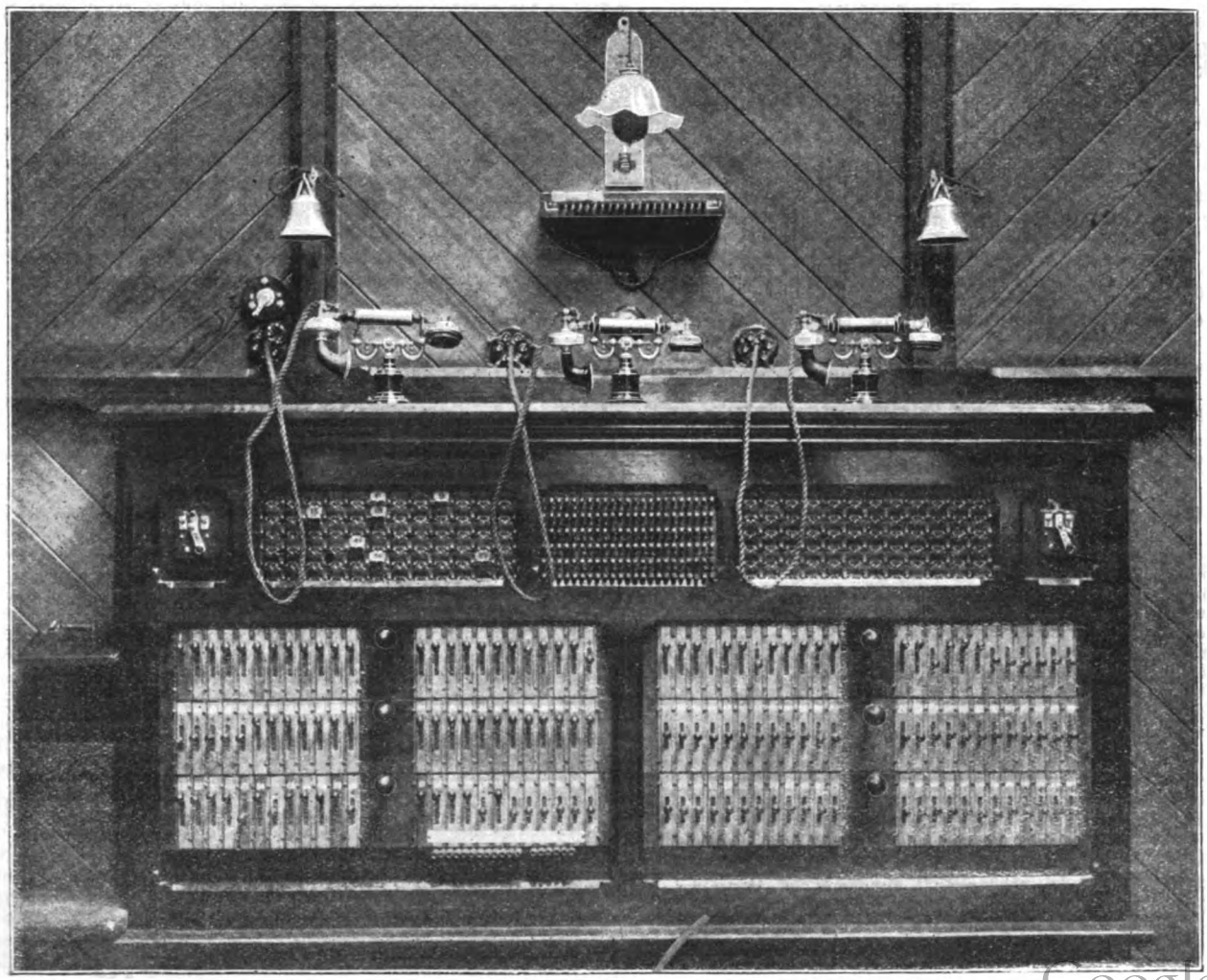

FIG. 58.—Call Wire Board in the Manchester Switchroom.

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without operators. Thus it is seen a number of the drum-switches have been pulled up to their topmost positions, so that any calls on the corresponding call-wires would be answered on the call-wire board.

Junction Working.

Outgoing junction wires are multipled over all the boards in the usual manner, each line being branched to two jacks on each section. If a subscriber wishes to communicate with another who is on one of the outlying exchanges, the operator at the central makes the connection to any free junction wire in the usual manner, and the originating subscriber has then to ring up the sub-exchange and ask for the number again.

Incoming junction work is dealt with on a portion of the small board seen on the left of Fig. 53. The table of this board is similar to that on the subscribers' boards, all the subscribers' lines being connected to branching jacks there. The canopy is on the single-cord system, the junction wires ending in plugs. There are call-wires from other exchanges, these wires terminating in the operators' receivers. The originating operator in the smaller exchange speaks on the call-wire to the operator at the incoming junction board at the central, and is given a junction-wire in the usual way. If the wanted subscriber is engaged she gets the "busy back" signal, if not engaged she sees the two subscribers through. Instructions to clear are given on the call-wire, automatic clearing signals not having been introduced yet. In case of a breakdown on the call-wire or the breaking of the cord of the plug, each junction-wire is also branched to a four-point jack and a listening key and self-restoring indicator are provided for each junction, as well as a double-ringing key for each operator. The listening key and jack are situated on the canopy; they are seen in the section in Fig. 54.

Trunk Service.

There are four ticket-wires on each section of the subscribers' boards. Any subscriber desiring a trunk connection is plugged into the jack in which a ticket wire ends, and repeats his demand direct to the "record table" at the Post Office. When the Post Office recording operator has taken down the demand she transmits a clearing signal to the National Company's operator. This clearing signal is the lighting of an incandescent lamp, and as soon as the operator observes it she clears the connection. When the call "matures" the Post Office communicates with the trunk section of the junction board through a call-wire, notifying the junction wire and number of the subscriber, and connection is made by the National Company's operator accordingly. Lamps are used to give clearing signals here also. The details of the arrangements will be dealt with in Article VIII., which will be devoted to trunk working.

The following figures may be found interesting:—

Total mileage of wire in the switchroom	1,328
Total number of spring jacks	96,700
Total number of soldered joints in switchroom	733,000
Number of calls a year in Manchester district, about	29,000,000
Number of subscribers in Manchester district, about	5,000
Number of operating staff	130
Number of circuits between the National Telephone Company's Exchange and Post Office for trunk connections	300

French Physical Society.—At a meeting of this society, held on January 21st, the election of officers for the present year took place. M. R. Benoît, chief of the "International Bureau of Weights and Measures," succeeds M. Bequerel as president, and Col. Bassot has been elected vice-president.

N.C.S. NEW PATTERN OF POTENTIOMETER.

The Davies Motor Company (successors to Nalder, Bros. and Co.) have just put on the market the new pattern of potentiometer illustrated in Fig. 1. The connections of the instrument and the method employed will be seen by reference to Fig. 2. A secondary battery is joined on to the two terminals F, and sends a current through the two dials C and D in series and then through adjusting resistances K and H. The C dial has 150 exactly equal coils in it, numbered from 0 to 150. The D dial has 100 equal coils in it, the whole dial being exactly equal to one coil in C. The dial K contains 19 equal small wire resistances, and H is a carbon resistance for fine adjustment of the current. A standard cell of known E.M.F. is joined up to A+ and A−, and the switch L is put over to A. Any convenient galvanometer, the most convenient form being a D'Arsonval, is joined up to the galvanometer terminals. Say the voltage of the standard cell, at the temperature used, is 1·4412; the arm of the C dial is then set to 144, and that of the D dial to 12.

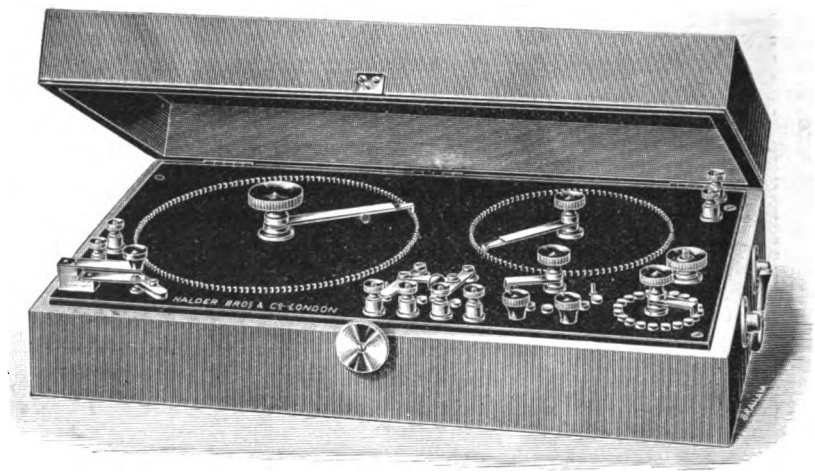

Fig. 1.—N.C.S. New Pattern of Potentiometer.

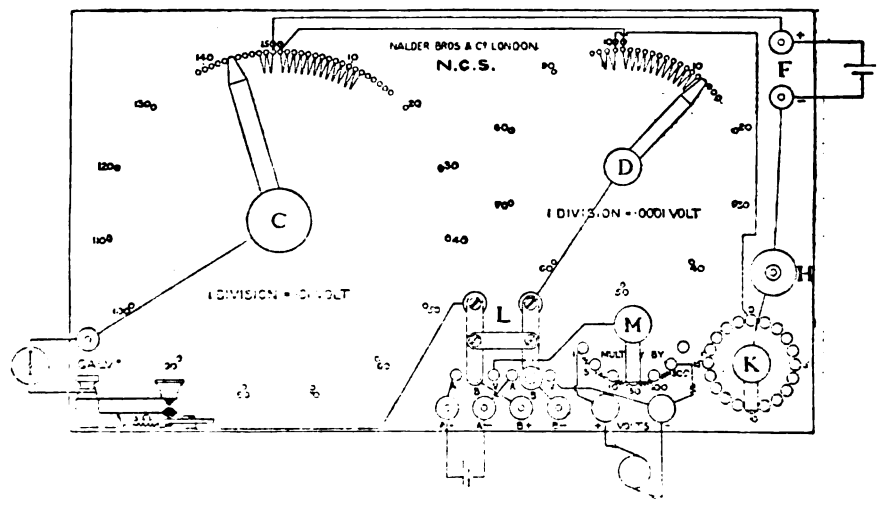

Fig. 2.—Diagram of Connections.

The resistances at H and K are now adjusted until closing on the circuit of the galvanometer and standard cell no deflection is observed. H and K are arranged so that any pressure up to three volts can be used at F. K is a dial rheostat, and H a carbon resistance. Screwing down the head H draws up a rod which compresses the carbon and reduces the resistance in circuit. The galvanometer key is provided with a catch so that normally the circuit is closed through a resistance of half a megohm on depressing the key. When balance is nearly obtained the catch is pushed aside and this resistance is short-circuited, and the final adjustment is made.

The potential difference to be measured, if not above 1·6 volts, is connected to the terminals B+ and B−, L is switched over to these terminals and the dial-arms adjusted till balance is obtained, when the dial readings give directly the potential difference required. Higher pressures are connected to the terminals marked "volts," which are bridged by a resistance M of 100,000 ohms, and points

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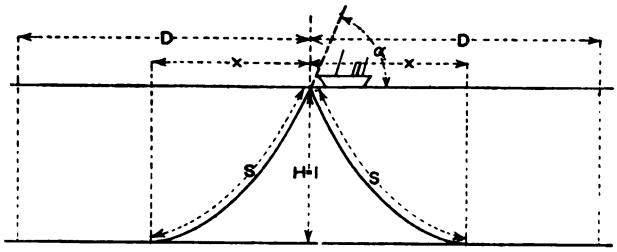
in this resistance representing $\frac{1}{3}$, $\frac{1}{10}$, $\frac{1}{30}$, $\frac{1}{100}$, or $\frac{1}{300}$ are connected by the arm to the potentiometer, the results of the test having thus to be multiplied by 3, 10, 30, &c., as the case may be. Not more than two milliamperes should flow through M for any length of time, so that, if higher pressures than 200 volts are to be measured, resistances should be used in series with them and allowed for in calculating the result.

CORRESPONDENCE.

SUBMARINE CABLE REPAIRS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As it is generally advisable to renew any cable which has been dragged over the bottom in the course of a repair, especially if the cable has been down some years, it is necessary to have an idea of the extent of this action. For my own use I compiled the accompanying table of the various relations, and I believe that others employed in cable work will find it of some assistance. The known weight of the cable in water (per knot) in conjunction with the dynamometer reading, gives an approximation for the length of the suspended bight (it must be remembered in using the table that S is half the bight), and this can be checked by the angle at the surface.



Of course, the table must be used with judgment, such things as currents and inequalities of the bottom having a considerable effect on the figures. The above sketch will show better than words the idea of the table

Table showing relation between depth of water-length of suspended bight, &c., &c., with various percentages of slack. Depth of water taken as unity.

Angle at surface.	Horizontal distance between apex of bight and place where cable touches the bottom.	Length of cable suspended between apex of bight and bottom.	Chart distance (D) on either side of apex of bight to cable undisturbed by lifting of bight, with the various percentages of slack given below. Percentage S > x.								
α	x	S	0%	1%	5%	8%	10%	12%	13%	15%	20%
° ′											
27 38	3·9	4·1	4·2	16	...	...	...	...	...	...	...
30 20	3·5	3·7	5·3	19	3·7	...	...	...	...	...	...
31 55	3·3	3·5	5·8	19	3·9	...	...	...	...	...	...
33 41	3·1	3·3	6·6	21	4·1	...	...	...	..	...	...
35 38	2·9	3·1	7·5	22	4·4	...	...	...	...	...	...
37 50	2·7	2·9	8·7	23	4·7	2·9	...	...	...	...	...
40 17	2·5	2·7	10·0	25	5·0	3·2	2·5	...	...	...	...
43 1	2·3	2·5	12·0	27	5·4	3·4	2·7	2·3	...	...	...
46 5	2·1	2·4	14·0	29	5·9	3·7	2·9	2·4	2·3	...	...
49 37	1·8	2·2	18·0	32	6·4	4·0	3·2	2·7	2·5	2·2	...
51 31	1·7	2·1	20·0	34	6·8	4·2	3·4	2·8	2·6	2·3	...
53 33	1·6	2·0	22·0	36	7·1	4·4	3·6	3·0	2·7	2·4	1·8
55 42	1·5	1·9	25·0	37	7·5	4·7	3·7	3·1	2·9	2·5	1·9
58 2	1·4	1·8	28·0	40	7·9	5·0	4·0	3·3	3·0	2·6	2·0
60 28	1·3	1·7	32·0	42	8·4	5·3	4·2	3·5	3·2	2·8	2·1
63 3	1·2	1·6	38·0	45	8·9	5·6	4·5	3·7	3·4	3·0	2·2
65 46	1·1	1·5	44·0	48	9·5	5·9	4·8	4·0	3·7	3·2	2·4
68 35	1·0	1·5	53·0	51	10·0	6·3	5·1	4·2	3·9	3·4	2·5
71 33	0·8	1·4	65·0	55	11·0	6·8	5·5	4·6	4·2	3·6	2·7
74 35	0·7	1·3	81·0	59	12·0	7·4	5·9	4·9	4·5	3·9	2·9
77 41	0·6	1·2	106·0	64	13·0	8·0	6·4	5·3	4·9	4·3	3·2
80 37	0·5	1·2	142·0	69	14·0	8·6	6·9	5·7	5·3	4·6	3·5

Thus, supposing depth = ½ knot,
dynamometer = 8 tons,
cable = 1½ tons per knot,
then the whole bight = 8/1½ = 2 knots;
but unit = ½ knot, ∴ bight = 4 units,
and ∴ S = 2 units,
and opposite 2, under S, we get the
angle α = 53deg. nearly,
and with 13 per cent. slack,
D = 2·7 units,
or = 1·3 knots.

Yours, &c., ANDREW GRAY.

C.S. "Grappler," Jan. 29, 1898.

STREET TELEPHONE KIOSKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like, with your permission, to be allowed to say one or two words on the subject of the kiosks referred to in your issue of the 21st inst.

You are quite correct in saying that the noise of the street traffic, though considerable, in no way lessens the distinctness of the conversation by persons using the telephones, but I think that this must be due also to a large extent to the fact that the glass forming the sides of the kiosks is double, with a space between the two glasses filled with transparent paper, which also prevents people on the outside from hearing what is going on within.

The kiosks are open for the public to use the telephones and messenger calls between the hours of 9 a.m. and 8 p.m. (not 6 p.m.).

I should also like to say, in reference to the brilliancy of the lights in the kiosks, that, though this is partly in view of the transparencies in the windows, one of its chief objects is to improve the lighting of the streets, in which respect it is a great advantage, the lights being kept burning all night; on each kiosk also the name of the street in which it is situated has been put, so as to show up brilliantly after dark.

Would you kindly note that the kiosks belong to this Company, by which they have been erected under the sanction of the local authorities, and for the present as an experiment only. It is believed that they will in many ways prove great conveniences to the public, be a great advantage in street lighting, and ornamental in many wide thoroughfares and open spaces, in which case it is hoped that their number will soon be greatly increased.—Yours, &c.,

E. CHAS. C. SMITH, Secretary.

The Street Syndicate (Limited),
1, Great Winchester-street, London, E.C., Jan. 27, 1898.

[A second letter from Mr. Smith, dated January 29th, requests us to state that "the telephone wires are at present fixed up only temporarily, and that they will as soon as possible be carried underground."—ED. *E.*]

DYNAMO EFFICIENCY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The method which M. Routin suggests for finding the efficiency of a dynamo, referred to in your issue of January 21st, p. 409, is substantially in principle the method I very briefly sketched out in a letter which appeared in *The Electrician* of February 17, 1893.

M. Routin calculates the energy absorbed by the dynamo by experimentally determining the change of rotational energy of the armature as it slows down from a high speed when the driving power has been cut off. The equation involves the term MR^2 the moment of inertia of the armature, and he eliminates this troublesome factor by performing a second experiment, in which a known fraction of the energy of rotation is absorbed by a brake. A brake, however, is not very reliable, and my suggestion was to find the value of MR^2 by attaching to the armature shaft a flywheel of known moment of inertia, mr^2, and then, following M. Routin's nota-

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tion, the moment of inertia of the armature is given by the expression

$$\frac{mr^2 \tan a'}{\tan a - \tan a'},$$

in which a and a' are the angles made by the tangents to the curves of speed and time with the axis of abscissa.

A knowledge of the moment of inertia of the armature would allow the whole power supplied to the dynamo to be found, and from this the efficiency could be calculated directly. This would, perhaps, be preferable to the method of summing the separate losses; it would, at least, be a check upon it. It may be noted that the use of a second dynamo as a motor is not essential, as any means of driving the dynamo and then suddenly cutting off the power would answer the purpose. No doubt a motor is the most convenient way of doing this.—Yours, &c.,

J. REGINALD ASHWORTH.

Rochdale Technical School, Physical Laboratory,
Jan. 25, 1898.

MOTOR VEHICLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has this morning been called to the account in your Paper of 28th inst., of the contract recently made by the Post Office authorities for the carriage of mails between London and Redhill and as some misapprehension has already been caused by one of the statements contained therein, I beg to say that the van in question was not built by Messrs. Julius Harvey and Co., who were, in fact, acting merely as contractors with the Post Office. While undoubtedly credit is due to them for the manner in which they have taken this matter up, yet I feel sure that they would not wish to take to themselves the additional credit of building the van, which was, as a matter of fact, designed and built by this Company at its works in the Isle of Wight.

This particular van was the first one constructed, being, in fact, almost entirely experimental, the system employed for generating steam having until then only been employed in steam yachts and launches. The van had, however, before she commenced the Redhill run covered somewhere about 3,500 miles of road, and was of service to the Government in another direction in carrying stores to the Salisbury camp last summer.

It may possibly be of more interest to your readers to know that, in addition to a number of vans which we are at present building to carry loads of 3 tons and upwards, we have also in hand a van which we specially designed for "biograph" work. It is arranged to carry a dynamo and small auxiliary engine, the latter being driven from the main boiler, and it will make its owner when travelling about the country quite independent of all local electrical plant.—Yours, &c.,

THE LIQUID FUEL ENGINEERING COMPANY.

20, Abchurch-lane, London, E.C., Jan. 29, 1898.

LEGAL INTELLIGENCE.

Salmony and Co. v. the Improved Electric Glow Lamp Company (Limited).

This case came before Mr. Justice Kennedy, sitting without a jury, in the Queeen's Bench Division last week.

Mr. Tindal Atkinson, Q.C., and Mr. F. Abrahams appeared for plaintiffs, and Mr. Rufus Isaacs for defendants.

Mr. TINDAL ATKINSON said the action was brought to recover £287. 15s. 1d., balance alleged to be due for the supply of electrical fittings and lamps. The defendants had paid £138. 7s. 7s. 4d. into Court. There were no pleadings, and only two items in the plaintiff's account were in dispute—one of £156. 13s., and another of £67. 14s. 2d. Those items related to the sale and delivery of certain lamp-holders. There was a counter-claim. The defendants said that the goods were not delivered at the proper time, and that when they were delivered they were rejected, but ultimately taken on the terms that they were to act as agents for their disposal. The plaintiffs emphatically denied this. They said the goods were supplied within a reasonable time, and were accepted. Although the defendants demurred in the first instance, the goods were ultimately accepted, and the defendants had used a quantity of them. Under the counter-claim the defendants, as he (Mr. Atkinson) understood it, claimed £100 under the circumstances he had mentioned. In 1895 his clients had control of the agency for the sale of silvered lamps. These were small electric lamps silvered on the top side so as to reflect and increase the amount of light. That was an agency for the United Kingdom and the Colonies, and they were the agents for a Mr. Schwabe of Berlin. The plaintiffs under that contract had effected some business, and among other contracts they had disposed of some of these lamps to a Mr. Brown of Eastbourne and Mr. McLeod of Glasgow, but the contracts with both these gentlemen were really contracts of agency. That was to say, that those persons had agreed to become the plaintiff's agents for the disposal of the lamps. They had also become personally liable to take from plaintiffs a certain quantity of the lamps, and pay for them, and in addition act as agents in their particular districts. A Mr. Fanter was the promoter of a particular syndicate which was proposing to take over the sale of these lamps in the United Kingdom, and also to acquire the patent rights, and in April, 1895, Mr. Fanta negotiated for the transfer to the syndicate of the agency which the plaintiffs held. Mr. Fanta was told of the existence of the contracts with Brown and McLeod. The result of those negotiations was an agreement, and it was under that agreement and an assignment which followed that the counter-claim was made. The learned council then went into the particulars of the various contracts, and said that under them the Company made various claims, one of which was that the plaintiffs should take no less than 22,500 lamps from them, whereas they only agreed to take 4,500. That he regarded as an attempt at imposition. One result of what took place was that Messrs. McLeod and Brown refused to be handed over to the syndicate. The parties met, and there was a long discussion and correspondence which applied to the orders alleged to have been given and repudiated, and to the delay in the delivery of the various appliances, which had to be manufactured in the interior of Germany and shipped from Hamburg. Counsel contended that all the plaintiffs undertook to do was to have the things made and delivered as quickly as possible, and said it was a fact that 2,200 out of 2,500 holders were received by the defendants in time to be used at the Jubilee. When the plaintiffs sent in their invoices they were returned. He submitted that there was nothing really in the defence or counter-claim.

Mr. H. M. SALMONY, the plaintiff, gave evidence in support of his counsel's statement. He maintained that he had fulfilled his part of the contract. His firm did their best to get the goods delivered from Germany in time for the Jubilee, and many of them arrived soon enough to be so used. He had never admitted that the goods were late in delivery, or that he had agreed to allow the defendants to retain them and sell them on a commission of 25 per cent. The usual commission for such a transaction would have been 5 per cent.

Mr. ERNEST ROSENBERG, a member of plaintiffs' firm, said that at an interview on September 16, 1896, defendants accepted their conditions, and an agreement was completed. Mr. Fanta wanted them to guarantee that Mr. Brown and Mr. McLeod would accept an assignment of their agencies, but those gentlemen refused to do so. The invoices were returned by the defendants, but they ultimately agreed to take the goods.

Mr. RUBENSTEIN said there was a discussion as to the £700, the alleged profits from the agencies, but no guarantee such as that suggested was given. There was only an offer from Mr. McLeod, but no acceptance of any contract.

His LORDSHIP said that the question seemed to be whether the defendants were entitled to rely on the special agreement which they set up and to damages, because the arrangement with McLeod was not a contract but only an offer.

Mr. RUFUS ISAACS said he did not propose to address his Lordship then, but would call his evidence.

Mr. FERDINAND FANTA said he was Managing Director of the defendant Company, and was Manager of the Syndicate before it was transferred to the Company. When the order for the holders in question was given, it was on the condition that they should be delivered within eight or ten days. It was absolutely essential that the Company should get the goods some time before the Jubilee, otherwise they could not put them on the market. When they were delivered on June 3rd or 4th it was not in sufficient time for the Jubilee. Some of them, however, were in time for the Jubilee, and about 2,200 were used. He gave instructions to the staff to refuse the goods after May 25th. The goods, however, were delivered in the absence of the warehouseman on June 7th or 8th. Witness afterwards met Mr. Salmony and Mr. Rosenberg, who chaffed him about the goods, and said he would have to pay for them. Witness told them that he did not want them and could not use them. They then asked him to try and make use of them. That happened on the afternoon witness was asked to do the lighting of St. James's-street, and he told Mr. Salmony and Mr. Rosenberg that he had something which might possibly enable him to use part of the goods. Those gentlemen agreed that he should do the best he could to dispose of part of the goods, and witness promised to do so. In point of fact, he said all he could with regard to that contract. He never agreed at any time to take the goods and pay invoiced prices for them. Mr. Salmony knew that the goods were delivered too late and that witness could not use them. Witness had from the plaintiffs credit for all that had been used and paid the money into Court. The goods for which he had not paid money into Court were still on his premises. They were goods which could not be used in this country on account of the patent law. At the time of the transfer witness said that he was told by the plaintiffs that the contracts they had on hand would amount to no less than £800 or £900, the plaintiffs said, however, that they did not want to pledge themselves to more than £700. Witness believed that the contract he was getting with McLeod was a firm contract. As a matter of fact, the Company had never got a farthing of profit out of the alleged £700 worth of contracts. Browne's contract was in abeyance, and nothing had been done. His complaint about the McLeod matter was that there was no business resulting from it. The people with whom the plaintiffs said they had contracts had refused to be bound by the transfer. He understood that McLeod did not consider he was bound either to Mr. Salmony or to the Company. Witness thought he had been deceived in the matter of the contracts with

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McLeod and Brown. The Syndicate was formed for the purpose of purchasing certain patents, Schwarber's amongst them. In order to successfully carry out his plans it was necessary that he should obtain the sole agency, which was then in the hands of the plaintiffs, and he had to purchase them out. That was not the principal object he had in view with regard to his agreement with the plaintiffs. In that particular negotiation the principal consideration was that witness would undertake the delivery of all lamps which Messrs. Salmony might have not only on their premises, but which they might have on their premises six weeks after that date, and it turned out that these amounted to some 10,000 lamps which had been invoiced to them, and which the Syndicate agreed to purchase for a higher price than the plaintiffs had paid for them. Witness stated that he never agreed to take the holders in dispute, but would try to dispose of them—acting as the plaintiffs' agents, in fact. Witness told Mr. Salmony that if he did succeed in disposing of them he should require a commission. He did not know that there was any representation as to the commission in the Company's books. When the plaintiffs sent the Company the invoices they were returned to them, but re-returned by the plaintiffs to the Company. Witness ordered the holders in question for the purpose of using them at the Brussels Exhibition. He told Mr. Salmony that they would not be any use to him unless he could use them for Jubilee Day, and then send them on to Brussels. Witness would have to decide about the Brussels contract in May. Not getting the holders delivered in time he could not get the contract. As a matter of fact, he did not press for that contract, and it was not accepted.

Judgment.

His LORDSHIP, having briefly reviewed the evidence, said there was no question in his mind that the contract with Mr. Brown, of Eastbourne, was an actual contract, and that the transaction with Mr. McLeod, of Glasgow, was one which might fairly be described as a contract in view. It was a contract in view and not in hand, although there was very little difference between them. Proceeding to deal with the counter-claim of the defendants, he said that if it was found that if a document or agreement had missed conveying what it was intended to convey, it was right and just that the document should be reframed for the purpose of getting at what both sides intended and what was meant. He had no doubt that at the time the agreement was made both the parties understood one thing only, and that was the benefit of the correspondence and arrangement with McLeod was to be transferred, whatever it was worth. The defendants had the full benefit of the objection they took, but they did not communicate with McLeod or try to verify what had been said with regard to him for fully two months. In fact, no question was ever raised until nearly a year later in any serious form—not until October 22nd did he find any serious complaint. McLeod had then refused to transfer his contracts, and it was only after that that the liquidator of the Syndicate (Mr. Bartlett) wrote and drew attention to the fact that the contracts with McLeod and Brown had not resulted in the business and profit which plaintiffs had guaranteed, and Messrs. McLeod and Brown had repudiated the right of the plaintiffs to hand the contracts over to the Syndicate. He repeated that there had never been any proper negotiations with McLeod and that no claim was made with with regard to him for nearly a year. The defendants' solicitors' letters were sufficient to show that what was intended and understood to be given was given and accepted on the terms of the guarantee which was written. He did not see why he should give the defendants damages on the counter-claim, because McLeod had declined to trade with them as the persons to whom his contract with another person had been handed over. Defendants took their risk of that. "A" could not assign to "B" a contract with "C" against the latter's will. The defendants took the risk of McLeod agreeing to the assignment, and McLeod declined. He could not therefore give defendants damages on the counter-claim. With regard to the claim, the matter stood thus: In March, 1897, a contract was made for the sale of these goods, which had to be manufactured in Germany and supplied to the present defendants. It was said they were not supplied in a reasonable time, but reasonableness of time must depend upon the circumstances, such as the time necessary to give the orders, to construct the articles, and to bring them to England. It must be a time reasonable to the vendor as well as the purchaser. If April 14 was agreed upon, the order could not have been carried out. When the order was carried out the defendants contended that delivery was too late, and sent back the invoices, but they afterwards took them back, and did, upon some terms which were not disputed, agree to take and pay for the goods. Therefore the question arose, on what terms and in what fashion? Did they take them as agents, or did they, when they found they could use a certain number during the Jubilee, take them? The same could not be said as to the lamps which were said to have been required for Brussels, as their tender there was refused. There was not sufficient weight of evidence to justify him in saying that any special agreement was come to. There was no trace in the books of any correspondence as to any such agreement, and no form of accounts was kept on that basis. In the face of the conflict of evidence he must be guided by the letters which passed. It appeared to him that there was no proof that the goods should not be paid for, as they were ultimately accepted, taken into the stores, and used by the defendants. He therefore gave judgment for the plaintiffs on the counter-claim and also on the claim, with costs.

On the application of Mr. TINDAL ATKINSON he made an Order for the money paid into Court to be paid out.

Lloyd and Lloyd v. Henderson and Co.

At Glasgow Sheriff Court an action was brought against O. and W. Henderson and Co., engineers and shipbuilders, at the instance of Lloyd and Lloyd, Birmingham, who are holders of letters patent in the United Kingdom for the Benardos system of electric welding. In April, 1892, the defendants applied to the plaintiffs for a licence to use the inventions comprised in the patents, and, after considerable correspondence, were supplied with the necessary electric welding plant and machinery, and were granted a licence to use the same as from Dec. 31, 1892, during the continuance of the patents, for the royalty of £200 per annum. The plant and machinery were used and the royalty paid for two years, but defendants refuse to pay any further royalty on the ground (1) that there was no completed agreement, the document not having been signed by the partners in the defendant firm, but only by one of them; (2) that the invention cannot perform the operation it was represented they could; (3) defenders have ceased using the inventions; and (4) the engrossment signed by the aforesaid partner is different from the draft of which the defendants approved. Defendants alleged that the alterations were withheld from them, and that had attention been called to the alterations no signature would have been given. The pleadings the plaintiffs deny, and declare that defendants, by letter of June 2, 1892, agreed to hold themselves bound by the deed and signature of Mr. Andrew Pitcairn Henderson, the partner referred to. They plead that the licence is binding according to the law of England as well as of Scotland, and that the defendants are barred from objecting to its terms and conditions.

National Company for the Distribution of Electricity by Secondary Generators (Limited).

On Wednesday Mr. Justice Wright heard a winding-up petition in the name of Mr. H. O. Ruelle relating to the above Company. It was a creditor's petition, and the matter at issue between the Company and the petitioner was the subject of litigation before Mr. Justice Stirling. The matter was therefore ordered to stand over, with liberty to apply for its re-insertion in the list.

Lyell v. Davis.

At Westminster (London) City Court on Wednesday an action was called in which Messrs. J. C. Lyell and Co. sued the defendants (a firm of carriers) to recover damages for the non-delivery of a quantity of electrical fittings entrusted to them for exportation to Stockholm. The plaintiff's case was that in August last they instructed defendants to ship the goods in question to Stockholm for the purpose of the celebration of King Oscar's jubilee, and they (the defendants) undertook that the goods should go by a certain ship and would reach their destination in time. This they failed to do, the goods not reaching the docks in time to catch the ship. The defence was that the goods were delivered in good time for the jubilee, but that the plaintiffs' clients at Stockholm could not get them fitted up in time for use at the ceremony. Judge Lumley Smith said there was a great conflict between the parties, and as the matter was one of some importance he would take time to consider his decision.

Salmony v. Theerman.

In the same Court the case of H. M. Salmony and Co. v. W. P. Theerman and Co. was heard, in which the plaintiffs sued to recover £12. 10s. in respect of electrical apparatus and other goods supplied to their order. Evidence was called to prove that a resistance frame, for which £8 had been charged, was made in the best possible way, and was in every way according to order. The defence was that galvanised iron wire had been used, whereas it should have been German silver, the result being that the frame was many times larger than it should have been, and was totally useless for the purpose for which it was intended. It was also alleged that it was a totally different article from that shown in the plaintiffs' catalogue, and from which the order was given. Defendants had offered to pay the plaintiffs a reduced price for the resistance in the hope that he might use it on another contract, but the offer was refused. Judgment was given for the plaintiffs for the amount claimed, with costs, subject to a deduction of £1 in respect of one of the smaller items in the account.

Wyman v. Salmony.

At the same Court a case was heard in which the plaintiff (formerly in the defendant Company's employ as a traveller on commission) sought to recover a balance of account alleged to be due to him in respect of commission on orders obtained. The plaintiff said he was discharged from the defendants' employ on the ground that he did not do sufficient business, and since that time he had not been able to get a settlement of his commission account. The defence was that Messrs. Salmony and Co. were perfectly willing to pay plaintiff whatever was due to him, and the only reason why this had not been done was because the customers had not paid their bills. If the plaintiff chose to go into the accounts he could at once have whatever was due to him. The case was adjourned in order to allow of a settlement being arrived at.

Cawte v. Penny-in-the-Slot Electric Supply Syndicate.

At Taunton last week Mr. Cawte, electrical engineer, Taunton, sued the Penny-in-the-Slot Electric Supply Syndicate (Limited) for £14, for goods supplied and £21 damages for breach of warranty. For the plaintiff it was stated that in the spring of last year an arrangement was made by which he was to do certain work in connection with the free wiring of premises in the district for the defendant Company. For the defence, Mr. C. O. Bastian was called, and said that the claim was against the Electric Extension Syndicate, of which he was Managing Director, and they admitted the claim for £14. 7s. for goods supplied. The statement of claim having been amended, judgment was given for the plaintiff against the Extension Syndicate for this amount, but without costs.

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TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Offic not later than first post Thursday morning. New Catalogues Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Bibliography of X-Ray Literature and Research, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Potentiometer and its Adjuncts": A Universal System o Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Secondary Batteries, their Design and Manufacture."—By E. J Wade. *In the Press.*

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 will be ready next Friday. Many new features of interest to the profession will be introduced, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, will be brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898.

Tenders Invited.—The Redditch Urban Council invite tenders for the following work in connection with their proposed electricity supply station:—(1) Erection of central-station buildings, &c.; (2) gas-producing plant for 230 H.P.; (3) double-cylinder gas engines, total power 350 H.P.; (4) alternators, total output 230 kilowatts; (5) concentric lead-sheathed armoured cables; (6) ten 20-kilowatt alternating current transformers; (7) switchboard and instruments; (8) counter-shaft, pulleys, ropes and belts. Specifications may be obtained from the consulting engineer (Mr. J. A. McMullen, M.I.E.E.), Hornchurch, Essex; and tenders must be sent to the clerks to the Council (Messrs. Browning and Hobson) by Feb. 14. An advertisement elsewhere contains further particulars.

——— The Corporation of St. Helens invite tenders for plant, &c., in connection with the supply of electricity for traction purposes. Tenders to Mr. W. J. Jeeves, town clerk, Town Hall, St. Helens, by Feb. 21.

——— The Wimbledon District Council invite tenders for the erection of electricity supply station buildings and chimney shaft. Tenders to the clerk (Mr. W. H. Whitfield), Broadway, Wimbledon, by Feb. 9.

——— The Hammersmith (London) Vestry require tenders for electrical stores for the 12 months ended March 25, 1899. Tenders to the Clerk, Town Hall, Broadway, Hammersmith, W., by the 15th inst.

——— The Vestry of St. Mary, Islington, require tenders for electrical and engineers' stores, &c. Tenders to the Clerk, Vestry Hall, Upper-street, Islington, N., by the 24th inst.

——— The Vestry of St. John's, Hampstead, invite tenders for the supply of various stores for the electricity department. Tenders to the Vestry Clerk, Vestry Hall, Hampstead, London, N.W., by the 16th inst.

——— Tenders are invited by the Municipal Authorities of Belmonte (Oviedo) Spain, for the concession for the electric lighting of the town for fifteen years. Tenders to El Secretario del Ayuntamiento de Belmonte.

Tenders Invited.—The Frederiksberg Sporveisog Electricitets-Aktieselskab is inviting tenders until March 12th for the supply of steam engines and dynamo accumulators for their new generating station. Particulars from and tenders to the company (Gammel Kongerei, 140, Copenhagen V.

——— The Municipal Authorities of Burgo de Osma (Soria), Spain, invite tenders until the 20th inst., for the concession for the electric lighting of the town for a period of four years. Tenders to El Secretario del Ayuntamiento de Burgo de Osma.

——— Tenders are being invited until March 21st by the Telegraph Department of the Victorian Government Railways for the supply of alternating-current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer-street, Melbourne.

——— The Société Nationale des Chemins de Fer Vicinaux, Brussels, require tenders for 38 electric tramcars. Tenders to the Société, 26, Rue de la Science, Brussels, from whom particulars may be obtained.

——— Tenders are being invited by the Spanish Post and Telegraph Authorities, in Madrid, for the supply of 19 tons of bronze wire, and 60 tons of galvanised iron wire. Tenders to be sent to La Direccion General de Correos y Telegrafos, Calle de Carretas 10, Madrid, by the 7th inst.

Offers Invited.—The Secretary of State for War requires offers (accompanied by competitive designs) for the supply of portable electric search-light apparatus. Some further particulars will be found in an advertisement elsewhere. The offers must be sent not later than Wednesday, April 27, addressed to the Director of Army Contracts, the War Office, Pall Mall, S.W.

Tenders Accepted.—The Bedford Corporation have accepted the following tenders for the supply and erection of plant at their electricity supply station:—Section A, Easton, Anderson and Goolden (250 unit alternator) £1,075; (B) W. H. Allen, Sons and Co. (420 B H.P. double-acting compound enclosed engine) £1,375; (C) W. T. Henley's Works Co. (vulcanised rubber cables) £1,683. 3s.

——— The following tenders have been accepted by the West Hartlepool Corporation for the supply of electric plant:—

Contract No. 1, Boilers (Lancashire) and Mechanical Stokers,	Easton, Anderson and Goolden	£1,530
„ No. 2, Engines, Dynamos, Pumps, &c.,	Crompton and Co.	8,344
„ No. 3, Storage Battery,	Tudor Accumulator Company	845
„ No. 4, Switchboard for Lighting and Traction Work,	Crompton and Co.	1,620
„ No. 5, Arc Lamps and their erection,	Crompton and Co.	239

The tender of the Tudor Company for the maintenance of the accumulators for five years was also accepted.

——— The Works Committee of the Brighton Town Council recommend the acceptance of the tender of Mr. A. H. Wood for wiring the Town Hall for the electric light at £705. Eleven tenders, ranging from £625 to £1,865, were submitted, and of these only six complied with the conditions of the electrical engineer as to the character of the materials and fittings for the work.

——— The Works Committee of the Hull Corporation have accepted the tender of Messrs. Siemens Bros. and Co. for the electrical equipment of the tramways (including the provision of 20 cars) for the sum of £42,228. 1s. 5d.

——— The Marylebone Guardians have received 18 tenders for wiring the new central administrative block at the Northumberland-street Workhouse, the amounts ranging from £870 to £1,480. 16s. 10d. It was proposed at the last meeting that the lowest tender (Messrs. H. Joel and Co.) be accepted. An effort was made to induce the Board to accept the tender of a local firm (Messrs. A. Emanuel and Sons), and eventually it was decided to refer the question to the Workhouse Committee, with instructions to accept "the lowest satisfactory tender submitted."

Appointments Vacant.—The Corporation of St. Helens invite applications for the office of resident electrical engineer for their lighting and traction plant. Commencing salary £200 per annum. Applications to the town clerk (Mr. W. J. Jeeves), Town Hall, St. Helens, by Feb. 15.

——— The Corporation of Barrow-in-Furness invite applications for the post of resident electrical engineer. Commencing salary £200 per annum. Applications must be delivered at the Town Hall, Barrow-in-Furness, by Tuesday, Feb. 8.

——— The Corporation of Birkenhead invite applications for the position of resident electrical engineer. Salary £300 per annum. Further particulars are given in an advertisement elsewhere, and applications must be sent in to the town clerk (Mr. Alfred Gill), Town Hall, Birkenhead, by Friday, the 18st inst.

Vacancies.—It will be seen from an advertisement elsewhere that a capable man is required for Spain to help organise the initial work of an electric lighting company.

——— There is a vacancy for an improver in the electricity department of the Dundee Gas Commissioners. Salary 20s. per week. Applications to the city electrical engineer (Mr. W. H. Tittensor) by Monday, Feb 7. See advertisement.

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Vacancy.—A switch-room attendant is required for the electricity works of the Vestry of St. Mary, Islington. Salary 30s. weekly. Applications to the electrical engineer (Mr. Albert Gay), 50, Edengrove, Holloway, London, N., by noon on Tuesday, 8th inst.

Liquidation.—It was resolved, at the meeting on Jan. 11, at 2, Warwick-street, Regent-street, W., to wind up voluntarily the National Company for the Distribution of Electricity by Secondary Generators (Limited), and to appoint Mr. J. H. Thornton, Winchester House, E.C., as liquidator. This resolution was confirmed at a meeting on Jan. 28.

Business Notices.—Messrs. Green and Treacher, inform us that their business is now conducted under the name of the Standard Electric Company.

——— Messrs. Scott Anderson and Beit, of Sheffield, have been appointed sole agents for the Voltex process of electric welding for Yorkshire, Lancashire, Nottingham, Derbyshire, Staffordshire, Cheshire, Worcestershire, and Warwickshire.

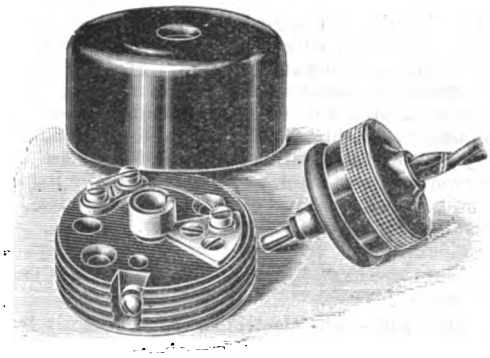
——— The Blackman Ventilating Company intimate that the whole of their business in Scotland will in future be conducted from their new address, 162, Hope-street, Glasgow, their former agency having been terminated.

Personal.—We have received the following from Mr. Mervyn P. O'Gorman :—

"Having negotiated the recent transfer of the business of the Fowler-Waring Company to the Western Electric Company, I have decided to join with Mr. E. H. Cozens-Hardy, chief assistant to the Brush Company's engineer, in an examination of Continental and American methods, with a view to a subsequent partnership in consulting work on our return to London."

Bankruptcy.—Under a petition presented on the debtor's own behalf, a receiving order was made last Tuesday at the London Bankruptcy Court against John Dewhurst, electrician, &c., 52, North End-road, West Kensington, London. An order of adjudication in bankruptcy was also made by Mr. Registrar Giffard. The amount of the liabilities did not transpire.

The "Gem" Wall Connection.—Mr. A. P. Lundberg has recently been devoting his attention to diminishing the size of, and rendering more compact, his various types of fittings, and we congratulate him on the neat design of the concentric wall-socket, illustrated below. The base of the socket measures only 1½in. in



diameter, and the cover increases the overall diameter to only 1⅞in., and the height to less than an inch. Short-circuiting of the two contacts in the socket appears almost impossible, even if it be attempted wilfully, the hole in the cover being only large enough to allow the passage of the ¼in. plug. Evidently to meet the wish of contractors, fuse-terminals have been provided in the fitting. We have but recently expressed our opinion that these should be omitted in wall-sockets, but it is only fair to Mr. Lundberg to say that, in the one before us, a short-circuit through the blowing of the fuse, though not absolutely impossible, appears extremely unlikely to occur.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 26 to Feb. 1, with the ports of destination :—

Argentina—Buenos Ayres, £386 (telegraph material); *Australasia*—Adelaide, £37; Brisbane, £1,975 (telegraph poles); Fremantle, £771; Sydney, £582; Wellington, £397 (including £292 telegraph material). *Belgium*—Ostend, £35. *Brazil*—Rio de Janeiro, £195. *Canada*—St. John (N.B.), £20. *Ceylon*—Colombo, £199. *China*—Shanghai, £532. *Denmark*—Copenhagen, £19. *France*—Boulogne, £69. *Germany*—Hamburg, £78. *Gibraltar*, £70. *Holland*—Amsterdam, £360; Flushing, £19; Rotterdam, £150 (telegraph material). *Hong Kong*—£76. *India*—Bombay, £13; Calcutta, £220. *Japan*—Yokohama, £3,978. *Jersey and Guernsey*—£25. *Malta*—£44. *Norway*—Christiania, £50. *Portugal*—Beira, £1,355 (telegraph apparatus); Lisbon, £300. *Siam*—Bangkok, £71 (telegraph material). *South Africa*—Cape Town, £1,324; Delagoa Bay, £83; Durban, £469; East London, £168. *Straits Settlements*—Singapore, £100. *Sweden*—Gothenburg, £15; Stockholm, £209 (including £179 telegraph wire). *Turkey*—Constantinople, £1,060. Total £15,454, against £14,377 in the corresponding week last year (Jan. 27 to Feb. 2).

Sell's Directory of Registered Telegraphic Addresses.—This useful annual is now ready, and can be obtained of the publisher at 167, Fleet-street, London. The information is official, being compiled from lists furnished on the authority of the Postmaster-General. The contents of the book are by no means confined to a mere list of telegraphic addresses; there is very complete information regarding Post Office telephones, and an extremely useful table is given of the telephone trunk line charges, which we suggest should be issued separately as there is an increasing demand for information on this subject. The well-edited preface gives some interesting statistics of the trade of the empire, written by Mr. Joseph Ackland, and particulars relating to the submarine telegraphic system of the world, with latest revised tariffs, is also included. A useful map is given, showing the shipping and cable routes to various points of the empire. Altogether the 1898 edition of "Sell's Directory of Registered Telegraphic Addresses" is a book to be commended as an important work of reference for those engaged in commercial pursuits.

"Municipal Year-Book."—The 1898 issue of the "Municipal Year-Book," which is now published by Messrs. Edward Lloyd (Limited), Salisbury-square, London, E.C., contains about 500 pages of closely-printed matter dealing with municipal subjects generally, and with water, gas, tramways, artisans' dwellings, lodging houses, &c., in particular. There is also a short section devoted to municipal electricity supply. In this section we are told that "the early history of electricity supply is full of failures and mistakes," but this information is not very new, nor is it very true, for we question whether any great industry of modern times has been established upon so sound a footing in so short a period and with so few failures and mistakes. The record of progress has been unvarying from the start, until to-day we find the supply of electric current one of the most uniformly successful enterprises of which this country can boast, and this notwithstanding the impediments of the early Electric Lighting Act. Our comments apply especially to municipal electricity supply. The tramways section is a fairly full one, but we must demur to the statement that "almost without exception every large town has completely municipalised the tramways, or is about to do so." Is it not rather a play upon words to dub the course adopted by the London County Council in connection with the tramways "municipalisation." The "Municipal Year-Book" should be in the hands of all who take an interest in municipal affairs, as a mass of information is provided in a very handy form, giving just such particulars as the general public are likely to seek in connection with the discussion of local matters. The book is bound in cloth, and published at 2s. 6d.

Calendars.—Messrs. King and Co., electrical engineers and contractors, of Leith, send a hanging sheet calendar, and Messrs. Nalder Bros. and Thompson a convenient tear-off pad.

A more elaborate calendar is to hand from the Peckham Truck Company, embellished with illustrations of trucks and cars.

Acton.—The members of the Acton District Councel appear to entertain curious notions as to the status and functions of a consulting engineer. Some time ago it was decided to obtain a report on the electric lighting question from two consulting firms, and one of these reports was to have been supplied by Messrs. Kincaid, Waller and Manville, but, as we announced at the time, as soon as this firm ascertained that a second engineer was to be consulted they declined to act. To get over this difficulty, the District Council at its last meetinw approved the suggestion that Messrs. Kincaid, Waller and Manville should be appointed to review the reports presented by two other consulting engineers. Mr. E. M. Lacy (of Messrs. Lacey, Clirehugh and Sillar) had notified the Council that his fee for preparing such a report would be fifty guineas, and Mr. W. H. Trentham notified that his report should be presented at the next meeting of the Council. It remains to be seen what view Messrs. Kincard, Waller and Manville take of this proposal.

The Council have before them an offer from the National Electric Free Wiring Company for the wiring of premises in the Council's district free of initial cost. The Company have been invited to submit further particulars.

Asylum Lighting.—At the meeting of the Metropolitan Asylums Board last Saturday the Northern Hospital Committee's minutes stated that Messrs. Burstall and Monkhouse had submitted a report on the electric lighting of the hospital, and the total cost of an installation was put at £10,350, with £884 as the annual upkeep cost *of maintenance*. The Committee recommended that the principle of lighting the hospital by electricity be adopted, and that the Works Committee be instructed to recommend to the Board a firm of engineers to be engaged to prepare a scheme on those

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lines, and the necessary drawings and specifications for the work. The report was adopted.

Birkenhead.—The Town Council decided on Tuesday to appoint a resident electrical engineer for their electricity supply works, and an advertisement relating to the vacant appointment appears in another column. The electricity undertaking is progressing satisfactorily, the limit of capacity of the present plant having been reached, and extensions will shortly have to be made.

Blackpool.—A further sum of £40,000 is to be expended upon the electricity supply undertaking of the Corporation. The matter was discussed by the General Purposes Committee, and the Council are to be recommended to apply to the Local Government Board for sanction to borrow this sum. Owing to the difficulty in securing prompt delivery of plant and machinery from manufacturing firms, it was reported at the Committee meeting that the necessary machinery had been provisionally secured, and that engineering firms would not undertake to fulfil their orders in less than two years. Without the additional plant the increasing demand for current could not be met.

The Council have adopted the recommendation of the Electric Light and Tramways Committee: "That the Electrical Engineer, and such members of the Committee who choose to go, should visit Hanover, Dresden, Berlin, and Paris, for the purpose of inspecting the tramway systems of these towns."

Bristol.—Colonel C. H. Luard, R.E., held a Local Government Board inquiry, on Tuesday, into the application of the Town Council to borrow £23,000 for extensions to the electric lighting system. The Town Clerk having given particulars of the progress of the undertaking and the previous loans sanctioned, the Borough Electrical Engineer (Mr. H. Faraday Proctor) gave technical details of the proposed extensions. The present loan would, he said, be employed in the extension of the street lighting system. There was no opposition.

Cardiff.—A Local Government Board inquiry was held here on Friday last by Mr. Herbert H. Law, into the application of the Town Council to borrow £29,500 for electric lighting extension purposes. The Town Clerk (Mr. J. L. Wheatley), Chairman of the Electric Lighting Committee (Ald. Carey), and the Borough Electrical Engineer (Mr. N. Applebee), appeared in support of the application. It was stated that £59,835 had already been borrowed for the electricity department, but extensions were necessary in order to meet the increasing demand for current in the town. At present the equivalent of 16,000 8 c.p. lamps was connected to the mains. There was no opposition.

Crieff.—At the last meeting of the Town Council, Provost Finlayson submitted a communication from Mr. R. F. Yorke, the well-known electrical engineer, of Glasgow, in which he set out particulars of an electric lighting scheme for the burgh. Mr. Yorke proposes to form a company for the purpose of establishing an electricity supply station, and to convey current by means of overhead wires from the generating station to be erected on the banks of the river Turrett. The public lighting would be effected by 12 arcs and 160 incandescents, but the Council would be required to enter into a contract for the public lighting at an inclusive sum of £160 per annum for 21 years. Current for private lighting would be supplied at 6d. per unit. The Council seem favourably disposed towards the scheme, and a special meeting is to be held to enable Mr. Yorke to attend and submit details.

Derby.—The Council decided on Tuesday to oppose the General Power Distributing Company's Bill.

Devonport.—The Electric Light Committee recommend the Town Council to engage Prof. A. B. W. Kennedy to report upon the question of the erection of electricity and refuse-destructor works.

Fire Prevention.—A commercial section of the British Fire Prevention Committee has been formed, and amongst the firms who are represented on the section are the British Thomson-Houston Company, the Edison and Swan Company, the General Electric Company, Strode and Co., and Rashleigh, Phipps and Co.

Ilford.—The Urban District Council are negotiating with the Great Eastern Railway Company for the purchase of land in Sylvan-road for the erection of an electricity supply station.

Lancaster.—The salary of the borough electrical engineer (Mr. C. M. Johnston) has been increased from £120 to £140 per annum. The question of providing additional plant at the electricity generating station has been referred to a sub-committee.

Lecture.—An interesting lecture was delivered on Tuesday, before the members of the Aberdeen Mechanical Society, by Mr. Alfred Blackman, the city electrical engineer.

Liverpool.—The four arc-lamp pillars to be erected on the plateau of St. George's Hall will shortly be in position. They have been cast in Cologne, and are, it is said, similar in appearance to those used for a similar purpose in the neighbourhood of Cologne Cathedral.

London Common Council.—At last week's meeting of the Common Council it was decided, on the motion of Mr. T. H. B. Hitching, that the Streets Committee consider and report forthwith as to the desirability of applying to the Board of Trade for an electric lighting order to enable the Corporation of London to supply electric light within the City from a station to be established by themselves or otherwise; and also to report as to the practicability of generating electricity from steam raised by burning the City's refuse in specially constructed furnaces in such electric light station.

Merthyr Tydvil.—A notification is given that the Board of Trade have revoked the Merthyr Tydfil Provisional Order (1896). Mr. D. Thomas has given notice that he will move, at the next meeting of the District Council, that a sum be included in the estimates sufficient to employ an electrical expert to report upon the question of the erection of a station capable of supplying electric current for lighting and traction purposes.

Penzance.—The Town Council have received a communication from an Electricity Supply Company, in which a scheme for the erection and equipment of an electricity supply station in the district is advocated, and terms and conditions for carrying out the work are detailed. The communication is being considered by the Lighting Committee.

Peterborough.—The Board of Trade have signified their approval of the system of electricity supply which the Council propose to adopt. A Local Government Board inquiry will be held on Tuesday into the application for sanction to borrow £15,000 for erecting electricity works. Notice has been given of opposition to the Peterborough Electric Light and Power Company's application for a Provisional Order.

Private Bill Legislation.—The scheme for the construction of an electric railway from New Cross to Waterloo has been abandoned.

A Bill has been lodged for the construction of an underground railway at Brighton, from the London, Brighton and South Coast Railway station to King's-road, with openings under the parade connecting with the beach. The length of the line will be 5½ furlongs. The promoters are Messrs. S. H. Doubleday, C. F. Webber and J. W. Kersley.

Ripon.—The Town Clerk has been instructed to report upon th best means of providing increased and improved facilities for the transfer of passengers between the city and railway station, and particularly as to the feasibllity of constructing an electric or cable tramway.

Salford.—The Electric Lighting Committee are negotiating for the purchase of land in Strawberry-road, Pendleton, for the erection of an additional generating station. Mr. Harwood, Chairman of the Committee, stated at Wednesday's meeting of the Council that if they could obtain possession of this land they would be able to erect buildings capable of housing plant of 24,000 H.P. capacity. It was very desirable that this should be done, as the demand for electric current and motive power was continually increasing. The salary of the borough electrical engineer (Mr. Charles Turner) is to be increased from £260 to £300 per annum.

The consideration of the report of the Tramways Committee, recommending the use of the overhead trolley system on the local tramways, was adjourned.

School Lighting.—The electric light has recently been installed in the Ealing Wesleyan School buildings. The work has been carried out by Mr. H. J. Dowsing. About 70 incandescents are used.

Sheffield.—The Brush Company has received an extension order from the Sheffield Electric Light and Power Company for a 600 kw. steam alternator for next winter's load, the plant to consist of an Inductor pattern alternator coupled direct to a Universal steam engine.

Shoreham.—The Southern Cross Shipyard and Engineering Company have asked the District Council, in the event of their deciding to establish municipal electricity works, to be allowed to submit estimates and specifications for providing an installation.

Stockton.—The minutes of the Gas Committee presented at the last meeting of the Town Council stated that comprehensive reports on the erection of electricity supply works had been submitted by the Gas Manager (Mr. William Ford), and the Consulting Electrical Engineer (Mr. C. S. Vesey Brown). The reports have been adopted, but the selection of a site for a generating station has been deferred for the present. In the meantime the Council propose to invite six electrical engineering firms to submit sketch plans and estimates of the cost of an electric light installation.

The Strike and Lock-out.—As indicated in our last issue, the result of the polling of the members of those sections of the engineering trade affected by the strike and lock-out showed a vast falling off in the number of votes recorded. The total poll is officially given as follows:—For the masters' terms, 22,585; against, 13,727, or a majority in favour, of 14,861. Considerably less than half the total number of men affected by the dispute recorded their votes. The total of 42,315 compares with 69,718 votes polled on the first ballot, and 55,974 on the second ballot.

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It was understood, however, that whatever the result of the ballot might be, the men would return to work on Monday morning last, and this proved to be the case, as work was generally resumed, but only a comparatively small percentage of the strikers were taken on. It is probable that some time will elapse before anything like the whole of the men find employment. Those members of the unions who have not obtained work remain on the funds. The successful stand made by the Employers' Federation against the men's attack has led to a general accession of members to the Federation, and it is doubtful whether the engineering firms of the country have ever been so united in their determination to once and for all settle the relations which shall exist between the employers and employed in this branch of industry, and it is more than likely that this feeling will lead to a considerable improvement in the relations existing between the employers and their men. Hitherto the men have been entirely under the surveillance of the local representatives of the unions, these men being usually under the immediate control of the leaders at head-quarters, and it will now be for the masters to ascertain who these local delegates are and to provide against any undue influence being brought to bear upon the workmen from this source. A firm and conciliatory spirit on the part of the masters at the present juncture may result in the late deplorable dispute proving an undisguised blessing. For some years past friction has been the rule in many of our leading engineering shops, and this is mainly because the men looked for their instructions and guidance from leaders far from the scene of their labours. The time has come for improving considerably this state of affairs.

Wallasey.—The Parliamentary Committee of this enterprising District Council propose that a Bill be promoted next autumn for power to take over and work the local tramways, and to introduce electric or other form of mechanical traction. Power is also to be sought to fit up consumers' premises for the electric light.

Walsall.—A Local Government Board enquiry was held on Friday last by Mr. W. O. E. Meade King into the application of the Town Council for sanction to borrow £7,000 for electric lighting purposes. Technical details were given by the Borough Electrical Engineer (Mr. Alex. Wyllie). There was no opposition.

Wigan.—The proposal to establish electricity supply works has been deferred until the views of the ratepayers have been ascertained.

Workhouse Lighting.—The Sheffield Guardians have decided to introduce the electric light at the workhouse offices at Westbar

Works Lighting.—An electric lighting installation has been put down at the Stoney Stanton-road brick making factory of Websters (Limited), Coventry. Brush plant is used. The brickfield will be illuminated by nine pairs of 2,000-c.p. arcs, while the interiors of the machinery houses, offices, &c., are to be illuminated by Brush incandescents. The installation has been supplied by Messrs. Ellis and Ward, of Birmingham.

COMPANIES' MEETINGS AND REPORTS.

City and South London Railway Company.

The twenty-seventh ordinary general meeting of this Company was held at Winchester House, Old Broad-street, last Friday. Mr. Charles Grey Mott (the Chairman of the Company) presided.

Mr. W. F. KNIGHT (the Secretary) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, it now devolves upon me to move the adoption of the report and accounts. I regret that upon this occasion we cannot recommend to you any increase of the dividend which was paid to you this time last year. This arises from several causes. The first is that in the corresponding half-year there was a very large increase for us in our traffic, and that arose from the fact of two very important matches of the Australian cricketers at the Oval, which gave us a considerable amount of additional revenue, and it also arose from the fact that the weather during that half-year was favourable for us—that is to say, it was severe, because it is the bad weather which is always the favourable weather for us. This year, as you know, we have had a very mild and dry autumn or early winter, which had militated very much against our traffic; but I consider, in spite of the circumstances, that it is very satisfactory that we still show some increase in our receipts from passengers and parcels of about £40. From that I think it is clear that the traffic of this line is making very steady progress in itself, and that there is, I think, a natural increase of that traffic apart from these exceptional sources of revenue which we had in the corresponding half of last year. When you consider that this line is only a very short line, and is an isolated line up to the present moment, it having no connections with any other lines, and also when you remember that it does not run through a district which is a very busy district, I think that you will say that the result of our working and the position in which we are at the present time justifies us under all the circumstances in looking forward to very great promise of the line in the future, especially when it gets the connections with the City, and the connections with several other railways which we shall then have. I think, gentlemen, that we have every prospect that the working of this line in the future will make it a thoroughly good substantial and paying undertaking. Gentlemen, with regard to these extensions, I am glad to say that they are going on very satisfactorily indeed, and very considerable progress has been made at Finsbury-pavement. One of the station tunnels is completed, and the other is in progress, and within a few weeks' time that too will be completed. Both tunnels are very nearly completed, the whole length of Moorgate-street up to the Bank. There is one which will require some few weeks yet before it is absolutely finished up to that point, and then we shall only have to tunnel a very little further up to the station in Lombard-street. The tunnel on the south side of the river starting at Denman-street from the London Bridge station and going in a southerly direction is very nearly completed, and will, within a few weeks time, be up to the junction with the old line—where the new line leaves the existing line. One of the tunnels from that station northwards towards the City is about one-third completed under the river, and we hope that everything will go on satisfactorily there. There is one matter, however, which is likely to be the cause of some delay, and that is in consequence of the necessity of our upholding the Church of St. Mary Woolnoth, at the corner of Lombard-street, which, as you know, has given us a great deal of trouble in the past. Delay has occurred in consequence of our having to provide the necessary girders and arrangements for upholding that building, and keeping the church intact in such a way that we could sink our shaft immediately underneath it. Those arrangements I need hardly tell you have caused considerable delay and expense, but I am happy to be able to say that the expense in the long run will not rest upon this Company, but the amount will, in fact, be deducted and paid by the church people themselves. At the same time it is a delay, and a very serious delay in the works, and it may be that it will be the cause of some slight delay in the opening of the line. And in view of that fact, and the necessity that we have had of upholding the church, which was put upon us by the House of Commons in opposition to the view of the House of Lords and subsequently passed by Parliament, we have felt that it was fair to ask Parliament in a bill which we are promoting this session, to grant us power, that if, in consequence of any delay in the line being completed within the time that we expected, and we consequently have to incur any expenditure in dividend upon the Preference Shares which we issued, that the amount of that dividend so incurred should be charged in the first instance to capital account. We are asking for these powers. Of course it is a question whether ultimately such payment would not form a part of the claim against the church people—still that would have to be determined by an arbitrator afterwards. I may perhaps in referring to the subject mention to you, as you doubtless are already aware, that we issued £200,000 of Preference Shares in order to raise the money of these extensions. These Preference Shares were raised with a deferred dividend which does not begin to accrue for a year from the present time—a year from the 1st of January, 1898, and therefore the first half-yearly dividend upon them does not become payable until August, 1899. We have to as I say look to the possibility of the line not being got through quite so early as we expected, and we have to face the possibility that we might have the burden of interest thrown upon the revenue of the Company, and therefore as I have already explained to you, we intend to ask Parliament, in case of such a necessity arising, to give us power to pay the dividend upon the Preference Shares out of capital. That question however may not occur, or we may not get the power, and I may say that at the present moment the reserves which we have in hand are equal to a half of the dividend that we should have to pay upon those shares. We have a quarter's dividend already in hand, and it only remains for us to raise the further £2,500 which we should have to pay before the time arrives. If we do not pay it out of capital we shall have to make gradual provision for it in other ways, so that it will not seriously affect the dividend you receive upon your Ordinary shares (hear, hear). Then, gentlemen, as we tell you in the report, we have been acquiring property for the station for the Clapham extension, because we think that it is very desirable that the line should, if possible, be completed by the time that the other extensions are finished and open, and therefore as I say, we have acquired a great deal—most of the property which is necessary for the two stations in connection with that extension. The line is only a short one, something less than a mile in length. We are, I may say, in negotiation with the contractors for the letting of the contract for that extension, and in view of this extension of the line which we shall have to work, we are of course providing for increased power at the generating station, and for increased arrangements there, because we like to look forward and to make provision in every way. We have bought the adjoining property for the purpose, and we propose to enlarge and very considerably enlarge the generating station there, so as to be ready at the time for the opening of the line. The contract time for the completing of this extension, I may mention to you, expires on the 30th of next September; but as you no doubt are aware, these things are not always quite completed within their contract time. Therefore, I look forward at all events that it may possibly be this time next year before this line is opened, or it may possibly be even later than that, but we have good grounds for believing that by this time next year we may be in a position to announce that the line is ready for opening. Well, in connection with the line, I may give you a little explanation. This line, as you are aware—the new line—strikes off from the old line on this side of the Borough station—which is the first station on the other side of the river—and in order to make easier inclines under the river, and also in order to make the station at London Bridge to connect with the L.B. and S.C.R. and the S.E.R., that piece of line which now exists between the Borough station and our present terminus at King William-street station will of course be thrown out of use unless we use it in connection with the extension of the line as an alternative route. Well, I think we shall have so much traffic upon our main line that it would not be desirable to utilise this piece of line for the running of alternated trains, and, therefore we think that it would be very much better to arrange for this present piece of line—between there and our City terminus, which you know has worked so well for

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so many years, although it is not equal to the works of this line in the future—to be continued and to be worked as our independent line, serving a different district, which does not possess the railway accommodation which it requires, and which we think it would use; and with this view we have been in negotiation with some parties who are willing to carry out the extension of the line and who have deposited a bill for the purpose of obtaining Parliamentary powers to do so. It is known as the City and Brixton Railway, which will join on this side of the Borough station and be continued through St. George's Circus, and go on as far as Westminster Bridge; and Lambeth Bridge and then it will turn round and go down the Kennington Road right away to Brixton Hill. Well, gentlemen, any of you who know Brixton and Brixton Hill will be aware that it is a very busy place and a very growing place, and that there is a vast traffic to be done up and down there. As a matter of fact, it is a far busier route than the line traversed by our present existing railway. Well, as I say, a bill has been deposited for the continuation of the line up to that point, and as at present arranged—or understood—this Company (The City and South London Railway Company) will work the new line. We shall work it from our central generating station, and we shall be able to work it at a very much less cost than an independent Company could work it. The terms upon which our Company will undertake the working of this line are not yet completed. We shall have no responsibility whatever in reference to the building and completion of the line, but when the line is completed it will be leased to us upon terms, of which, although we know the general ideas, I may tell you have not yet been settled, and, therefore, we cannot submit them to you to-day. We shall have to have a meeting—it is called a Wharncliffe meeting—on the 17th of February, when we propose submitting to you the Company's bill and also our own Bill, and we shall then give you full details as to the terms which we shall ask you to approve if you are so inclined, and which will set forth the provisional arrangement with the City and Brixton Company. You may further be interested in knowing that in view of an interchange of traffic with other companies we have entered into an arrangement with a line which is called the Central London Railway, and which you know is a line which commences at the Mansion House and goes by the way of Holborn and Oxford-street right away to Shepherd's Bush. They will have, we believe, a very important and a very heavy traffic, and we have arranged that the platforms of their stations at the Bank and our station, which is also below, shall be connected by means of a short subway. The levels are not very different—there is only about 15ft. difference in the levels—and I think, therefore, it will be very easy for us to make a short underground connection between the two platforms by way of an incline, so as to allow the passengers of their company who arrive at the Bank station to come through the subway straight to our platform, where they can go anywhere upon our line, and the passengers who are brought up our line will be able, by means of the subway, to get anywhere they wish upon the Oxford-street and Holborn route. We consider that there will be a very large interchange of traffic in consequence of that, and we think that it will prove an arrangement that will give an accommodation to a vast number of people in London who have hitherto not been sufficiently well served in their means of rapid locomotion. Then there is our Finsbury-pavement station, which is exactly opposite to the booking-office of the Moorgate-street Station of the Metropolitan Railway, and the passengers from stations on our line will be landed within a few yards of the booking-office of the Metropolitan Company, so that there should be a considerable interchange of traffic between the two lines. That will give us another mode of interchange of traffic which should prove very easy and very commodious for the public at that point. Then we shall also have interchange of traffic at London Bridge with the South Eastern and the London, Brighton and South Coast Companies. Provision has been made for a short underground subway connecting with the platforms of the Brighton Company with those of this Company. We have not quite settled the matter at the present moment, because the arrangements with the London, Brighton and South Coast Company have not yet been completed, but anyhow, our station will be so very close that the passengers can easily reach the booking office, and go down by the lifts. Now I come to the Clapham extension, and when that is completed we shall have a station very near a station of the London, Chatham and Dover Railway Company—the Clapham-road Station—and there also there will be a means of interchange of traffic with that line. In addition to that there are two other lines which are coming to Finsbury-pavement, and for which powers have already been got—they are likely to be carried out before very long. One is the Great Northern and City, which goes to Finsbury-park from Finsbury-pavement, and the other is the Epping Forest and Walthamstow line, which you know comes from a district which is a very populous and a very busy district, and the terminus of that line will also be very close to our Finsbury-pavement station. So that you will see that these various lines will bring traffic to us from all parts of London, and we shall be capable of having an immense interchange of traffic with these different railways. I believe that very satisfactory arrangements will be obtained by this Company by the interchange of traffic, and I think that we may look forward to as large a traffic as we shall be able to carry on this line before very long—that is, when these other lines are completed. With all these sources for the interchange of traffic in the future, I feel confident that we shall be able to place the City and South London Railway Company in a position which will satisfy the most exacting shareholder. We ourselves have deposited a Bill for an extension of the time which is necessary for that part of the line which it is not at present proposed to construct, *i.e.*, from Finsbury-pavement to the Angel at Islington. As we were going for this Bill for extension of time, we thought that we would ask for extra powers also, and we have asked for powers to put in additional sidings at the Clapham Common end of the line—to put in a short siding for the accommodation of our terminal station there, and as I have already told you, we have included various other powers in the Bill, such as the payment of dividends upon the Preference shares which we have issued. But all these matters in connection with the Bill will be submitted to you at the Wharncliffe meeting, to be held three weeks hence. During the half-year we have paid off old debentures to the extent of £10,000, and we are going to pay off the balance of £17,800, which has either been paid off or will be paid off within three weeks from now. That, of course, is a very satisfactory thing, as you thus get rid of some £28,000 of debenture bonds carrying 5 per cent., and you are able to obtain the money, taking the present price, at rather less than 3 per cent. (Cheers.) Therefore I think that it is a very good transaction for us, and it will reduce the amount of the debenture interest which we shall have to pay in the future. It is a great advantage to have been able to convert the whole of these debentures into debenture stock. I think that it was a very wise precaution which we took when we issued these debentures as terminable debentures, and did not saddle ourselves with a large permanent interest, because we are now able to obtain the money much cheaper than we could at that time. I will now, if you please, turn as usual to the accounts, and give you some particulars. Dealing first of all with the capital account, you will see that the balance in hand on the 1st of July was £64,087, and we have received during the half-year, from the issue of stock at a premium, £12,708, making £76,795. We have reduced our old debentures (debenture debt) by £8,500, that is to say that we have paid off £10,500, and we have re-borrowed to the extent of £2,000, leaving the amount reduced by £8,500. If you will turn to the details of expenditure on capital account, on page 4 you will see that we have expended on new works £47,312, which added to the amount of £8,500, leaves a balance of £20,983 on capital account. Now, as regards the revenue account, the passengers and parcels during the past half-year, as compared with the corresponding period last year, show an increase of £40, transfer fees of £24, rents of £130, sundry receipts of £52, making altogether a total increase of £246, but on the other hand when you look at the expenditure you will and that maintenance shows a decrease of £59, locomotive power as increased by £155. We have spent more money in regard to locomotive repairs. Carriage repairs, there is a decrease of £72. Traffic expenses have increased by £25, general expenses by £21, law charges by £2, and rates and taxes—our old enemy—has increased by £33, making a nett increase in expenditure of £105, and after deducting that from the increase in the other side, it leaves us with a balance of £141 to the good. Well, we have had decreased debenture interest during the half-year, £218, and we shall have further advantage in debenture interest as time goes on, then we have a decrease in banker's interest, because we did not have so large a balance there as in 1896. We have an increase in the dividend on Preference shares for the few extra Preference shares we have issued of £29, making altogether a nett profit of £234, but on the other hand there was a decreased balance brought forward at the beginning of the half year of £38, which makes the sum of £196 nett which has been added to the balance carried forward as compared with this time last year. This time last year we carried forward a larger balance, and this enabled us to pay you by drawing upon that balance a 2 per cent. dividend, but this year we have not only carried forward a larger balance than we did, but we have added £196 to it, so that we are carrying forward £1,510. With the balance to the reserve £1,000, which we have carried added to the amount of £1,510 carried forward we have £2,500, which is a quarter's dividend, as I have already told you, in reserve upon the preference shares, which we may or may not possibly need. I need not tell you that we do all we can to advance the line, and we have done all we can to work it in a prudent way, and we thought it better and more prudent instead of giving you a larger dividend for this half-year to be content to continue to pay the same dividend, and to keep this money in hand as reserve and a security for the future. Well, perhaps, now, you would like some details, as I give you under ordinary circumstances, of the working of the railway. You will see that the ratio of working expenses during the past half year shows a slight decrease, it having amounted to 56·68 per cent. of the receipts against 56·81 per cent. in the corresponding half year—a slight decrease, but if we take away, as we have been accustomed to do, the cost of the working of the lifts, so as to make the railway working the same as an ordinary railway the figures come out at 49 per cent. this half year, compared with 49·25 per cent. for the corresponding half year. The receipts per train mile for this half year have amounted to 2s. 3·63d., against 2s. 3·25d., and we have had an increase in the receipts of very nearly a farthing per train mile. Our receipts for passengers are a 1·91d. per passenger against 1·87d. last year. I believe that 1·91d. is the largest average receipt per passenger since the line was opened. It comes out as nearly as possible at 2d. per passenger. The locomotive expenses per train mile have been 5·83d., against 5·64d., which is a very slight increase, attributable to the increased ratio of locomotive expenses to which I have referred, and if we deduct from it the carriage of the coal, which we usually do, it comes out at 4¾d. per train mile run. There is a decrease train mileage this year of £1,083. I think, gentlemen, I have now dealt with every question that there is for me to bring before you to-day, and subject to any question that any shareholders may desire to ask, I beg to move—

"*That the report and accounts for the half-year ending December* 31, 1897, *now submitted to the meeting, be approved and adopted.*"

Mr. SAMPSON HANBURY seconded the motion.

Mr. SHEPPARD said that he would like to inquire whether the Directors thought that they would be able to carry all the passengers that were likely to come upon the line. He did not know if he was one of the exacting shareholders to whom the Chairman had referred, but he would like a little more information. He did not quite clearly understand whether it was the intention of the Directors to make a subway between their station at Finsbury-pavement and the Metropolitan Company's system, as they were so close together. He wished to know whether a subway was necessary. He also desired to know whether there was any chance of their carrying any goods upon their line, because in the figures which

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the Chairman had given he had only referred to passenger traffic. As regarded their working arrangements with the company to be formed to build the line down to Brixton-hill, he wished to know whether their existing generating station would be sufficient, because if that was the case there ought to a material reduction in the amount of the working expenses. (Hear, hear.) He did wonder how on earth they were going to carry all the passengers they expected to get upon the line by the interchange of traffic with the various railways to which the Chairman had referred

The CHAIRMAN, in reply, said they had no idea whatever of carrying any goods on that line. It was purely and absolutely a passenger line, and he did not think it was possible that they could carry goods upon it. They proposed to run a two minutes service—a train every two minutes, or perhaps even more often than that, and he did not see how they could possibly run any goods trains between a two minutes' passenger train service. They were especially a passenger line, and he thought it was best to keep it a passenger line, and to give the very best possible service to the public—(Hear, hear)--and to make the line as nearly as possible perfect. With regard to the question of a subway at Moorgate-street, they had thought over the matter very carefully, but there was a great difference in the platforms of the two stations, and after carefully considering the matter they did not think it would be so much to the advantage of their passengers as in other cases, because their experience had shown that instead of climbing a lot of steps, and in this case they would have to be very narrow steps, or a very steep incline, the passengers preferred to come up by their lifts. The stations of the Metropolitan Company were only below the ground about one story, while the stations of this Company were about three stories below the street, and, therefore, they thought it better to bring them up in the lifts, when they would only have to cross a narrow street—no distance whatever—right into the booking-office, where they could take their tickets for the Metropolitan system. As regards the generating station, he had already said in his speech they had acquired adjacent property with a view of increasing that generating station, and they believed that they would be able to effect a very considerable economy in this direction. The more modern plant which had been invented since this Company first started would also bring about economy in fuel, and further add to saving in expenditure. As regarded the point of dealing with the amount of traffic, which they expected to come upon their line, he would be very glad indeed when the time arrived that they were taxed to their utmost capacity. It was true that for an hour and a half in the morning their trains were crowded, but with the greater accommodation which they would have in consequence of the improvements which are about to be instituted, they would be able to run much longer trains, carrying a larger number of passengers. They anticipated being able to carry three times the number of passengers per train than they were now carrying. They would be very glad when the time came that their traffic was so great that they could not cope with it without coming to the shareholders and asking them to find increased capital to make more tunnels, but in the meantime they had every reason to look forward with satisfaction to the early future, and he hoped, when he met them a year hence, to lay before them a satisfactory statement as to increased traffic.

The resolution for the adoption of the report and accounts was then put, and unanimously carried.

The CHAIRMAN then moved—

"*That the dividend on the Five per cent. Perpetual Preference shares Nos.* 1 *to* 9, 191 *be paid in full for the half-year ended December* 31, 1897."

The CHAIRMAN then proposed—

"*That a dividend at the rate of* 1¾ *per cent. per annum be paid on the Consolidated Ordinary Stock for the year ended* 31*st December*, 1897."

Mr. EDWIN TATE seconded the resolution, which was carried unanimously.

Mr. S. B. HEWARD proposed the re-election of the Chairman as a Director of the Company.

Mr. ATWELL seconded the motion, which was carried unanimously.

The CHAIRMAN: I beg to thank you very sincerely, gentlemen, for the kind way in which you have re-elected me on the Board of this Company. My connection with this line has always been a labour of love, and I am not going to rest satisfied—if my life is spared—until I have made this concern a thoroughgoing financial success, as I believe confidently it will be in the future, and a very great public convenience for the whole of the City of London.

Mr. James Lorrimer Oliver having been reappointed auditor of the Company, a vote of thanks to the Chairman and Directors, to Mr. Jenkin (the Manager), to Mr. Knight and the staff terminated the proceedings.

An Extraordinary General Meeting of the proprietors of the company will be held at the offices, 46, King William-street, E.C., on Thursday, 17th inst., for the purpose of considering the bills now before Parliament for further powers as to the construction of works and acquisition of land by the company, and also for the incorporation of the City and Brixton Railway Company with power to construct an underground electric railway from the City and South London line, in the parish of St. Saviour, Southwark, to Brixton-hill.

Yorkshire House-to-House Electricity Company (Limited).

A meeting of the members of this Company was held on Tuesday at the Great Northern Hotel, Leeds, Mr. Grosvenor Talbot presiding.

The CHAIRMAN hoped the shareholders would consider the report a satisfactory one. The amount of capital which had been raised by shares was now £131,992—an increase of £37,372 over last year—and they were also going to make another call of £1 per share, payable at the end of the present month. The total amount now expended on capital account was £161,009, an increase of £55,632. They had added 1,000 H.P. to their engine capacity, which now amounted to 2,800 H.P. They had also very largely improved the means of distribution of current over the busy part of the town. It had always been their intention to adopt this system of low tension in the busier parts, and now that they had such an enormous number of customers they found that it was cheaper and far more convenient. The expenditure in all classes was: on buildings £17,230, machinery and instruments £20,000, mains and transformers (including sub-stations) £17,470, and meters £932. The result of the year's working showed that after deducting £2,300 for depreciation (the amount fixed by the Government auditor), there remained a profit of £10,703. 1s. 11d., added to £392. 12s. 2d. carried over, leaving them with £11,095. 14s. 1d. to deal with. An interim dividend at the rate of 5 per cent. per annum was paid on July 1st, amounting to £2,624. 8s. 1d., and they had now left to dispose of £8,471. 6s. The Directors proposed to pay the dividend at the rate of 7 per cent. for the half-year, making 6 per cent. for the whole year. That required £4,142. 3s. 7d., leaving £3,000 for reserve, and £1,329. 2s. 5d. to carry forward. The Company was now on the soundest possible basis. In one shape or another their reserve now amounted to £17,929. 2s. 5d. During the year they had increased their number of lamps from 39,396 to 49,150; and the number of units sold from 701,409 to 833,280. This was a very considerable increase, but it was by no means the limit of the annual increase the Company ought to have. The result of the year's working had been satisfactory from another point of view. They had had to work with a very large increase of capital, and most of their money had been unproductive until towards the close of the year. The cost of production had been the lowest that had ever been shown in any station in England, and he believed that this year again they would not be beaten. The total cost per unit this year had been 1·50, against 1·73 last year. Such results as these pointed definitely to the efficiency of the management and to the general excellence and economy of the plant. The value of electric light undertakings was now assured, and the shares of those electric light companies paying dividends were very little lower than the best municipal securities. At the beginning of this year the Company reduced the price of current from 6d. to 5d. per unit, and the Directors were confident that this reduction in price would result in an enormous increase in the demand for supply. With the other concessions made, the electric light in Leeds was now the cheapest possible illuminant anybody could use. The shareholders would doubtless wish to know what steps were being taken by the Leeds Corporation towards acquiring the undertaking. The directors at present knew only what had been published in the newspapers, but the Corporation were sending a deputation to meet the Directors on Tuesday, the 8th inst., to discuss the situation. He did not think any of them would wish to unnecessarily force the Corporation to go to the expense and trouble of getting an Act of Parliament, provided always that the monetary interests of the shareholders were not affected by any proposal that the Corporation might desire to make. The business was flourishing and progressive, and no payment that the Company could get under their Act of Parliament would be equal in value to the property and rights which the Corporation would gain, and which the Company had to surrender. The Chairman paid a high tribute to the permanent staff, and especially to Mr. W. T. Green, the secretary, and Mr. Harold Dickinson, the engineer. In conclusion, he said the Company were now for the first time in a position to cope with any demand that might be made upon them, and if they could get a sufficient amount of lighting the price would become cheaper and cheaper. Some discussion followed on the respective positions of the Ordinary and Founders' Shareholders in the event of the Company's undertaking being absorbed by the Corporation; but the Chairman advised that the matter should stand over till they were in possession of the proposals of the Corporation.

Central London Railway Company.

The half-yearly general meeting of this Company was held on Wednesday, at 16, Great George-street, Westminster, Mr. Henry Tennant presiding.

The SECRETARY (Mr. R. O. Graham) having read the notice calling the meeting—

The CHAIRMAN, after stating that the number of shareholders had increased during the period under review to 1,073, said: On reference to the report you will observe that the expenditure up to the end of the past half-year has been £1,606,948, and that the amount received on shares is £1,407,042. The expenditure, therefore, seems to have been more than the receipts, and the capital account shows a debit balance of £199,906. Now this, in the main, is explained by the fact that £228,000 odd appears as owing to the Electric Traction Company under certificates from the engineers—that is, the engineers have certified that such a sum is due to the contractors and the Company have not paid them. The Traction Company, as you are aware, covenanted to take up a certain number of shares, and they now stand in the accounts as unissued shares. This the Traction Company are ready to do, and, therefore, the sum entered as payable to them will be disposed of on the transaction as to the shares being completed, which will be done before long. When that has been done the whole of the share capital will stand as issuedwith not less than £6 per share paid up. I think there is nothing else in the accounts that I need trouble you about. What is more important is the question of the progress of the works, which is dealt with in the engineer's report. According to that report, good progress has been made during the past six months, no serious hindrance to the operations having occurred. You will observe a very interesting fact, namely, that three-fourths of the ordinary tunnel—the main line tunnel—has been completed, as well as one-half of the station tunnels, and nearly the whole of the lift and staircase shafts have been constructed. A very difficult work had to be undertaken, namely, the

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diversion of the sewers, and gas and water and other pipes had to be taken up or removed below the pavement at the Bank station. I am pleased to say that this is proceeding satisfactorily; part of it is practically complete, and the public subways are well advanced. The operations in connection with the access of the Waterloo and City Company to the public subways at the Bank are also making satisfactory progress. We have also agreed provisionally to the construction of a low-level connection between the platforms of the City and South London Company's station at the top of Lombard-street and the platforms at the Central London Bank station. The arrangements for the supply of the electrical equipment have been made, and the works have been commenced. There is no material in the present position of the Central London Railway for a lengthy speech, but when that time comes I certainly hope there will be materials, not only for making a speech, but also one essential material, namely, that on which mutual congratulation can take place. I now move—"That the report and accounts be received and adopted, and that the payment of interest at the rate of 3 per cent. per annum on the paid-up capital of the Company be approved."

This was seconded by Lord COLVILLE OF CULROSS, and was agreed to.

Mr. Tennant was re-elected as a Director, Mr. Pannell was re-appointed auditor, and the meeting closed with a vote of thanks to the Chairman and Directors.

Anglo-American Telegraph Company (Limited).

The report of the Directors of this Company for the half-year to Dec. 31 last states that the total receipts (including balance £8,507. 5s. 11d. brought forward) amounted to £187,832. 0s. 11d. The traffic receipts show an increase of £6,540 compared with the half-year to Dec. 31, 1896. The total expenses, including repair of cables, &c., amounted to £58,372. 4s. 5d., an increase of £371. 16s. 8d. over the corresponding period of 1896.

The Directors have, before declaring the net profits, set apart £12,000 to the renewal fund, leaving a balance of £117,459. 16s. 6d. Interim quarterly dividends of 14s. per cent. on the Ordinary and £1. 8s. on the Preferred stock were paid on Nov. 1 last, absorbing £49,000, leaving £68,459. 16s. 6d., out of which the Directors recommend final dividends of 19s. 6d. per cent. on the Ordinary and £1. 19s. on the Preferred stock, amounting to £68,250, a total distribution for the year of £3 per cent. on the Ordinary and £6 on the Preferred stock. The balance of £209. 16s. 6d. is carried forward.

The cables and land lines of the Company are in good working order.

St. James' and Pall Mall Electric Light Company (Limited).

The report of the Directors of this Company for the year to Dec. 31 last states that the extension of Carneby-street Station is on the point of completion, and will soon be equipped with a full plant of 5,000 H.P. It has been working satisfactorily throughout the year in connection with the station at Mason's Yard. Steady progress has been made in the increase of the Company's supply to private consumers, and the principal streets of the district are now lighted by electricity.

By an agreement the holders of Founders' shares, subject to confirmation by the shareholders, will receive an allotment of 120 Ordinary shares at par in exchange for each Founders' share, this exchange to take effect from Jan. 1, 1898. As our readers are aware, in order to carry out this agreement, steps are being taken to increase the capital of the Company to £300,000 by the creation of 20,000 new Ordinary shares of £5 each, of which 12,000 £5 shares are to be issued at par to the holders of the Founders' shares. This will give the Company £60,000 additional capital at once, and will, in effect, extinguish the Founders' shares.

The net earnings of the Company during the past year have amounted to £29,093. 17s. 7d. Of this sum £6,996. 10s. was distributed in August last in payment of an interim dividend at the rate of 7 per cent. per annum for the half-year to June 30th on the Ordinary shares, and 7 per cent. per annum on the Preference shares. The balance, £22,097. 7s. 7d., together with £327. 15s. 9d. from last year's account, leaves £22,425. 3s. 4d. now to be dealt with. The Directors propose the payment of a dividend at the rate of 7 per cent. per annum on the Preference shares for the second half of the year, £3,500; on the Ordinary shares for the second half-year of 11s. per share, making, with the interim dividend paid on Aug. 2, 14½ per cent. for the year, £10,989; a dividend of £75s. 10s. 4d. per share on the Founders' shares, £7,551. 13s. 4d. Carried forward to Ordinary shareholders' undivided profit account, £384. 10s.

Newcastle-upon-Tyne Electric Supply Company (Limited).

The Directors' report for the year ending Dec. 31 last, states that the demand for electricity continues to improve satisfactorily, the units sold being 660,906, against 535,953 last year. The total profit for the year, including balance brought forward, is £5,095. 10s. 3d. Out of this the Directors recommend a dividend at the rate of 7 per cent. per annum for the year, on account of which an interim dividend at the rate of 5 per cent. per annum was paid on July 15 last. The total dividend will absorb £3,144. 15s. 6d., leaving a balance of £1,914. 14s. 9d. £62. 15s. is written off preliminary expenses in connection with increase of capital sanctioned last year, £1,200 is put to reserve and depreciation account (now £2,200), and £651. 19s. is carried forward. In order to meet the developments rendered necessary by the constantly increasing demand for electrical energy, it is intended to issue, at once, part of the new capital sanctioned at the last general meeting. The Directors recommend that the shares be offered to existing shareholders *pro rata* at a premium of £1. 10s. per share; the amount of this premium to be added to th depreciation and reserve fund. The Directors, feeling greatly indebted to the Durham College of Science for assistance in scientific questions on various occasions in their past history, ask for authority from the shareholders to make an annual subscription of not exceeding £50 to that institution.

Waterloo and City Railway Company.

The report of the Directors of this Company states that the total outlay of capital up to December 31, 1897, is £473,776. 3s. 1d, of which £113,170. 8s. 8d. was expended during the past half-year. The engineers' report, dated Jan. 13, 1898, is as follows:—

All the tunnels are finished except a portion of the white glazed tiling in the up City station tunnel, and in the inclined approach to the Central London Company's subways at the Mansion House. In the down or southern tunnel the permanent way has been laid from Waterloo to the cross-over road at the western end of the City station, and in the up or northern tunnel the permanent way has been laid from Waterloo to the river shaft, and the remaining length of road laying is in hand. The low-level station at Waterloo is finished, and all the three communications between the high and low-level stations will be completed early next month. The yard for the terminal sidings at Waterloo is finished and ballasted, and more than half the sidings have been laid. The whole of the permanent way materials for the sidings are on the ground. In the generating station the first portion of the engine and boiler houses is ready for the reception of the machinery. All the boilers have been delivered and three have been fixed. Two engines have been delivered and are being fixed, and it is expected that current for experimental purposes will be available about the middle of February. In addition to the engines mentioned above, the remaining four machines and the whole of the dynamos are nearly ready, and the switchboard work and other apparatus for the station is far advanced. The travelling crane is delivered and in use.

The electrical work in both tunnels is now complete as far as the river shaft. Beyond the shaft the contractors for the electrical work are following on towards the City as quickly as possible, and will reach the cross-over road in the down tunnel in about a month. The rolling stock has been delivered to the London and South-Western Railway Company, and is now being erected at their Eastleigh carriage works. One train is practically complete, and the others are far advanced. The signalling arrangements have been approved by the Board of Trade. The contract for the same has been let, the work is in hand, and fixing will very shortly be commenced. The works now remaining to be completed are:—(1) The permanent way in the up tunnel between the shaft in the River Thames and the City station. (2) Portions of the platforms and tiling in the City station and inclined approach tunnel, and the short staircase and landing connecting the inclined tunnel with the up and down platforms. (3) The remainder of the buildings at the generating station at Waterloo. All the above will, we believe, be ready by the middle of March. The large lift for lowering the rolling stock is making good progress, and is expected to be in working order on or before Feb. 20. Of the two temporary exits for passengers at the Mansion House (pending the completion of the Central London subways), one is well advanced, and it is hoped will be ready simultaneously with the completion of the Waterloo and City Railway. The other is progressing, but its completion depends upon the levels of the gas and water mains at the eastern end of Queen Victoria-street, the exact positions of which have not yet been definitely ascertained by the Central London Railway Company, by whom these outlets are being constructed.

Liverpool Overhead Railway Company.

The report of the Directors of this Company for the half-year to Dec. 31 last states that the gross revenue receipts amount to £37,583, and working expenses to £24,240. 4s. 1d. The number of passengers carried during the last two years is as follows:—

	Half-yr. to June 30,'96.	Half-yr. to Dec. 31,'96.	Half-yr. to June 30,'97.	Half-yr. to Dec. 31,'97.
First class	455,561	476,817	608,278	621,392
Second class	2,284,823	2,473,828	2,618,844	2,790,768
Workmen (spec. return tickets)	999,191	968,489	1,042,133	1,055,330
Total	3,739,575	3,919,134	4,269,260	4,467,490

The total receipts from all sources amount to £9,942. 15s. 11d., which, with £3,810. 6s. brought forward, leaves available for dividend £13,753. 1s. 11d. The Directors recommend the declaration of dividends at the following rates, less income tax, payable on and after Feb. 11:—5 per cent. per annum on Preference shares (£3,000), 3½ per cent. per annum on Ordinary shares (£7,875), leaving a balance of £2,878. 1s. 11d. to be carried forward.

NEW COMPANIES, STATUTORY RETURNS, &c

W. J. JENKINS AND COMPANY (LIMITED).—This Company was registered on January 27, with a capital of £20,000 in £10 shares, to acquire the business carried on at East Retford, under the style of W. J. Jenkins and Company, and to carry on the business of electrical, gas and mechanical engineers, suppliers of electricity and gas, metal workers, &c.

LANGDON-DAVIES ELECTRIC MOTOR COMPANY (LIMITED).—This Company was registered on January 27, with a capital of £70,000 in £1 shares, to enter into an agreement with the Davies Motor Company (Limited) for the acquisition of certain patents and other rights and properties, to commercially develop and obtain contracts for the supply and sale of alternate current motors, and to carry on the business of electricians,

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electrical engineers, electric light and power contractors, electrical manufacturers, and makers of dynamos, motors, apparatus, and fittings. The first subscribers are: C. W. S. Crawley, engineer, C. E. Cree, A. W. Cree, H. E. Cree, W. S. Matingly, W. Langdon-Davies, engineer, and A. Soames, engineer. The first directors are: C. E. Cree, A. W. Cree, W. Langdon-Davies A. Soames, and C. W. S. Crawley.

ROCHDALE ELECTRIC COMPANY (LIMITED).—This Company was registered on Jan. 31, with a capital of £5,000, in shares of £1 each, to enter into an agreement with Mr. William D. Watson to carry on the business of electricians, mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers, and to carry on the business of a telephonic, telegraphic, and electric light, heat, and power supply company. The first subscribers are: W. D. Watson, R. T. Golding, T. Snape, J.P., T. Watson, Miss M. G. Lendrum, Mrs. Mabel M. Watson, and R. Watson. The first Directors are: Thomas Snape and William D. Watson.

TREHEARNE ELECTRICAL ENGINEERING COMPANY (LIMITED).—This company was registered on January 26, with a capital of £2,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of, and dealers in, electrical apparatus. The first subscribers are: S. G. Trehearne, electrician, J. A. England, A. G. Jackson, R. Bridge, W. H. Hughes, F. C. Powell, and H. C. Clarke.

UNITED ORDNANCE AND ENGINEERING COMPANY (LIMITED).—This Company was registered on January 29, with a capital of £550,000, in £1 shares (of which 275,000 are £5. 10s. per cent. Cumulative Preference), to acquire the benefit of a contract with Messrs. Schneider and Co., of Creuzot, for the manufacture in the United Kingdom and the British Colonies of the Schneider-Canet Artillery, to acquire and take over as a going concern the business of Easton, Anderson and Goolden (Limited), incorporated in 1894, to enter into an agreement with Mr. Ernest T. Hooley, and to carry on the business of mechanical, electrical, hydraulic, mining and general engineers, and manufacturers of and dealers in guns, gun carriages, torpedoes, ammunition, missiles, explosives, weapons, &c. The first directors are:—Admiral H. F. Nicholson, K.C.B., Francis Elgar, H. McCalmont, M.P., Charles Cammell, Colonel Paget Mosley, T. Percival Wilson, and H. K. Baynes.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26d. per oz. (Feb. 3). Consols (2¾ per cent.) 112½—112¾ for money, 112¾—112⅞ for account; 2½ per cent. 105¾—106¼ (Feb. 3.) Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Days, Feb. 8 and 22; Ticket Days, Feb. 9 and 23; Pay Days, Feb. 10 and 24; Mining Share Carry-over Days, Feb. 7 and 21.

BUENOS AYRES AND BELGRANO TRAMWAYS COMPANY (LIMITED).—An extraordinary general meeting of this Company was held on Tuesday to consider the draft agreement with the Buenos Ayres and Belgrano Electric Tramway Company. The Chairman (Mr. J. Morris) explained that the latter Company was formed to take over and amalgamate their undertaking and the concession granted to, and the line constructed by, Mr. Carlos Bright. The capital of the new Company is to consist of £320,000 Five per Cent. Debenture stock, £200,000 A Six per Cent. Cumulative Preference shares, £150,000 B Six per Cent. Cumulative Preference shares, and £500,000 Ordinary shares. The price to be paid for their property was £168,000 Five per Cent. Debenture stock, £137,500 B Preference shares, and £107,500 Ordinary shares of the new Company, while for the completion of the lines under the Bright concession, and the electrical equipment of both the Belgrano and Bright lines, £300.000 was required, which it was proposed to raise by the issue of the £200,000 A Preference shares, and £100,000 Five per Cent. Debenture stock. Mr. Morris pointed out the advantages to be derived from the adoption of electric traction, with which it was possible to estimate accurately the cost of running cars, as it made companies to a certain extent independent of fluctuations in trade and other temporary causes of that kind. The agreement was duly approved by the meeting.

COVENTRY ELECTRIC TRAMWAYS COMPANY.—The ordinary general meeting of this Company will be held at 4, Bank Buildings, London, E.C., on Wednesday, the 16th inst.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The Directors of this Company recommend the payment of a dividend on the Ordinary shares at the rate of 6 per cent. per annum, free of income tax, for the half-year ended Dec. 31.

DUBLIN AND LUCAN STEAM TRAMWAY COMPANY.—In the half-yearly report just issued the Directors announce that they are still in negotiation for the electrical equipment of the line.

DUBLIN UNITED TRAMWAYS COMPANY (LIMITED).—According to the report of the Directors, to be submitted at the meeting on Tuesday next, the receipts for the half-year ended Dec. 31 amounted to £19,250. 1s 6d. from the Dublin United Tramways Company, and £3,588. 15s. from the Dublin Southern District Tramway Company, making, with the balance brought forward, &c., £23,409. 7s. 5d. at credit of revenue account. £21,529. 18s. 3d. of this is available for division, and out of this sum the Directors have declared a dividend at the rate of 6 per cent. per annum on the Preference shares, and at the rate of 4 per cent. per annum on the Ordinary shares. The section of the Clontarf line from Dollymount to Annesley Bridge has been worked by electricity since Nov. 11 last with very satisfactory results, and it is expected that within the next few months electric cars will be running to Nelson's Pillar from Annesley Bridge on the north side, and from Haddington-road (Dalkey line) on the south. The new line connecting Rathmines with Ball's Bridge *vid* the Appian way and Pembroke road is being constructed

EASTERN TELEGRAPH COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company will be held at Winchester House, Old Broad-street, E.C., this day (Friday), at noon, to confirm, as a special resolution, the resolution passed at the extraordinary general meeting held on Thursday, the 20th ult., which was fully reported in *The Electrician* of Jan. 28, p. 467.

GIANT'S CAUSEWAY, PORTRUSH AND BUSH VALLEY RAILWAY COMPANY (LIMITED).—The Ordinary general meeting of this Company was held at Portrush on Tuesday. The Directors report stated that there was a falling off in the receipts during the past year compared with 1896. In the passenger traffic there had been a decrease in numbers, the total number being 79,015. The falling off had arisen from the interference of the Board of Trade with their electric traffic, and from the unusual "wetness" of the summer season.

GREAT NORTHERN TELEGRAPH COMPANY.—The numbers are published of 100 debentures of £100 each (1883, series B) of this Company, which have been drawn for payment on March 1 next at Messrs. C. J. Hambro's, 70, Old Broad-street, E.C.

NATIONAL TELEPHONE COMPANY (LIMITED).—The tranfer books of the Preference and Ordinary shares of this Company are closed from the 4th to the 17th inst. inclusive, preparatory to the payment of the dividend for the half-year ended Dec. 31.

NORWICH ELECTRIC TRAMWAYS COMPANY.—A special meeting of the proprietors of this Company will be held on Wednesday, the 16th inst., at 4, Bank Buildings, E.C., to consider the Bill now before Parliament for the construction of additional tramways in Norwich. The ordinary general meeting of the Company will be held on the same day.

SANITAS COMPANY (LIMITED).—The Directors recommend the payment of a final dividend of 1s., and a bonus of 9d. per share, making a total distribution for the year of 13¾ per cent. on the fully-paid shares, and a final dividend and bonus of 1s. 2½d. on other shares.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed Wednesday, 9th inst., as a special settling day in 20,000 Six per Cent. Cumulative £5 (fully-paid) Preference shares (Nos. 34,001 to 54,000) of the New General Traction Company (Limited), and have ordered the same, as well as the further issue of 832 Five per Cent. Perpetual Preference shares (Nos. 8,420 to 9,251) of the City and South London Railway Company, to be quoted in the official list. The Committee have been asked to appoint a special Settling Day in 150,000 Six per Cent. Cumulative Preference (fully-paid) Shares of £1 each (Nos. 1 to 200,000).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Jan. 23 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,808.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half-month ended Jan. 31 is £1,890, against £2,465 in the corresponding period of 1897. The September receipts (estimated at £3,184) realised £3,191.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Jan. 29	3,584	+684	...	...	...
Bristol Trams & Carriage	„ 28	2,344	+606	4	9,553	+ 2,162
City & South London Ry.	„ 30	1,059	- 42	5	5,393	- 95
Dover Tramways	„ 29	103	...	21	2,368	...
Dublin United (Southern)	„ 28	437	+ 76	4	1,720	+ 80
Liverpool Overhead Rly.	„ 30	1,337	+110	5	6,847	+ 486
Sheffield Tramways	„ 30	969	+188	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Jan. 26.	Price Wednesday, Feb. 2.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 29. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	3/0	Central London Ordinary	9¾ 10½	9¾ 10½	2 13 6	June and December	10½	..
142,106	10	1/0¾	Do. (£6 paid)	5¾ 6	5¾ 6¼	2 17 7	„ January and July	6	5¾
£880,000	Stock	2¾	City and South London Railway Con. Ordy.	69 71	69 71	2 14 10		70½	69¾
8,419	£10	5%	Do. 5% Perpetual Preference	15½ 16	15½ 16	3 2 6	„ „	15⅞	15¾
£'35,701	Stock	4%	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	138	..
54,000	10	2/8¾	Waterloo and City Ordinary	12¼ 13	13½ 13¾	2 3 8	June and December	13½	13¾
37,500	10	3%	Liverpool Overhead Railway Ordinary	11⅜ 11½	11 11⅛	2 12 5	February & August	..	..
10,000	10	5%	Do. 5% Preference	16 16½	16 16½	3 0 7	„ January and July	..	..
125,000	Stock	4%	Do. 4% Debenture	108 110	108 110	3 11 5		..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price Jan. 26.	Price Wednesday, Feb. 2.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending Jan. 29. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£923,960	Stock	14/0	Anglo-American	61 63	62 64	4 10 2	Feb., May, Aug., Nov	62	61⅞
£3,038,020	Stock	23/0	Do. Preferred	111 112	112 113	5 3 2	" "	112	111½
£3,038,020	Stock	5/0	Do. Deferred	12⅞ 13⅛	13 13½	.. ..	.. ..	13½	12⅞
£ 37,400	£100	4%	*African Direct Telegraph (Red)	100 104	100 104	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	6 7	6 7	.. ..	.. ..	..	..
130,000	10	3/0	Brazilian Submarine	16½ 17	16⅝ 17⅛	4 1 2	Mar., June, Oct., Dec	16⅝	..
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112 116	112 116	4 6 2	June and December	..	..
10,000,000	$100	$23¾	Commercial Cable Capital Stock	187 192	187 192	4 3 6	Jan., Apr., July, Oct	..	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	105 107	106 108	3 14 1	" "	107	108½
16,000	10	8/0	Cuba Submarine	8 9	8 9	8 17 10	February and August	8½	..
6,000	10	10%	Do. Preference 10 per Cent.	18 19	18 19	5 5 3	" "	18	..
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	.. ..	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅝ 106⅝	103⅝ 106⅝	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10½ 11	10½ 11	5 13 7	Jan., Apr., July, Oct	10⅞	10½
400,000	£10	2,6	Eastern	18 18½	18 18½	3 10 3	" "	18⅜	..
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	19 20	19 20	3 0 0	" "	19½	19½
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131 134	131 134	2 19 11	May and November	132½	..
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899 xd	102 105	100 103	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension	18⅜ 19½	18⅜ 19½	3 13 8	Jan., Apr., July, Oct	19½	19½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock xd	132 135	130 133	3 0 2	February & August	..	..
£125,700	£100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	99 103	99 103	4 17 3	January and July	102	101½
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99 103	99 103	4 17 3	" "	102	101½
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 xd	104 107	102 105	3 16 2	February & August	107	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅝ 111⅞	108⅝ 111⅞	3 12 1	May and November	108	..
180,227	10	1/9	Globe Telegraph and Trust xd	12 12½	12 12½	3 14 0	Jan., Apr., July, Oct	12½	12
180,042	10	6%	Do. 6 per Cent. Preference xd	17½ 18½	17⅝ 18½	3 5 9	" "	18⅜	18
150,000	10	5/0	Great Northern of Copenhagen	27 28	27 28	3 11 5	January, April, July	27½	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	101 104	101 104	4 17 7	March & September	..	..
17,000	25	12/3	Indo-European	52 55	52 55	4 10 11	May and November	54	53
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1901	108 111	108 111	5 10 1	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105 108	105 108	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	7½ 8½	8 9	4 8 11	April and October	8½	..
3,381	£100 Cert.	6%	Submarine Cables Trust	138 143	140 145	4 2 9	" "	..	..
15,609	10	6/0	West African Telegraph	4 5	4 5	5 0 0	.. ..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103 106	103 106	4 14 4	March & September	104½	..
80,000	10	..	West Coast of America	¾ 1½	¾ 1½	.. ..	.. ..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	105 107	105 107	3 14 9	June and December	..	..
88,321	10	1/0	West India and Panama	⅝ ⅞	½ ¾	.. ..	May and November	..	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7 7½	7½ 8	7 10 0	" "	7½	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5 7	5 7	8 11 5	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105 108	105 108	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	9¾ 10½	10½ 10¾	2 15 9	May and November	10	9⅞
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½ 8	7½ 8	3 15 2	" "	7½	..
33,129	7½	1/6	Do. Deferred Ordinary	2½ 3½	3½ 3¾	.. ..	" "	..	..
£382,220	..	4%	Do. 4 per Cent. Debenture Stock	105 107	105 107	3 14 1	June and December	107½	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105 110	105 110	6 7 10	Feb., May, Aug., Nov.	..	..
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	..	..
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	3 3½	3 3½	5 14 4	August	..	..
224,550	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16 1/16	1/16 1/16	.. ..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2 2½	2 2½	8 0 0	October	..	..
484,597	5	3/0	National	6⅜ 6¾	6⅜ 7	4 5 9	February & August	6 13/16	6½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15 17	15 17	3 10 7	" "	16½	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14 16	14 16	3 15 0	" "	16	..
20,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6 6½	6 6½	3 16 11	" "	6½	..
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	102 107	104 109	3 4 0	June and December	106½	105½
171,504	1	0/4	Oriental	⅜ ½	⅝ ¾	6 13 4	April and October	..	..
58,000	5	5/0	United River Plate	4 4½	4 4½	5 11 1	July	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101 106	101 106	4 14 6	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.						
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	10⅜	10½ 11	..	March	..	..
£50,000	5	..	Do. (New Issue) £3, 10s. paid	..	.. ..	..	..	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	29½ 30½	29½ 30½	2 5 11	February & August	3 3/16	28½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17 18	17½ 18½	3 4 10	January and July	17⅞	..
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129 134	129 134	3 14 3	June and December	..	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	14 15	14 15	2 3 6	February & August	15	14
20,000	5	2/3	Do. 4½ per Cent. Preference	6½ 6¾	6½ 6¾	3 6 8	" "	6⅞	..
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	— —	— —	— —	January and July	..	..
£26,000	5	2,6	Chelsea Electricity Supply Ordinary	10⅜ 11½	11 11½	3 6 8	March	11⅜	11
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	112 114	112 114	3 14 7	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	14⅜ 15½	15⅜ 16½	.. ..	.. ..	15⅞	14⅜
20,000	£10	6/0	Do. 6% Cumulative Preference	15⅜ 16½	15⅜ 16½	3 13 10	March & September	16 3/16	15⅞
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	9½ 10½	10½ 11½	.. ..	.. ..	11	9 7/16
10,000	£5	7%	Do. 7 per Cent. Preference	11½ 11⅝	11½ 12	2 18 4	March & September	11⅝	11⅜
111,000	£5	..	London Electric Supply Ordinary	3½ 3⅝	4½ 5	.. ..	.. ..	..	..
48,050	£5	..	Do. Preference	6⅜ 6⅝	6¾ 7	.. ..	.. ..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	19 20	20 21	2 12 4	April and October	20½	19½
12,500	10	3/8	Do. Issued at 2 prem. (fully paid)	19 20	19½ 20½	.. ..	" "	19⅝	19½
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117 121	117 121	3 13 6	June and December	..	..
6,452	10	8/0	Notting Hill Electric Ordinary	18 19	18 19	2 2 1	March	18½	..
275,000	1	..	Rand Electric	1 1/16 1 1/16	1½ 1⅝	.. ..	.. ..	..	..
£125,000	Stock	..	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90 95	90 95	5 5 3	..	9½	9 7/16
150,000	$100	82	Royal Electric Company of Montreal Shares	145 147	145 147	.. ..	.. ..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105 107	105 107	4 4 1	April and October	..	..
19,980	5	3/6	St. James and Pall Mall Electric Ordinary	18 19	18 19	3 0 6	February & August	18⅝	18⅜
20,000	5	3/6	Do. 7 per Cent. Preference	10 11	10 11	3 3 6	" "	10⅛	10⅜
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	101 104	101 104	3 16 0	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	16½ 17½	18 19	3 3 2	March & September	18½	17
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	£3	5%	Brush Electrical Engineering	2½ 2⅝	2½ 2⅝	— —	—	2 7/16	2 7/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2½ 2⅝	2½ 2⅝	5 1 1	—	2 7/16	..
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109 113	109 113	4 0 9	February & August	..	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102 105	102 105	4 6 2	June and December	..	..
10,000	£10	..	British Aluminium Ordinary	— —	.. ..	— —	—	..	..
20,000	10	..	Do. 7% Cumulative Preference	— —	.. ..	— —	—	..	..
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	7½ 8½	8 9	5 11 1	June and December	8⅜	..
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	107 112	108 111	4 1 3	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	— —	—	..	..
28,150	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2 2½	2½ 2¾	— —	—	..	..
£82,850	100	—	* Do. 5% First Mortgage Debentures (red.)	86 91	86 91	5 6 5	January and July	..	..
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 3	2½ 3	5 10 0	February & August	2⅝	2½
17,139	5	2/9½	Do. (£5 paid)	4½ 5½	4½ 5½	5 0 0	" "	4⅝	..
£200,000	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	103 105	103 105	3 16 2	June and December	..	..
110,000	£2	1/1½	Electric Construction Co. (Limited) xd	2⅝ 3	2⅝ 3	3 10 0	February & August	2 15/16	2⅝
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½ 3⅝	3¾ 3⅞	4 3 4	August	3⅜	3 7/16
91,116	1	10/0	Elmore's Patent Copper Depositing	⅜ ½	⅜ ½	.. ..	.. ..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	21 22	21½ 22½	4 8 11	February & August	21½	..
8,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	19 20	3 10 0	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 10	" "	..	..
50,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	23 24	23½ 23¾	4 5 1	" "	23 11/16	22⅞
800,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103 107	103 107	3 14 9	March & September	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	39 42	39 42	4 2 5	March and July	40½	..
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102 105	102 105	4 15 3	January and July	..	..
£22,500	£5	3,6	Willans and Robinson Ordinary	7⅞ 8½	8 8½	4 2 4	April and October	7⅞	..
£22,500	£5	3/0	Do. 6% Cumulative Preference	6⅞ 7½	6⅞ 7¼	4 2 9	" "	7⅛	7 1/16
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	105 107	106 108	3 18 6	May and November	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

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NOTES.

As announced in another column, the organisation of the Corps of Electrical Engineers, Royal Engineers (Volunteers) is now practically complete, and applications—which we trust will be sufficiently numerous—may now be made to the Adjutant, Capt. BRADY, R.E., for membership in the ranks. The staff of officers has been augmented by the addition of Mr. ANDREW BAIN, as lieutenant, and the Hon. R. CRAVEN, as second lieutenant. Last summer the commissioned officers passed through a regular period of training at the Needles, I.W. Some changes have been made in the arrangements for recruiting, with the object of draughting men from a somewhat higher stratum than was originally intended. It has been rightly felt that the social status of the corps will be largely determined by the class of men from which its first recruits are drawn; and in order to secure a higher standing than previously contemplated, it has been decided that members shall pay for their uniforms. Probably the first recruits will be drawn from among the members of the Institution of Electrical Engineers, with which the corps has been associated in its initiation and will, it is hoped, continue to fraternise. In this way it is expected that a congenial company of men will be banded together who, if they take the trouble to make themselves efficient, will not only have a means of obtaining an agreeable and healthy holiday at little or no expense—for the initial outlay is returned to those who become efficient—but will also have the satisfaction of feeling that they are serving Queen and country. We are glad to hear that the War Office is encouraging the development of the corps, and is giving practical evidence that it values the scheme.

A CHANGE is about to be effected in the arrangements made by the Institution of Electrical Engineers for the publication of abstracts and classified lists of articles appearing in technical journals. Up to the present these abstracts and lists have been printed at the end of the parts of the regular volumes of *Proceedings* of the Institution. In future, however, the *Proceedings* will appear without these additions, and once a month there will be issued to members a separate publication consisting of a series of abstracts, to be prepared under the direction of a Joint Committee of the Institution and the Physical Society. The arrangement is novel, and will come as a surprise to the majority of members outside the Councils of the two Societies. We trust the somewhat different aims and interests of the two scientific bodies will not prevent these abstracts from being of practical value to the members of the Institution. Hitherto each institution has issued a separate series of abstracts corresponding to its own particular interests; but in neither case have the abstracts generally been up-to date. We trust the new arrangement will lead to improvement in this respect.

MR. CAMPBELL SWINTON'S lecture at the Royal Institution last Friday evening was an admirable *résumé* of the experimental researches in the region of cathode and Röntgen rays phenomena, and, cast as it was in a popular mould, it can scarcely have failed to make the more prominent features of the subject intelligible to a lay audience. The *embarras de richesse* in the way of possible experiments seemed, however, to produce a reactionary embarrassment on the speech of the lecturer, who hesitated frequently whether to show another experiment or to say something more about the experiment just exhibited. His affectionate lingering in the neighbourhood of the pith-ball model of an atom, and the evident tendency to dwell on the early period of experimental activity, conjured up in one's imagination a vision of the tail lights of the last train and the prospect of a long walk home. One of the most brilliant experiments in cathode-ray phenomena was that in which a small piece of lime was raised to high incandescence by the bombardment of the torrent of molecules, the incan

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descence being of a strangely intermittent nature, rising and falling automatically like the light of an extremely variable star. Towards the close of his lecture Mr. SWINTON explained the probable electrical condition of the interior of a focus tube, and discussed the influence on the character of the rays of the position of the cathode and anode with respect to one another, and to the walls of the tube.

IN hot haste, and before the decision has been published in respect of the Glasgow telephone inquiry, the Highways Committee of the London County Council have decided to make the following recommendation with regard to the telephone service in London—

"That, with the view of obtaining an investigation with regard to the telephone service in London, similar to the inquiry recently held as regards that service in Glasgow, the Council do make an application under the Telegraph Act, 1892, to the Postmaster-General for a licence empowering the Council to provide an independent municipal telephone service for the county of London."

As an amendment it was proposed that the Government should be asked to investigate the condition of the telephone service, and that the Select Committee of the House of Commons, appointed in 1895, should be re-appointed. This amendment, however, did not receive the approval of the Committee. That an exhaustive enquiry into the metropolitan telephone service is probably near at hand is evident from the discontent repeatedly exhibited in certain quarters; but whether such an enquiry will be made by Parliament or the County Council remains to be seen. Lord RUSSELL, who, as Chairman of the Highways Committee, refused to move the resolution, considers a Parliamentary Committee the right body to thresh the matter out; and, if inquiry there must be, we are inclined to agree with him.

The Railway and Canal Commissioners have (as will be seen from the report elsewhere) supported the decision of Mr. Commissioner KERR in the appeal made by the Corporation of London—the successors to the defunct City Commission of Sewers—against the judgment by which they were restrained from opposing the laying of fresh telephone lines in the City by the POSTMASTER-GENERAL, or from imposing the restriction that the lines should not be leased to the National Telephone Company. The previous decision, which is now upheld, was that consent should be regarded as given and the condition set aside.

Royal Society.—Among the Papers down for reading yesterday was one by Mr. W. G. Rhodes bearing the title "Contributions to the Theory of Alternating Currents."

Electricity within the Arctic Circle.—Electricity for purposes of street illumination in the far North is growing rapidly in favour. The first town to adopt this form of illumination was Hammerfest, which lies north of latitude 70deg., and now Tromsö is also lighted by electricity, which during the long winter nights can certainly be used there to advantage.

Conversazione.—The students of Finsbury Technical College will hold their annual conversazione at the college on the 18th inst. Dr. Thompson has promised to lecture on "Wireless Telegraphy." Mr. Ives will give an exhibition of colour photography, and glow-lamp making will be demonstrated by Mr. Robertson.

A 12,000-volt Supply System.—We read in *l'Industrie Electrique* that a central station for the distribution of electrical energy has been erected at a paper mill at Lancey. Fifty villages within a radius of 25 miles are supplied by this station, and alternating current at 12,000 volts is used. The current is transformed down to lower pressure in converters placed on the poles.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Ceara—Maranham	Dec. 23, 1897	—
Curaçao—La Guayra	Jan. 5, 1898	—
Para—Maranham	Jan. 22, 1898	Feb. 7, 1898.
Bolama—Bissao	Jan. 28, 1898	—
Emden—Vigo	Feb. 7, 1898	—

Electric Tramways in Rome.—A Nuremberg firm has obtained the concession for the construction of an electric tramway from Rome to Albano and Rocca di Papa, the completion of which is to be effected within the present year. A further application has been made to the authorities for permission to construct an extension from the Piazza San Pietro to the Porta San Giovanni.

"Annales d'Electrobiologie."—We have received a copy of the first number of this bi-monthly, which is being produced under the direction of Drs. D'Arsonval, Tripier, Apostoli, Oudin and Doumer, the latter gentleman officiating as editor-in-chief. The volume, which is of magazine size and has some 140 pages, contains the articles on electro-medical subjects by the writers cited above

A New Thermo-Electric Couple.—According to the *Elektrotechnische Rundschau*, a newly-discovered thermo-electric element has just been patented in Germany. This consists of iron and an alloy of copper with 40 per cent. nickel, and this combination is said to possess the peculiarity that the electrical resistance is not influenced by the temperature It is further claimed that next to the bismuth-antimony combination this is the most sensitive and the strongest yet discovered.

Municipal Electric Association.—It has been decided to hold the next Convention in London on June 8, 9 and 10, when papers upon the following subjects are to be read:—"Management of Electrical Undertakings," "Repayment of Loans and Appropriation of Profits," "Uniformity of Plant and Apparatus," "Electric Traction," The Use of Accumulators in Connection with Lighting and Traction Systems," "Switchboard Apparatus," "Auxiliary Apparatus," and "Stand-by Supply."

The Telegraph in China—In a former treaty between the Russian and Chinese Governments the latter bound itself to construct a direct telegraph line between Pekin and Kiachta on the Siberian border. The fulfilment of this agreement until recently has been continually postponed, but lately, according to the information received by the *Frankfurter Zeitung* the Chinese Government has promised to complete the line before the end of the present year, and work has already commenced.

The Heilmann Locomotive.—The tests of the Heilmann locomotive on the Paris-Argenteuil-Mantes line are being continued. On the 1st inst. successful trials were made with a load of 250 tons, and at a speed of 30 miles an hour, which was occasionally increased to 47 miles an hour. The train was made up of 20 carriages, and the locomotive behaved well, both on curves and gradients. A sister locomotive, exactly similar to the one now being tested, has just been finished and will undergo a similar series of tests.

A Patent Office Record.—The 31st of December, 1897, being the last day of the old United States patent law *régime*, under which inventors who had patents in foreign countries could take out similar ones in the States, and gain protection for the full legal term, it appears from a despatch from Washington that that day's business was the largest in the history of the patent office, the fees received during the day amounting to £1,875. Nearly 48,000 applications for patents were received by the office during the year, 4,000 in excess of any previous year.

Electrical Progress in Japan.—Latest information to hand is to the effect that considerable activity is being shown in electrical matters in the Empire of the Mikado, but that

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electric traction enterprise is somewhat hampered by the indisposition shown by the authorities to allow the overhead trolley system in the chief cities and towns. This has led to many of the schemes now under consideration being designed upon the conduit and accummulator car systems. Water-power transmission projects are also occupying the attention of the Japanese authorities and engineers.

Tramways and Roadways.—"Tramways in towns," said Mr. W. Worby Beaumont, in his recent presidential address to the Society of Engineers, "are metallic admissions of the badness of our ordinary roads, and of the great saving that will be possible when universally good roads and horseless vehicles predominate; we permit these tramways to destroy the roads and the wheels of every ordinary vehicle, to cause numerous accidents and great discomfort, simply because two horses can haul 42 passengers in a tramcar on rails, while they can only haul 26 in an omnibus on bad macadam."

Royal Institution.—A General Monthly Meeting of the members of the Royal Institution was held on the 7th inst., when a number of new members were elected. The special thanks of the members were returned to Mrs. Tyndall for her liberal donation of £1,000, presented in the name of the late Prof. John Tyndall, for the promotion of science. Thanks were also returned to Sir Frederick Abel, Sir Andrew Noble and Professor Dewar, for donations to the fund for the promotion of experimental research at low temperatures. It was announced that the centenary of the Royal Institution would be celebrated next year.

Lighting of the Dominion Government Buildings at Ottawa.—The Dominion Government proposes putting in an electrical installation in all the departmental buildings at Ottawa. At present the Parliament block furnishes its own electricity. The intention is to erect a power-house to supply all the Government buildings with electric light, and also with power to work electric pumps for fire-extinction purposes in every building. The annual cost at present for gas is £4,600, and an electric system is estimated to effect a saving of £2,600 a year. There will be about 4,000 incandescent lights in the several buildings to be supplied. The total cost is estimated at less than £16,000,

Fires in Shop Windows.—In view of the numerous fires that have recently taken place in shop windows in Germany, the German police have issued a notice containing the following recommendations. All glow lamps used in shop windows should be provided with globes, shades or wire-guards, or so arranged that they cannot come into direct contact with inflammable material. If the lamps are surrounded with silk or other fabrics the covering must not envelope the lamp completely, so that the air can circulate between the lamps and the covering. Arc lamps should be provided with ash-trays of metal instead of the glass ones usually employed. Conducting wires in the windows should be well insulated.

Turin International Exhibition.—The authorities have decided to offer for competition in the Electrical Section of the Turin Exhibition a prize of the value of 15,000 lire (about £600). This will be given in honour of, and named after, Galileo Ferraris, and is for any invention, apparatus, machine, or number of allied machines, forming an important advance in the adaptation of electricity for industrial purposes. The competition is international, and open to competitors of all nations, an essential condition being that the invention, &c., is represented at the Exhibition and be submitted to practical tests. An international Committee will be elected to decide upon the award.

Röntgen Society.—We must look to the new Röntgen Society to help in clearing up many obscure problems relating to high vacua. To judge by the last meeting there is being shown some degree of activity by the more enthusiastic members. Mr. Mackenzie Davidson's exhibit of a very practical-looking apparatus with which to localise a foreign body embedded deeply in flesh marked a step of progress in that difficult branch of X-ray work. The method suggested has, in fact, already been found of great practical advantage in the removal of metal particles from the eye, and the risks associated with such operations are thereby considerably reduced. No less interesting was Dr. Walsh's Paper on the radiography of soft tissues. All who work on these practical aspects of the matter are, at the same time, carefully watching for new physical phenomena that may throw light on their nature, so that in the near future it may be possible not only better to control the action of the focus tube, but also to obtain increased definition—a most important matter as regards photographic results.

Electrical Tramways on the Continent.—The substitution of electricity for horse traction on the tramways of the great cities of Europe is coming more and more to the fore every day, and as evidence of this, it may be mentioned that at the present moment the municipalities of Berlin, Vienna and Moscow are all engaged in the preliminaries for the transformation of the existing tramway systems. The two chief Moscow companies are negotiating with the authorities for permission to amalgamate the existing lines and utilise electric power on same. The work of installation will probably be entrusted to the Berlin firm which is promoting the scheme. As far as Vienna is concerned, arrangements are now being concluded for a trial use of electricity on part of the tramway system of this town. The *Oesterr. Ungarisches Eisenblatt* states that it has been decided not to experiment with overhead wires, but that the communication of current by means of a central track-conduit will be adopted. The work is to be jointly carried out by two firms, one of which is German, the other Austrian.

Rapid Transit in New York.—The rapid transit tunnel project received a serious set-back in the utterances on the subject contained in the message of Mayor Van Wyck to the Municipal Assembly of New York. He said that the recent Court proceedings regarding the plans submitted, and the very important and far-reaching questions then and there raised, make it apparent that some other form of relief must be decided upon, otherwise our justly impatient people would be required to wait during a very indefinite period, covering certainly a number of years, until a final decision could be obtained in the tedious litigation already begun and threatened. Nor was it at all certain that after such delay, they would not find as the only outcome additional and more serious difficulties. He reminded the Assembly of its solemn duty to refuse any public expenditure, no matter for what purpose intended, which was likely to cast even a shadow on the credit of the municipality. He advocated making the best possible use of the present facilities (elevated railways) by improvement and extension. These could be made within a fixed and definite time, and would afford some relief in the direction of the popular demand. To his mind there was not sufficient reason for the continued employment of steam locomotives on the elevated railways, and he urged the Assembly to demand and insist upon the substitution of electric power in the operation of these roads. The remarks of Mayor Van Wyck on this subject, together with the legal difficulties encountered by the Rapid Transit Commissioners in carrying on their work, makes it look as if the whole matter had received a staggering blow, from which it will take many years to recover—if it ever does.

Obituary.—We have to record the death of another of the pioneers of the telegraph service, Mr. G. K. Winter, M.I.C.E., M.I.E.E., F.R.A.S., who was associated with telegraphs for about 40 years, and was out of this period telegraph engineer to the Madras Railway for 34 years, passed away on the 17th ult. at Madras. Last year Mr. Winter's health broke down, and he came home for a few months to recruit. His progress appeared satisfactory, and he was able to return to India in November last. He was, however, again attacked early in the present year, and succumbed to an affection of the heart. Mr. Winter was associated with Mr. W. T. Ansell in Ireland in connection with the early work of the Electric and International Telegraph Company. Of an inventive turn of mind, he was the owner of many patents dealing with the application of electricity to railway working, and was the inventor of a system of intercommunication with trains and of a single-wire electric block signalling system, and more recently of an

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improved electrical block instrument ticket-delivery system for single line work. These inventions are at the present time in use on many of the principal Indian railways. Mr. Winter leaves a widow and four children to mourn his loss, as well as many friends and acquaintances in the old country and in India.—— We regret also to record the death of Mr. O. B. Shallenberger, of the Westinghouse Company of America, at Colorado Springs, on the 23rd of January. Mr. Shallenberger was born at Rochester, Pa., U.S.A., on May 7, 1860, and entered the United States Naval Academy in 1877, where he made a special study of subjects bearing on the practical applications of electricity, and became especially interested in incandescent lamp work. He graduated in 1881, and was assigned duty on the European station. After two years' service he resolved to quit the Navy and to devote his attention to electrical work. He was for some time with the Union Switch and Signal Company, of Pittsburg, and shortly after the organisation of the Westinghouse Electric Company he became chief electrician to that concern until 1892, when he was appointed consulting electrician. His name is associated with a number of inventions, chiefly connected with alternate-current working, the principal development being the well-known Shallenberger meter. His health broke down in 1893, and he was at the time of his death recruiting at Colorado Springs.

The Magnetic Properties of Tempered Steel.—In the *Comptes Rendus* of Dec. 27, 1897, Madame Sklodowka Curie gives an account of an interesting investigation on the magnetic properties of tempered steel. Bars of steel were heated by a spiral of platinum which also served to magnetise them, the heated bars being tempered by plunging into water. The state of magnetisation was followed by the aid of a pivoted compass needle. It was found that for a bar to take the temper, a temperature higher than that of the magnetic transformation of the metal was necessary, or, in other words, that the steel had to be in a feebly magnetised state at the moment of plunging. The maximum remanent intensity of magnetisation at the centre of the bar, and the coercive force, were obtained for various steels, and the results are set forth in a table and curves. These show that the coercive force grows with the percentage of carbon up to a percentage of about 1·2, and decreases for higher percentages. The intensity of remanent magnetisation on closed circuit at first increases with the percentage of carbon, attains a maximum for a percentage of about 0·5, and then decreases for higher percentages. The maximum intensity of induced magnetisation decreases continuously as the percentage of carbon increases, and finally the hysteresis at first increases with the percentage of carbon, and would appear to pass a maximum for a percentage higher than 1. An examination of the results obtained with special steels shows that the introduction of various metals to form alloys does not in general greatly modify the remanent intensity on closed circuit; it diminishes the maximum induced intensity and increases the coercive force and the hysteresis. This increase of the coercive force renders certain special steels suitable for permanent magnets. The presence of small quantities of boron, silicon and maganese seems to have no perceptible influence. Nickel, chromium and copper in small proportions (less than 4 per cent.) improve the magnetic qualities of the steel. Finally, steels containing tungsten and molybdenum are the best for magnets. It is noticeable that the metal whose effect is relatively small (nickel and chromium) affect those steels most which are less carbonised, whilst the more active elements improve steels, whatever their carbon percentage. The presence of molybdenum and tungsten even gives magnetic qualities to steels with very large percentages of carbon (1·7 to 2 per cent.). The coercive force may exceed 60 for carbon steel, attains 70 to 74 for tungsten steels such as Allevard's, and reaches 80 to 85 for molybdenum steels. The latter might, therefore, be used to greater advantage than tungsten steels for the manufacture of permanent magnets.

Ambroin.—A little more than a year ago we referred in these columns to an insulator bearing the above name, and compounded of copal-resin and a silicate. It was claimed for this material that its specific resistance was moderately high; that it was less inflammable than celluloid, vulcanite, or ebonite; and that it withstood fairly well the action of all acids but acetic, though it was attacked by alkalies. Since that time the material has been manufactured on a larger scale both in France and Germany, and in a recent number of *l'Electricien* a little more information about it is given. It is said to be formed of a mixture of copal-resin, asbestos, mica, &c., in proportions which are varied according to the quality of the material desired. These ingredients are powdered and then intimately mixed, submitted to a "special chemical treatment," and finally placed in steel moulds, where the mixture is submitted simultaneously to the action of heat and to a considerable pressure. The ambroin objects moulded in this way require little or no finishing, and absolutely regular screw-threads can be formed if desired. The specific gravity of the material varies from 1·2 to 1·7. Its absorption of moisture is slight. Samples of ambroin, other patent insulating materials, and vulcanised fibre were placed in water at 75°C. for an hour and a-half, after which the ambroin had only increased 0·32 per cent. in weight, the other products from 1·4 to 8·5 per cent., and the valcanised fibre 24·5 per cent. The tensile strengths of ebonite and ambroin are given as 112lb. and 215lb. per sq. in. respectively, and when tested for compression a piece of ebonite began to lose its shape at 450lb. per sq. in., and the specimen of ambroin developed a crack at 615lb. per sq. in. Five different qualities of the material are made by the French manufacturing company; (1) specially adapted for the insulating sockets, bases, &c., of electrical apparatus, (2) resisting acids, (3) resisting alkalis, (4) resisting high temperatures, and (5) black, for medical and surgical instruments. No. (1) will only soften after a half-hour's exposure to a temperature of 200°C., while No. (4) is unaffected by this temperature and can be subjected momentarily to temperatures as high as 2,000°C. The acid and alkali-resisting varieties are said to be especially suitable for secondary and primary battery-boxes. The works near Paris are at present equipped with nine hydraulic presses of various sizes and 14 ovens, for the preparation of the material; 12 more presses and 14 additional ovens are to be erected. Electrical power distribution is used in the works, and arc and incandescent lighting at 220 volts. It should be added that the figures and tests given above appear to have been furnished by the manufacturers and not to be the results of independent tests.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 11th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting, in the rooms of the Chemical Society, Burlington House. Address by the President. Paper to be read: "On Electromagnetic Induction in Plane Cylindrical and Spherical Current Sheets, and its Representation by Moving Trails of Images," by G. H. Bryan.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "The Protection of Power Transmissions from Lightning," by J. T. Morris.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Metals used by the Great Nations of Antiquity," by Dr. J. H. Gladstone, F.R.S.

WEDNESDAY, February 16th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover Square, W.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting at 28, Victoria-street, Westminster, S.W. Paper to be read: "Telephones and Telephonic Apparatus," by F. K. Jewson.

FRIDAY, February 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6:30 p.m. Students' visit to the generating stations of the St. Pancras Vestry. Applications to join this party should be made at once to the Students' Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbott's Terrace, W.)

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday noon.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Electric Wind.—Some interesting quantitative results have been obtained on this subject by Svante Arrhenius. He used a little wheel resembling the three legs of the Isle of Man (only with four spokes), which he suspended by a metallic wire attached to the centre and electrified by an influence machine. Needles were attached to the turned ends of the spokes. These needles had "points" with a radius of curvature of about 0·015mm., as seen in the microscope. The wheel was suspended in an exhausted vessel, and the torsion was measured by a mirror and scale. By inserting a large condenser in the circuit the deflection could be made very steady. An electrometer and a galvanometer served to measure the quantity of electricity given off by the points. A difference of behaviour between positive and negative electrification was at once apparent. Negative electricity is less easily given off than positive, especially at low pressures. When the pressure is increased the reaction of the wheel increases in proportion, but more rapidly in gases which, like acetone or carbon bisulphide, are easily condensed. This increase is specially marked in the case of negative electrification, so much so that at higher than atmospheric pressures it is probably more rapidly given off than positive. The author does not seem to have investigated the influence of illumination, which is now known to exert a very pronounced inflence on discharges.

[Arrhenius, *Wied. Ann.*, No. 13, 1897.]

Electrification of Air.—To dispose of the problem concerning the electrification of the air itself, E. Warburg has adopted the plan of blowing air through a stream of electric wind and then catching it in a wire cage connected with an electrometer. The wind proceeds from a platinum needle stuck in the cork of a glass tube, and impinges upon wire gauze connected to earth through a galvanometer. The gauze surrounds the needle point, but holes are left for the air current to traverse. The latter is blown through a tube crossing the large tube at right angles. The question then is: Will the air blown past the needle point be electrified; and if so, what is the carrier of the electrification? Electrification is clearly indicated, but it is reduced to the vanishing point by freeing the air from dust, or by driving the blast through the meshes of the wire gauze. Hence the carrier must be the dust or some other set of particles, such as particles of platinum from the needle. If instead of the platinum needle a platinum wire heated by a current is used, considerable electrification is shown, but this vanishes when hydrogen is substituted for air, the reason being that in hydrogen, as is well known, the platinum does not disintegrate. Finally, if moist air is substituted for dry air, electrification is again shown, but it may be stopped by gently heating the tubes. The carrier in this case is probably, therefore, condensed moisture. Hence, in spite of the contrary conclusion of Arrhenius the balance of evidence is against the direct electrification of a gas.

[Warburg, *Wied. Ann.*, No. 13, 1897.]

Magnetism and Concussion.—C. Fromme some time ago showed that the effect of concussion on magnetism may be closely imitated by alternating currents diminishing to zero. He has now investigated the connection between the magnetic properties of a wire or a coherer, and electric discharges through them or in their neighbourhood. He finds that while electric waves exert a powerful influence upon the conductivity of a coherer their influence upon its magnetic properties as a whole is negligible. A search in this direction for a strictly temporary change for the purposes of signalling must therefore be fruitless. The magnetic moment of a wire is equally unaffected by the impact of the electric waves. A discharge, on the other hand, which traverses either the wire or the coherer has the effect of a mechanical shock. The effect of a shock is dependent upon previous magnetisation. No amount of shocking will bring about a state in which the minimum permanent magnetism is established immediately on magnetisation. This minimum is, owing to its stability, of great practical importance. It can best be brought about by alternate magnetisation and concussion. As the process continues, the loss due to concussion gradually decreases, and the value on concussion is sensibly the same. In this manner a constant permanent magnet may be obtained. It is better to choose a low permanent magnetisation for stability.

[Fromme, *Wied. Ann.*, No. 13, 1897.]

Electrolysis of Platinum Chloride.—Platinum chloride is a body whose constitution has as yet been little investigated by electrochemical methods. F. Kohlrausch has made some experiments on two of its forms represented by the formulæ H_2PtCl_6, a kind of double chloride of hydrogen and platinum, and $PtCl_4.5H_2O$, a hydrated platinum chloride. The amount of platinum deposited from aqueous solutions is very different from the amount which might reasonably be expected. With a current of 0·121 amperes, and a current duration of 1·75 ampere minutes, the amount of platinum deposited is 28·2mgr., and the loss on ignition is 0·65mgr. This indicates a valency for the platinum lying between 2 and 3. Hence its valency is not 4, and certainly not 8. The ignition loss is probably due to hydrogen. The other salt, $PtCl_4.5H_2O$ shows a still more extraordinary behaviour. At low current-densities, say below $\frac{1}{10}$th ampere per sq. cm., no platinum at all was deposited. At greater current-densities platinum was deposited as a grey mass, turning white on ignition. But, in view of the fact first mentioned, it is certain that this is merely a secondary action. At the same time, the platinum cathode bends in a way which shows that the newly-deposited platinum contracts, probably owing to the entrance of the hydrogen. At the anode, instead of chlorine, oxygen is given off.

[Kohlrausch, *Wied. Ann.*, No. 13, 1897.]

Motions of Membranes between Electrolytes.—The phenomena of electric osmose have been utilised by physiologists for the explanation of organic processes, but in all applications up to the present it has been necessary to assume that a large quantity of electricity passed before any perceptible change of configuration was produced. But that this is not necessarily so, and that certain molar movements may be produced instantaneously, has lately been shown by F. Braun. When two electrolytes are divided by a semi-permeable membrane, and a current passes from one to the other across the membrane, part of the electrolyte is conveyed into the substance of the membrane, and modifies the tension of the latter. This tension differs with the substance, and hence a reversal of the current will produce a further tension or a relaxation of the membrane, according to its direction. This may be made clearly visible by immersing a vessel filled with one electrolyte, and closed on one side with an animal membrane, into a tank containing another electrolyte in solution. The vessel ends at the top in a gauze tube, which, half filled with the liquid, indicates the slightest motion of the membrane. Electrodes are immersed in the vessel and in the tank. Motions such as those observed have some analogy with the motion of the interior nerve substance, or the changes of form exhibited by amœbæ when under the influence of an electric current

[Braun, *Wied. Ann.*, No. 13, 1897.]

BOOKS RECEIVED.

"Elektrische Licht und Kraft-Anlagen." By Dr. Ludwig Fischer. (Wiesbaden: C. W. Kreidel.) Price 6M. 60pf.

"The Official Gazette of the United States Patent Office." Nos. 2 and 3, Vol. LXXXII. Published by the Authority of Congress. (Washington: Government Printing Office.)

"Glass Blowing and Working." By Thomas Bolas. (London: Dawbarn and Ward.) Price 2s.

"Transportable Akkumulatoren." By Johannes Zacharius. (Berlin: W. and S. Loewenthal.

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ON THE MAGNETIC FIELD DUE TO A CURRENT IN A WIRE PLACED PARALLEL TO THE AXIS OF A CYLINDER OF IRON.—II.

BY G. F. C. SEARLE, M.A.

(Concluded from page 456).

§ 8. I now pass on to consider the magnetic field due to a current flowing along a wire parallel to the axis of a solid cylinder of iron. It will be convenient to examine the geometry of the problem before dealing with the magnetic side of the question. Take two fixed points A and B (Fig. 7), and let P be a point which moves so that the ratio AP/BP is constant. Let C and D be the positions of P when it passes through the line AB. Then we have

$$AP : BP = AC : BC = AD : BD.$$

Hence CP and DP bisect the angles APB and APP′ and therefore DPC is a right angle. Thus P describes a circle on DC as diameter. Let O be its centre; join OP. Let ϕ denote the angle PAB and ψ the angle PBA. Then the exterior angle $APP' = \phi + \psi$ and therefore $DPA = \frac{1}{2}(\phi + \psi)$. Thus, since $PAC = \phi$, we have $PDA = \frac{1}{2}(\phi - \psi)$ and consequently the angle at the centre $POA = \phi - \psi$. Hence also $OPA = \psi$ and therefore, since $P'PA = \phi + \psi$, we have $OPP' = \phi$. Further, from the triangles OPA, OBP we have

$$OA : OP = \sin\psi : \sin\phi = OP : OB.$$

Hence $OA.OB = OP^2 = OC^2$. The points A and B are called *inverse points* with respect to the circle, and are such that if two tangents to the circle are drawn through B, the chord of contact passes through A.

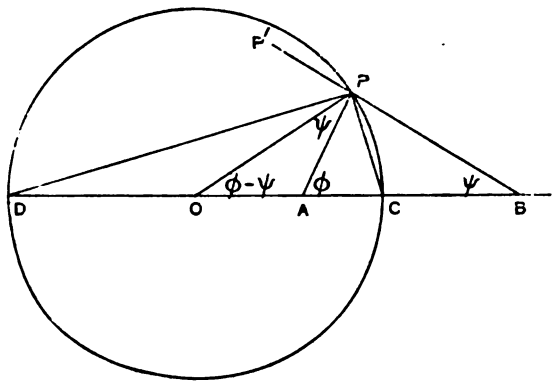

Fig. 7.

§ 9. Now let CPD be the section of a solid cylinder of iron, of permeability μ, and let a current, i, flow along the line which cuts the plane of section in A, the positive direction of the current being from the reader to the paper. As explained in § 2, the conditions to be satisfied are—

(*a*) The normal component of the *magnetic induction* must be continuous at the interface between iron and air.

(*b*) The tangential component of the *magnetic force* must be continuous at the interface.

I shall assume that the magnetic force in the iron is the same as that which would be due to two currents, i at A and u at B, if the iron extended to infinity in all directions, and that the magnetic force in the air is the same as that which would be due to two currents, v at A and w at O, if the iron were removed. The positive direction of all the currents is into the paper from the reader.

Now the magnetic force at P due to the current i at A is $2i/AP$ at right angles to AP. Hence the magnetic forces due to i, u, v, and w along the normal OP outwards from the circle are

$2i \sin OPA/AP$, $2u \sin OPP'/BP$, $2v \sin OPA/AP$, zero,

or by § 8.

$2i\sin\psi/AP$, $2u\sin\phi/BP$, $2v\sin\psi/BP$, zero.

But from the triangle PAB we have $\sin\psi/AP = \sin\phi/BP$. Hence the normal magnetic forces become

$2i\sin\phi/BP$, $2u\sin\phi/BP$, $2v\sin\phi/BP$, zero.

Thus, expressing condition (*a*) we have

$$\mu(i+u) = v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Now, if the tangential magnetic force is continuous at the interface, the difference of magnetic potential between C and P will be the same whether we go along a path in the air or go along a path in the iron. Expressing this condition, we have, since $POA = \phi - \psi$,

$$i\phi - u\psi = v\phi + w(\phi - \psi) \quad . \quad . \quad . \quad . \quad (8)$$

There is the further condition that the work done in taking a unit pole once round *any* circuit linked with a current is equal to 4π times the strength of the current. The work done in any circuit in the iron enclosing A is $4\pi i$, and that done in any circuit entirely in the air is $4\pi(v+w)$. These two quantities are equal, and thus

$$v + w = i \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Substituting from (9) in (8) we have at once

$$u = w \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

Solving equations (7), (9) and (10) we find

$$u = -\frac{\mu-1}{\mu+1}i, \qquad v = \frac{2\mu}{\mu+1}i, \qquad w = -\frac{\mu-1}{\mu+1}i. \quad (11)$$

Referring to § 2 we see that u has the same value as was found there for the case of a block with a plain face. Thus if in Fig. 2 we draw a circle on the left hand side of the boundary between iron and air, such that it has as inverse points with respect to it the two points (i) when the current i cuts the section (ii), the image of this point in the plain face of the iron, then the lines of magnetic induction in the cylinder are completely represented by the portion of Fig. 2 included within this circle. The field in the air is due to the two currents v at A and w at O. The case of the block with the plane face is simply an extreme case of the present problem. The radius of the cylinder has become infinite, and the current w has gone away to infinity.

§ 10. By putting $1/\mu$ for μ in the expressions (11) we have

$$u = \frac{\mu-1}{\mu+1}i, \qquad v = \frac{2}{\mu+1}i, \qquad w = \frac{\mu-1}{\mu+1}i. \quad . \quad (12)$$

This gives the solution for the case in which a current i flows along a wire at A placed eccentrically in a tunnel bored in an infinite block of iron. The solution can also be found by repeating the investigation of § 9. On comparing this result with that of § 3 we see that the magnetic field in the air within the tunnel is the same as that on the left-hand side of Fig. 3, the circular boundary being drawn as directed in § 9. In the iron the field is that due to the two currents v at A and w at O.

The current i is in a magnetic field due to the current u at B. The magnetic force at A is thus $2u/AB$, and therefore i is attracted towards the nearest part of the surface of the tunnel with the force

$$2\frac{\mu-1}{\mu+1}\frac{i^2}{AB} \text{ dynes per centimetre.}$$

§ 11. I shall now consider the case in which the current i flows along a wire placed at B outside the cylinder. I assume that the magnetic force in the air is that due to *three* currents, i at B, u at the inverse point A and u' at the centre O, while the magnetic force in the iron cylinder is due to the single current v at B. Expressing condition (*a*) of § 9 we have by the same method as employed in § 9

$$i + u = \mu v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

We express condition (*b*) by making the difference of magnetic potential between P and C the same for the two distributions of currents. This gives us, since $POA = \phi - \psi$,

$$u\phi + u'(\phi - \psi) - i\psi = -v\psi \quad . \quad . \quad . \quad (14)$$

Since the total current inside the cylinder is zero, we have

$$u' = -u \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

Solving (13), (14) and (15), we find

$$u = \frac{\mu-1}{\mu+1}i, \qquad u' = -\frac{\mu-1}{\mu+1}i, \qquad v = \frac{2}{\mu+1}i \quad . \quad (16)$$

Thus the lines of induction in the iron are simply circles about B. The distribution of magnetic force in the air is much more complicated, being due to the three currents i, u,

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and u'. We see that the case of a current in air near the plane face of a block of iron is obtained from the present case by making the radius of the cylinder infinite.

The magnetic force at B due to the currents u at A and u' at O is

$$2i\frac{\mu-1}{\mu+1}\left(\frac{1}{AB}-\frac{1}{OB}\right).$$

Hence the current i at B, and the cylinder are attracted towards each other with the force

$$2i^2\frac{\mu-1}{\mu+1}\left(\frac{1}{AB}-\frac{1}{OB}\right) \text{ dynes per centimetre.}$$

§ 12. By putting $1/\mu$ for μ in the expressions (16) we have

$$u=-\frac{\mu-1}{\mu+1}i, \quad u'=\frac{\mu-1}{\mu+1}i, \quad v=\frac{2\mu}{\mu+1}i \quad . \quad (17)$$

This gives the solution for the case in which the current flows through the iron at B near to a tunnel CPD bored in a solid infinite block of iron. The magnetic force in the tunnel is due to the single current v at B, and thus the lines of force in the tunnel are simply circles about B. The field in the iron is due to the three currents i, u and u' at B, A and O respectively. This case and that considered in § 8 may be made rather more practical by supposing the wire carrying the current i to be led through a *small* tunnel. Since very close to i the lines of force are circles about i, this will not alter the distribution of magnetic force either in the iron or in the air. Of course, the radius of this tunnel must be very small compared with the radius of the cylinder CPD which we have been considering.

§ 13. When I wrote §§ 2 and 3, I did not notice that the results obtained are true, whatever the form of the circuit. But it is easy to show that this is the case. Consider the problem in which a current i flows in a circuit A of *any shape* in the air near the plane face of an infinite block of iron. Assume that the magnetic force in the air is the same as that due to two currents, the one i flowing in A, and the other u flowing in B, the image of A, and that the magnetic force in the iron is the same as that due to a current v flowing in A. The positive direction of the current in B is such that the "swimming man" in B moves so as to be always at the image of his comrade in A. Let the co-ordinates of any point be x, y, z, the plane of y, z coinciding with the interface, and let the magnetic potential at x, y, z due to i be $if(x, y, z)$. Then the potential at any point in the air is $\Omega_1 = if(x, y, z) - uf(-x, y, z)$, and that in the iron is $\Omega_2 = vf(x, y, z)$. Now, on account of the continuity of the tangential magnetic force, the magnetic potential is continuous at the interface, and thus we have $\Omega_1 = \Omega_2$ when $x = 0$. This gives us

$$i-u=v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

The continuity of the normal magnetic induction gives us

$$\frac{d\Omega_1}{dx}=\mu\frac{d\Omega_2}{dx}$$

$$\text{or } i\frac{d}{dx}f(x,y,z)+u\frac{d}{d(-x)}f(-x,y,z)=\mu v\frac{d}{dx}f(x,y,z).$$

It will be noticed that the sign of u has been changed to enable $d/d(-x)$ to be written instead of d/dx. The three differential coefficients have the same value when $x = 0$, and thus we find

$$i+u=\mu v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

From (18) and (19) we have

$$u=\frac{\mu-1}{\mu+1}i, \quad v=\frac{2}{\mu+1}i,$$

the same values as were found in § 3.

The result just obtained has been verified by H. Jaeger.* The results of this paragraph and of § 3 have been tested experimentally by Prof. S. P. Thompson and Mr. Miles Walker in their experiments on Mirrors of Magnetism.† The theory employed by them supposes that μ is infinite, but on account of the large value of μ for real iron, there is very little discrepancy between the theory and the experiment. The results have also been tested by H. Jaeger.* His results do not differ appreciably from those given by the theory when μ is infinite.

* *The Electrician*, January 28, 1898, p. 443 ; *Wied. Ann.*, No. 13, 1897.
† *Phil. Mag.*, 1895 (1), p. 213.

ON MAGNETIC SHIELDING.—III.

BY PROF. H. DU BOIS.

(*Continued from page 317.*)

Corollaries of Theoretical Equations.

§ 17. In the last equations of the preceding paragraph the shielding effect was given explicitly in terms of the permeability or susceptibility ; conversely this gives us, of course, a means of expressing μ as a function of the shielding ratio g, whenever this is determined in some way or other. This at once leads to a simple method of measuring the *initial permeability* or susceptibility of iron sheet or wire, details and examples of which will be given below.

If we denote the outer circumference $2\pi R$ of the cylinder by a—easily measureable with a paper strip—the last formula (5*B) reduces to

$$g-1=\frac{\pi d}{a}(\mu-2)\doteq\frac{4\pi^2 d}{a}\kappa, \quad . \quad . \quad . \quad (8^*)$$

or inversely,

$$\kappa=\frac{a(g-1)}{4\pi^2 d}. \quad . \quad . \quad . \quad . \quad . \quad (9^*)$$

As usual, all this may be found theoretically in "Maxwell" ("Treatise," § 433): "If we wish to determine the susceptibility by measuring the magnetic force within a hollow [spherical] shell, and comparing it with the external magnetic force, the best value of the thickness of the shell may be found from the equation

$$1-\frac{r^3}{R^3}=\frac{9}{2}\cdot\frac{1+4\pi\kappa}{(4\pi\kappa)^2}.$$

The magnetic force inside the shell is then half of its value outside."

Now it is not very likely for any one to attempt to mould his material into the shape of a hollow sphere or a pair of hemispheres in order to measure its permeability; on the other hand, nothing is easier than to roll a small cylinder of, say, transformer sheet. It may be stated at once that Maxwell's elegant mathematical rule, which prescribes halving the field (*i.e.*, $1/g=\frac{1}{2}$), need not be strictly adhered to in practice; good results may be obtained with values of $1/g$ between, say, $\frac{2}{3}$ and $\frac{1}{3}$. As the iron sheet is often of a thicker gauge in such cases than was assumed in carrying out the last simplifications of § 16 (where d was assumed to be of the order $R/100$), it is useful to give another simple formula for cylinders, which is nearer the truth than (8*) or (9*), when d is of the order $r/10$. The inner radius r is now introduced, being given at once when the sheet is coiled round a glass or brass tube of known diameter; it is found that

$$g-1=\frac{1}{2}\frac{d}{r}\left(1-\frac{3d}{2r}\right)(\mu-2) \quad . \quad . \quad . \quad (10^*)$$

or inversely,

$$\mu-2=\frac{2r}{d}(g-1)\left(1+\frac{3d}{2r}\right) \quad . \quad . \quad . \quad (11^*)$$

§ 18. The relation of the theoretical shielding effect to the weight of the sheaths used to obtain it will now be investigated analytically, being of primary importance in all practical applications. This question has been treated very elaborately by Prof. Rücker† for spherical shells, not for the cylindrical case. To this rather complicated discussion, occupying over 20 pages of somewhat severe mathematics, the reader is referred. In the following paragraphs the treatment is condensed to a mere sketch, which, however, contains hints sufficient for most practical cases. Let a spherical space of given

* *Wied. Ann.*, No. 13, 1897 ; *The Electrician*, Jan. 28, 1898, p. 443.
† Rücker, *Phil. Mag.* (5), Vol. 37, p. 95, 1894. Through an unfortunate oversight this valuable paper was not mentioned among the general literature in § 1.

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radius, r, be shielded, in the first place, by a single shell, the weight, w, of which may be easily shown to be proportional to

$$w \propto \frac{1}{p} - 1 \left(\text{where } p = \frac{r^3}{R^3}\right).$$

But by (5) (§ 12) we have $g - 1$ proportional to $(1 - p)$; if now we refer the shielding effect to unit weight, we find

$$\frac{g-1}{w} \propto \frac{1-p}{\frac{1}{p} - 1} = p.$$

Now for an infinitely thin shell $p = 1$; as the thickness increases p at first hardly diminishes, and $g - 1$ consequently is nearly proportional at first to the weight and thickness; as soon, however, as the latter exceeds, say $\frac{1}{20}$th or $\frac{1}{10}$th of the radius, the shielding effect begins to increase at a much slower rate than the weight of the shell. When the thickness is increased until $d = r$, and therefore $R = r + d = 2r$, we have $p = \frac{1}{8}$; then $g - 1$ has attained $\frac{7}{8}$ of its asymptotic maximum value, the latter corresponding to $p = 0$ and according to (5) being given by

$$(g-1)_{max} = \frac{2}{9} \frac{(\mu-1)^2}{\mu} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

Evidently $(g - 1)$ tends towards this value as the outer radius and the weight of the shell increase indefinitely.

This discussion tends to show that it is not advisable to increase the thickness of a spherical uni-lamellar beyond a certain value; within the usual range of initial permeability we may say that 10 per cent. of the mean radius is a reasonable limit. Then p is about 0, 7, corresponding to a thickness of 15 per cent. in the cylindrical case, for which the above discussion holds as well. This limit of thickness is considerably below what is often used in practice.

§ 19. Beyond this it is better to subdivide the iron, and bi-lamellar sheathing has to be reverted to, which will go sufficiently far for most purposes. In this case the discussion is not quite so simple, so that it would occupy too much space to reproduce it in detail; it leads to the conclusion that in order to shield a given spherical space with two shells of minimum iron-weight the following expression,

$$\frac{81\, p_{12}\, p_1\, p_2\, g_1\, g_2 - 4\mu^2\, p_{12}^2\, p_1\, p_2\, m_1\, m_2}{4\, p_{12}\, p_2\, m_1 + 4\, m_2}, \quad . \quad . \quad (13)$$

must be made a maximum; it is derived from the simplified equation (IIA.), in which, moreover, $\frac{1}{2}$ is neglected in the factor $(\mu + \frac{1}{2})$. For cylinders 64, q and n has to be written instead of 81, p and m respectively. From this the most economical design with regard to weight may be calculated, the permeability and two conditions being given, so as to determine the three independent variables p_1, p_2 and p_{12}.

Generally p_1 and p_2 will be predetermined, and p_{12} remains to be disposed of. Denoting the latter by x, the differentiation of (13) leads to the following quadratic equation,

$$4\,(\mu^2 p_2\, m_1^2\, m_2 - p_2^2\, m_1^2)\, x^2 + 8\,(\mu^2 m_1\, m_2^2 - p_2\, m_1\, m_2)\, x - (81\, g_1\, g_2\, m_2 + 4 m_2^2) = 0, \quad . \quad . \quad (14)$$

from which x may be found and the ratio of the radii of the air-space thus determined, being of course $= \sqrt[3]{x}$ in the case of spheres. If, for instance, on the one hand we consider two comparatively thick shells of geometrically similar shape, so that $p_1 = p_2 = p$, then the above condition leads to the following approximate equation for the air-space,

$$p_{12} = \frac{\sqrt{1+p} - 1}{p}, \quad . \quad . \quad . \quad . \quad . \quad (15)$$

holding very nearly for spherical as well as for cylindrical sheaths, and independent of the permeability, provided this be sufficiently large.

If, on the other hand, we consider two thin shells—not necessarily both of similar shape—the equations for which have been given in § 16, we are led to the approximate condition

$$p_{12} = \sqrt{\gamma^2 + \gamma} - \gamma \quad . \quad . \quad . \quad . \quad . \quad (16)$$

in which γ denotes the ratio m_2/m_1 or n_2/n_1. When p and γ converge towards unity (15) and (16) tend to identity. Hence we infer that for the simplest case of two thin shells of similar shape, so that

$$m_1 = m_2, \text{ or } n_1 = n_2,$$

the air-space is best determined by choosing

$$p_{12} = \sqrt{2} - 1 = 0{\cdot}4142 = \frac{1}{2{\cdot}4143}.$$

Therefore the most advantageous ratio of radii R_1 and r_2 of air-space is found to be

$$\frac{r_2}{R_1} = \sqrt[3]{2{\cdot}4143} = 1{\cdot}3415 \quad . \quad . \quad \text{(sphere)}$$

$$\frac{r_2}{R_1} = \sqrt{2{\cdot}4143} = 1{\cdot}5538 \quad . \quad . \quad \text{(cylinder)}$$

In other less simple cases the radial ratios of the air-space, calculated from the conditional equation for minimum weight, do not come out very much different from the above. We may therefore say that whenever the question of weight has to be kept in view, it will be best to fix that ratio at 1·3 to 1·4 for spheres, and 1·5 to 1·6 for cylinders.

Graphical Representation.

§ 20. The theory of bi-lamellar sheathing developed in the preceding sections is illustrated by the diagram in Fig. 3. Two cylindrical sheaths of permeability $\mu = 202$, and dimensions chosen so as to give round numbers are combined; the principal data are given in the following table:—

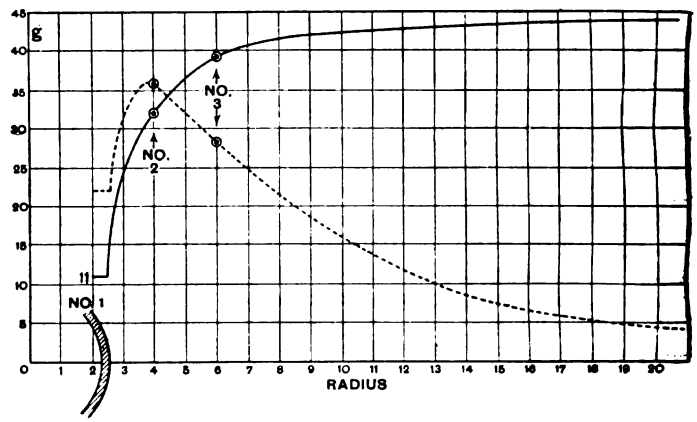

FIG. 3.—Cylindrical Bi-lamellar.

No.	$\frac{r}{R}$	q	n	g	$g_1 g_2$
1	0·895	0·800	0·200	11	= 44
2	0·97	0·940	0·060	4	

In the diagram sheath No. 1 is shown in place with outer radius $R_1 = 2{\cdot}5$; No. 2 is now supposed to expand in the way explained in § 14, while retaining its radial ratio of 0·97; to abscissæ representing the successive values of its inner radius (from 2·5 upwards) the shielding effect of the combination is plotted by equation (IIA*) of § 16 as a full-drawn curve. From the above table $g_1 = 11$; when sheath No. 2 is placed so as to surround No. 1 without air-space g becomes equal to 14, and then rapidly increases, as No. 2 proceeds outwards, towards its asymptotic value $g_1 g_2 = 44$. The dotted curve represents g as referred to unit weight of the sheathing on an arbitrary scale of ordinates; this curve is seen to reach a maximum for the value $r_2 = 3{\cdot}9 = 1{\cdot}56\ R_1$, in accordance with the theory of the preceding paragraph. The two points marked ⊙ in the curves refer to the cylinders No. 2 and No. 3 mentioned later, whose dimensions nearly agreed with the round numbers here adopted for simplicity's sake; the experimental results obtained with these sheaths will be shown to be in accordance with theory.

§ 21. The importance of a line-of-force diagram for the full understanding of any magnetic problem can hardly be overestimated. It bristles with information valuable from the research point of view, as well as for merely demonstrative purposes, and may be checked by an iron-filings picture. The

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two-dimensional cylindrical problem lends itself particularly well to this method of representation, the configuration being determined with the aid of the simplest cylindrical functions. In the diagram (Fig. 4) the four quadrants represent four different cases of cylindrical uni-lamellar shields of permeability 102 and various thickness; the data may be taken from the following table :—

No. of quadr.		No.	$\frac{r}{R}$	p.	g.	Description.
1	2	1	0·98	0·96	2	Very thin cylinder
		2	0·92	0·84	5	thin cylinder
4	3	3	0·50	0·25	20	thick cylinder
		4	0·0	0·0	25	solid cylinder

The cylinders are supposed to be placed at right angles to the plane of the diagram in a uniform horizontal field. The lines of force or induction are drawn in full and numbered so as to be easily followed throughout their course; wherever the tangential law of refraction that with $\mu = 102$, the lines of induction must be very nearly tangents to the surface inside the substance of the shell.

§ 22. The case of the solid cylinder (quadrant 4) is particularly interesting*; the value of the shielding ratio given in the above table ($g = 25$) would apply to an infinitely narrow axial tunnel; in iron of average permeability the value of $\mathbf{B}'$ is known to be very nearly double the $\mathbf{H}_e$ of the impressed field (thrice for the case of a solid sphere); this result holds to the same order of approximation as the well-known simplified relation $\mathbf{B}' = 4\pi\mathbf{I}$. Therefore the resultant force in the iron denoted by $\mathbf{H}'_t$ is

$$\mathbf{H}'_t = \frac{\mathbf{B}'}{\mu} = \frac{2\mathbf{H}_e}{\mu}$$

It follows that the equipotentials are much farther apart in the iron than at a sufficient distance outside, the ratio of the intervals being $\mu/2$, or, in the example chosen, 51, as may be seen in quadrant 4.

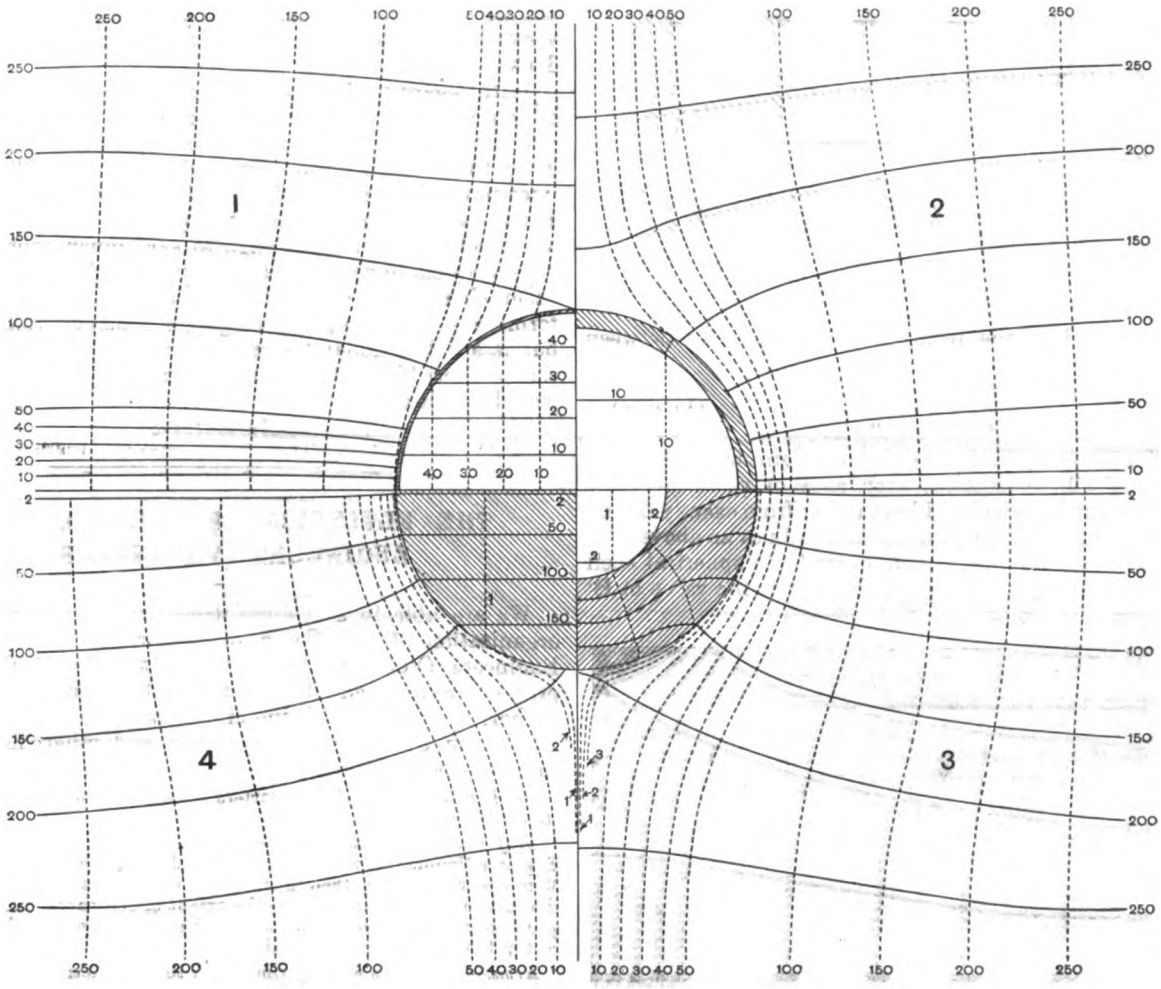

FIG. 4.

limited space has prevented their being drawn inside the shaded ferromagnetic shell, they must be understood to run nearly parallel to its boundary. The equipotential curves are dotted and of course orthogonal to the lines of force. The diagram speaks for itself; the particular configuration in each quadrant must, of course, be supposed symmetrical over the three other quadrants. The discontinuities at the boundaries are worth attention; the lines of force are seen to enter the ferromagnetic at an angle of incidence, which is quite perceptibly oblique at the *outer* surface of the thin shell, and diminishes as the shell increases in thickness; for the thicker shells the lines of force are very nearly normal to the outer surface (compare § 2). With regard to the *inner* bounding surface it is evident from the condition that a uniform field must exist inside the shield, that all the lines emerge parallel to the original direction of the impressed field, and therefore in general are not normal to the boundary. It follows from

Now it is well known to follow from the theory of conjugate functions, by the principle of reciprocity, that if we exchange the ferromagnetic (shaded) and unmagnetic parts in the diagram the lines of force and equipotentials change places as well. Therefore the dotted curves also represent the lines of force or induction for an air-tunnel with iron cores of different diameters (1, 2, 3); or for an entirely coreless tunnel (quadrant 4), surrounded by a ferromagnetic of indefinite extension and permeability, 102.

§ 23. If, then, we denote the total force in the tunnel by $\mathbf{H}_t$, the induction in the surrounding iron by $\mathbf{B}'$, we now have by the above

$$\mathbf{H}_t = \frac{2}{\mu}\mathbf{B}' \quad . \quad . \quad . \quad . \quad . \quad (17\text{A})$$

* Line-of-force diagrams for paramagnetic or diamagnetic *solid* cylinders have been given often enough (*e.g.*, "Maxwell's Treatise," Vol. II., plate xv.); but as the permeability has generally been assumed very small the course of the equipotentials is rather different from that depicted in Fig. 4.

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which holds for any tunnel of circular section (*see* Fig. 5 A) *e.g.*, through an armature; it appears at once from this formula that the field is very much weaker than it would be in an ordinary air-gap. For in the ideal case of an infinitely narrow crevass at right angles to the lines of force (Fig. 5 B) we have the well-known elementary result

$$H_t = B' \quad . \quad . \quad . \quad . \quad . \quad . \quad (17\,B)$$

whereas when the crevass is parallel to their direction (Fig. 5 C) we have of course

$$H_t = \frac{1}{\mu} B' \quad . \quad . \quad . \quad . \quad . \quad (17\,C)$$

When the section of the tunnel is oblong (*e.g.*, elliptic, oval, rectangular) in the direction of the field, as illustrated

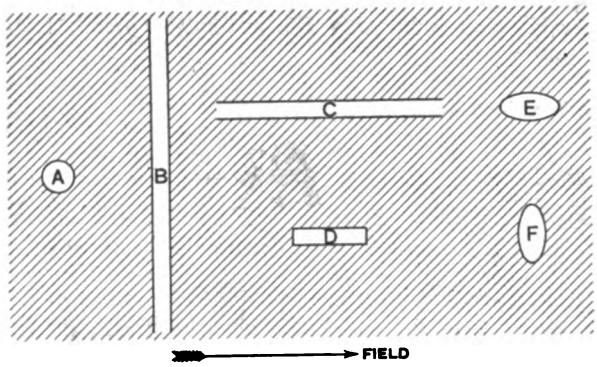

FIG. 5.

in Fig. 5, D and E, the result will evidently lie between A and C, and we may write

$$\frac{1}{\mu} B' < H_t < \frac{2}{\mu} B' \quad . \quad . \quad . \quad (17\,D, E)$$

which sufficiently indicates the order of magnitude. Moreover for tunnels of elliptic section, such as E or F, the accurate value of H_t might be calculated by starting from exactly fitting elliptic cores and proceeding on analogous lines as above.

By considering (12) § 18, which holds for a spherical shell of infinite outer radius, and substituting in it the value of B'

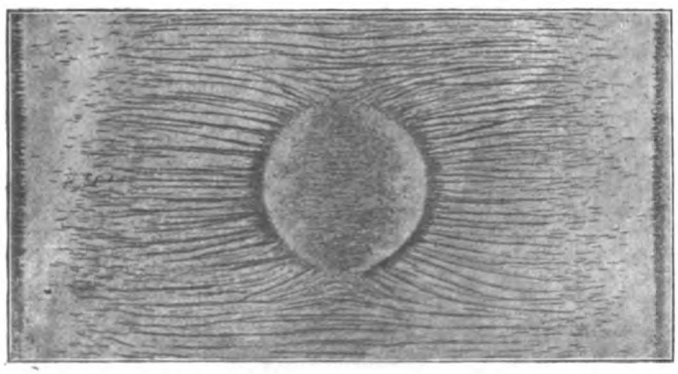

FIG. 6.

expressed in terms of the impressed field H_e, we may also obtain a formula for a spherical cavity in an extensive "soft" ferromagnetic, to which of course the two-dimensional diagram of Fig. 4 does not apply. For sufficiently high values of the permeability it is found that to the same order of approximation as above

$$H = \frac{3}{2} \frac{1}{\mu} B' \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

lying midway between (17 A) and (17 C). In the same way (17 A) may be verified by considering a cylindrical shield of infinite outer radius.

The problem of differently-shaped crevasses, cavities and tunnels in magnetically soft surroundings, which was referred to in § 10, is thus solved to an order of approximation quite sufficient for most purposes; it would, moreover, offer no difficulty to develop the strict formulæ in the same way.

§ 24. The theoretical diagrams of Fig. 4 were checked by a number of filings pictures prepared in the writer's laboratory with cylindrical sheaths placed in a uniform field.* One of these is reproduced in Fig. 6, obtained with a thin transformer-plate cylinder, approximately corresponding to quadrant No. 1 in Fig. 4. It has to be borne in mind that much stronger fields (10 to 50 C.G.S. units) must be used to obtain good pictures than correspond to the small range of constant permeability, and that the varnished paper has to be laid on the top of the cylinder, so that the condition of infinite length in both directions is not fulfilled. Notwithstanding this, the pictures fairly represent the theoretical curves. It would lead too far to discuss all the details observed; the oblique incidence of the chains of filings comes out distinctly in the figure reproduced, whereas with thicker shields they are seen to actually emerge at right angles (§ 21). The weaker field inside the shield is marked by the lines being much thinner (the filings less drawn together) than outside; we need only suppose the thicker chains to consist of a number of lines in order to obtain agreement with the conventional representation of the intensity of the field by the density of the lines.

With regard to the mode of preparing the pictures, it may be stated that they were obtained with the pharmaceutical "ferrum hydrog. reductum," properly sifted, as this powder gives the best definition for such purposes. The so-called "ferrum pulv." is too fine, and gives indistinct clouds in some places. For demonstrative purposes the coarsest filings are much better, and, strange to say, much more sensitive. It is possible to detect a field of 1·5 C.G.S. unit by means of them when spread on an elastic drum, the oblong little chips forming a much better "magnetic coherer" than the finer but less "directional" powder particles. Probably a collection of short bits of the thinnest iron wire obtainable ($\frac{1}{50}$mm.) would do better still.

(To be continued.)

THE ELECTRICAL ENGINEERS, ROYAL ENGINEERS (VOLUNTEERS).

We are able to announce the practical completion of the organisation of the Corps of Electrical Engineers, Royal Engineers (Volunteers). The following particulars are reprinted from a circular that has been drawn up by the authorities, and is now being circulated among members of the Institution of Electrical Engineers, and others interested in the movement:—

Head Quarters.—The head quarters of the Corps will be at 13, Victoria-street, Westminster.

Uniform.—The uniform will be the same as that worn by other Royal Engineer Volunteers, with such modifications as the War Office approve. Members will pay for their own uniforms, but the Corps will reimburse the cost to efficient members to the extent of one-half of the Government grant they earn by their efficiency, so that after two years' efficiency the cost of the uniform will be repaid.

Arms.—The Corps will be armed with the Lee-Metford rifle.

Training.—The training is divided into two kinds—military and technical. The military work consists of infantry drills, musketry, &c. The technical work includes every application of electricity to war, with the exception of telegraphy, and such other work as will be useful to an electrician or engine-driver in carrying out his duties, such as signalling, fitting, loading, priming and connecting up submarine mines, a certain amount of boat work, and knotting, splicing, &c. This work will be carried out partly at headquarters, but mainly at defended ports.

Efficiency.—In order to become efficient each member must attend a continuous training at a defended port for at least eight days each year. In addition, 78 hours' technical work must be done each year (48 after passing as "expert"). Each working day—after the first eight—of the continuous training counts as six hours; each full day counts six hours; each half day four hours. The remainder may be made up in periods of 1, 1½, 2, 2½, 3, and 3½ hours.

Allowances.—The capitation allowance is £5. An allowance of 5s. is made for a whole day, 2s. 6d. for a half day; but a "recruit" must attend 40, a "trained man" 20, an "expert" 10 hourly drills before earning these allowances. During the continuous training each member earns 5s. a day. The whole of these allowances will be devoted to the maintenance in camp and to the remuneration of efficient members.

* A number of originals were shown to the Berlin Physical Society on December 17, 1897.

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Drills.—Drills (both military and technical) will begin as soon as members are enrolled. Intending members are requested to study the conditions of efficiency. Every effort will be made to make it easy to comply with them.

Extracts from Rules.—Below will be found extracts from the Rules of the Corps:—

5. Every enrolled member who is non-efficient in any year shall pay to the funds of the Corps, on or before November 10 in that year, a sum equal to half the Government capitation allowance which he failed to earn. . . The Commanding Officer shall have power to remit payment, wholly or in part, in special cases.

8. No person shall be admitted as member or honorary member unless proposed by one or more members of the Corps, and approved by the Commanding Officer.

24. Any member wishing to leave the Corps may do so on November 2, providing he shall have given notice of his intention not later than the 30th of the preceding September. Failure to comply with this rule shall render him liable for half the amount of the succeeding year's capitation grant.

Intending Members.—Intending members should write to the adjutant, Capt. Brady, R.E., 13, Victoria-street, S.W., who will supply all information. They should give their full name, address, occupation, and electrical qualifications. If they wish to join as engine-drivers they should state their qualifications for that work.

Applications to Join.—Every application must be accompanied by a reference to a member of the Corps or to some other person well-known to the Commanding Officer. Before enrolment each candidate must be passed as fit by a medical officer.

Term of Enrolment.—Every member shall be enrolled for three years at least. A member leaving before completing three trainings shall be liable to a penalty. Hence a member who serves for three years, and is efficient in each year, will be put to practically no expense, as he will have incurred no penalties, and the cost of his uniform and camp expenses will have been refunded to him.

J. HOPKINSON, F.R.S., Major,
Commanding the Electrical Engineers,
R.E. (Volunteers).

SPARKING: ITS CAUSE AND EFFECTS.*

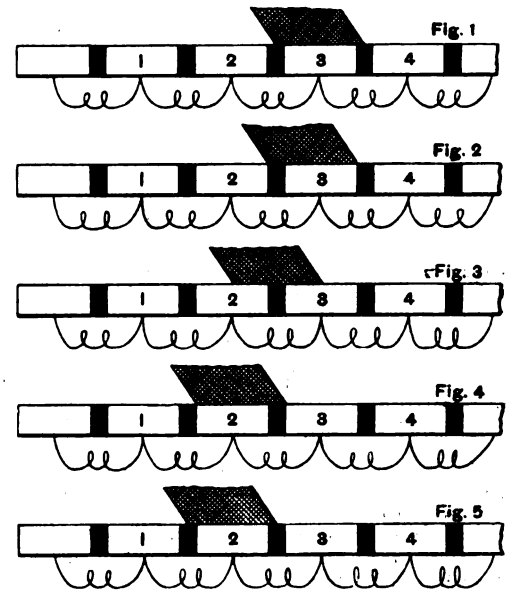
BY THORBURN REID.

Present theories in regard to the operation of commutation and the nature of sparking show considerable progress beyond those of a few years ago. The most important step forward was taken when the reactance of the coil under commutation was recognised as the greatest obstacle to perfect commutation, and the duty of overcoming this reactance was assigned to the E.M.F. set up by the cutting of the lines from the field by the coil under commutation. It was also recognised that this must be limited by the available reversal E.M.F. This was a long step forward, but it stopped just short of a complete explanation of the phenomena involved. This failure was due to an erroneous idea which has fastened itself on the theory from the start, that injurious sparking was due to the current sparking across the gap between the brush and the receding segment, by reason either of incomplete reversal of the current or of over reversal.

I shall attempt to show in what follows that sparking from either of these causes may be harmless and that the real injury is done before the segment leaves the brush. Taking first the simplest case of commutation, that of a coil of n turns with its ends connected to adjacent commutator segments, we may state the operation of perfect commutation thus:—First: Consider a coil which is approaching a brush through which the current is entering the armature from the outside circuit. The brush covers the segment connected to one end of this coil, and half of the brush current is passing through the coil from segment 3 to segment 2 (Fig. 1), the other half from segment 3 to segment 4. Second: Consider this coil receding from the brush which now covers segment 2, as shown in Fig. 5. Half of the brush current is now passing through the coil from segment 2 to segment 1, the other half passing through the next adjacent coil from segment 2 to segment 3. The current in the coil 3-2 now has the same value under the conditions shown in Fig. 5 as it had before in Fig. 1, but its direction of flow through the coil has been reversed. Between these two positions of the coil with reference to the brush the whole operation of commutation has taken place, requiring generally but a very small fraction second.

Fig. 2 shows the first operation in commutation. The two ends of the coil are now connected through the brush, and the current passing around the left-hand circuit of the armature has two possible paths, the one through segment 2, the other through segment 3. The amount of current which will flow from the brush direct to segment 2 depends on the difference of potential between the brush and segment 2, and on the resistance of contact area of segment 2. Since the difference of potential of any two points in a circuit is the same through whatever path the current flows, this difference of potential is equal to the algebraic sum of the potentials reckoned from the point of contact of the brush with segment 2 to the point of contact of the brush 3, across this contact and through the coil to segment 2. The difference of potential in the commutator segment need not be considered, as it is negligible. The difference of potential in the brush itself is also negligible. The difference of potential across the area of contact of segment 3 varies directly with the current flowing across it, and inversely with the area of contact. The difference in potential in the coil 3-2 depends on three factors, the C.R. drop in the coil, the counter E.M.F. of self-induction due to change in the value of the current, and the E.M.F. due to cutting the lines of force of the field. This last we will call "reversal E."

The C.R. drop varies with the current flowing in the coil. The counter E.M.F. or inductance drop varies with the rate of change of the current in the coil. Reversal E varies with the rate of cutting of the field lines. The C.R. drop at the contact area and the C.R. drop in the coil both oppose the current, and the inductance drop aids it as long as the current is decreasing. The reversal E may act in either direction, but is usually opposed to the inductance E. Therefore the difference of potential between the brush and segment 2 equals the C.R. between the brush and segment 3 plus the C.R. in the coil 3-2 minus the inductance drop in the coil, plus reversal E. It is seen that, as the brush moves over from the position of Fig. 2 to that of Fig. 3, the area of contact of segment 2 increases, while that of segment 3 decreases. Thus the resistance of the current path from the brush to segment 3 and through the coil to segment 2 is continually increasing



while the resistance from the brush to segment 2 direct is decreasing. Therefore the C.R. drop across the contact area of segment 3 will increase or decrease according as the contact area of current decreases more rapidly. Thus throughout the period of commutation there is an increasing opposition to the passage of the current through the segment 3, and an increasing facility for its passage through segment 2 due merely to the changes of the areas of contact of the brush with the two segments, and to the consequent changes of resistance. For perfect commutation, which is the case we are considering at present, the impedance of the coil E should always be equal and opposite to the reversal E, as will appear later.

The next period in commutation is that during which the current in the coil is increasing to its final value after having passed through zero. When the current in the coal is zero one-half of the brush current is passing through each of the two segments under the brush, on the proper assumption that the current divides equally between the two halves of the armature. The C.R. drop at the contact surfaces of the two segments will then be inversely proportional to the area of the contact surfaces, and the difference between the impedance E and the reversal E will then, as before, be equal and opposite to the difference between the two C.R. drops at the contact surfaces. It should be noted here that although the current in the coil is zero, its rate of change may be considerable, and thus cause considerable inductance E. While the current in the coil is increasing the inductance E is in opposition to the current while the reversal E is in the same direction with the current. Thus, while in the first period of commutation the inductance E prevented the decrease of the current, in this period it prevents its increase. The reversal E on the other hand aids the decrease of the current in the first period as well as its increase in the second. The increase

* Paper read before the American Institute of Electrical Engineers, Dec. 15, 1897.

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of the contact surface of segment 2 and the decrease of that of segment 3 still continues to aid the flow of the current from segment 2 through the coil to segment 3, so that the effect of all these varying E.M.F.s is just the same throughout this period as throughout the first period, but the resistance of the coil itself, which in the first period aided the decrease of the current in this period opposes its increase. Finally, just as segment 3 leaves the brush (Fig. 4) the current in the coil becomes equal to one-half the brush current and no current passes through the brush to segment 3, and the segment leaves the brush without any difference of potential between it and the brush.

Now consider how the current should vary during the period of commutation so that the energy of commutation will be developed equally over every part of the contact surface and so that the amount of energy developed shall be a minimum. First consider the variation of the current which will satisfy the first of these conditions. This condition will be fulfilled if the current-density in every section remains constant as long as the area of contact is changing; for every part of the segment remains in contact with the brush for the same length of time; that is, the time required for that part to pass from the heel to the toe of the brush. Therefore, since every part is receiving energy at the same rate and for the same length of time, the energy developed in each part is equal. While the whole segment is covered any change in the current-density will affect every section equally, so that the current may vary in any way during that period without causing unequal distribution of energy. Consider how the current should change so as to develop the least energy. That is, how the current must be distributed between the contact surfaces of the segments so as to develop the least possible amount of energy.

Let R_1 and R_2 be the resistance of the two segments, and C_1 and C_2 the corresponding currents C being the total current flowing. Then we have for the rate at which energy is being developed at any period

$$W = C_1^2 \times R_1 + (C - C_1)^2 R_2. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Differentiating and equating to zero, we have

$$C_1 = \frac{R_2}{R_1 + R_2} C. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

To determine whether this gives a maximum or minimum value, substitute in equation (1) for C_1 the values $C=0$ and $C_1 = C$, and we get for $C_1 = 0$ $W = C^2 R_2$, and for $C_1 = C$, $W = C^2 R$. Both these values are higher than that obtained by substituting from equation (2) in equation (1), namely:

$$W = \frac{R_1 R_2}{R_1 + R_2} C_2.$$

Therefore that value of C_1 makes W a minimum. This means that for each position of the brush the energy developed at the contact surface will be a minimum when the current divides between the segments under the brush in the ratio of their areas of contact. It is seen that under these conditions the current-density remains constant, and that therefore the requirements of equal distribution of energy are also fulfilled.

Perfect commutation may now be defined as a complete reversal of the current in the coil under commutation in such a manner that the portions of the current flowing through the two segments to which ends of the coil are connected shall be proportional to the respective contact areas of the segments. It was shown above that $C_2 R_2 = C_1 R_1 + C.R.$ drop in the coil plus the inductance E in the coil plus the reversal E. If therefore the sum of the C.R. drop of the coil plus its inductance E were always equal and opposite to the reversal E, $C_1 R_1$ would be equal to $C_2 R_2$, which is the condition for perfect commutation as defined above.

Following are some of the various ways in which imperfect commutation may occur and the manner in which this imperfect commutation causes injury to the commutator:—

First: Suppose that the current flowing across the contact surface of the receding segment does not decrease as rapidly as the contact surface of that segment decreases. The current-density then increases and is a maximum at the last part of the segment that touches the brush. More energy is thus concentrated at that point than at any other, and owing to the fact that time is required to conduct that energy to other parts of the segment that part will be raised to the highest temperature. This temperature may be high enough to melt, or even volatilise the copper of the segment, therefore when the brush leaves the segment the current continues to flow through the film of melted copper, volatilises it and draws an arc. This arc constitutes the injurious or "vicious" spark. The removal of the volatilised copper from the receding edge gradually wears that edge away. Reduction of the contact surface thus continually increases the current density, and the arc is formed at an earlier stage of the commutation when the current to be broken is greater, and thus the spark increases in viciousness until the commutator has to be turned down before the machine will run at all. Again, the energy developed at the receding edge of the segment may not be sufficient to melt the copper. In this case the current to be broken when the segment leaves the brush will jump across from the brush to the segment. This spark has no deleterious effect, since most of its energy is developed in the space between the segment and the receding brush, instead of being concentrated at the edge of the receding segment. This spark is of the same bluish colour as that of the Ruhmkorff coil, by which it may be distinguished from the injurious spark, which is yellow.

Second: Suppose that the current flowing across the contact area of the entering segment increases more rapidly than the contact surface increases. The current-density in that part of the segment then increases, and more energy is concentrated at this point than at other parts of the segment, and it will accordingly be raised to a higher temperature. If this temperature is not high enough to melt the copper no harm results, and there is no spark since the contact is not broken at that point. If, however, the temperature produced is high enough to melt the copper, the melted copper may be carried along by the brush, and the entering edge of the segment is thus gradually eaten away. This will not show by any sparking immediately, but it will eventually cause a spark to appear in the following manner: The eating away of the entering edge of the segment gradually reduces the area of the entering segment, and thus increases the resistance of that segment. This delays the decrease of current in the receding segment, and the current-density in both segments increases until the temperature gets high enough to produce a spark as described in the first case of imperfect commutation. Another incidental injury that may occur is the deposition of the melted copper at the back of the segment, thus raising the surface of the segment at that point, and this, together with the depression of the surface at the front of the segment, would cause the brush to jump and chatter, which of itself would cause deleterious sparking. This would explain the cases where a machine runs perfectly sparkless when first set up, but after a time commences to spark, the spark increasing in intensity and deleterious effect and disappearing when the commutator surface has been turned up, only to reappear after sufficient time has elapsed. The wearing away of the front edge of the segment is hardly likely to be noticed since no injury would be looked for until the spark appeared, and then the cutting of the back edge would be much more prominent, because that, being produced by an arc, would have a roughened appearance, while the surface of the front edge would be left smooth by the rubbing off of the melted copper.

Third: The reversal E may be large enough not only to reverse the current in the coil under commutation, but even to increase it beyond the value of half the brush current. In this case the extra current would flow through both segment surfaces, but owing to the fact that this current would be increasing while the receding segment was reducing its contact area, that segment would get hottest, and as soon as it reached the melting point an arc would be drawn and destructive sparking would ensue.

The problem that the designer of the modern machine has before him is to design a machine that will run from no load to 25 per cent. above full load without sparking, and without movement of the brushes. In the case of machines intended for lighting, the conditions of no shifting of the brushes is not generally required, but most of our modern lighting machines are made to fill that requirement. The current to be reversed therefore varies from the exciting current of the machine up to 25 per cent. above its full-load current. The inductance E and C.R. drop in the coil also vary in this proportion, and for perfect commutation through all these varying loads it would be necessary for the reversal E also to vary in the same proportion. As a matter of fact, the reversal E does not vary in anything like the same proportion, and may even decrease with increase of load, on account of distortion of the flux coming from the field by the armature ampere turns.

Perfect commutation for any particular position of the brushes can, therefore, only take place at one value of the load. At heavier loads than this critical one the current is not completely reversed before the segment leaves the brush, and at lighter loads it is more than reversed. This problem may be stated a little more precisely in the following manner: Assume that the brushes are set as far back as is consistent with sparkless running at the maximum load at which the machine is required to run sparklessly. This means that the reversal E is just equal to the coil impedance E at that point. Now let the load be removed gradually. The impedance E of the coil under commutation is reduced while the reversal E remains practically constant. The tendency is, therefore, for the current to be more than reversed, and this tendency increases as the load is reduced until finally, when the load has been removed entirely, there is no current to reverse, and the reversal E simply tends to produce a current in the coil under commutation. The production of this current is now opposed by the inductance and resistance of the coil and by the resistance of the brush-contact surfaces, the contact surfaces of the two segments being in series as regards this current. If the impedance of the coil is low as compared with this contact resistance, the reversal E would be small compared with the C.R. drop across the contact surfaces at full-load current. Therefore the current produced by

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the reversal E would be small as compared with the full-load current.

We may also note here that, whereas the variation of the contact resistances aids the reversal of the current, as soon as this current becomes greater than that which flows through the armature, the excess current must pass across the contact areas of both the segments under the brush. The resistances of these two surfaces are then placed in series as regards this current, and the lowest possible resistance that these could have would be reached when the brush covers an equal surface on each segment, making the contact resistance in the path of this current equal to twice the resistance of the contact surface of either segment at that time. The resistance of this path then starts at infinity, decreases to this minimum and goes back to infinity again.

Now examine more closely the order of events in commutation at no load. The resistance of the coil circuit first starts at infinity and rapidly decreases, while the reversal E starts at a minimum and more slowly increases. As soon as a current commences to flow inductance T enters the problem. If there were no contact resistance the current would reach its normal full-load value at about the middle of the commutation period. This, of course, assumes that the reversal E is of such a magnitude as to reverse the current at full load without the aid of the varying contact resistances. In fact the reversal E does a very small part of the reversing at full load when the inductance is small compared with the contact resistances. The current at the middle of the commutation period would therefore be much smaller than the normal full-load current, even if there were no contact resistance to limit it. Now introducing this contact resistance, which starts at infinity and decreases to a minimum, which may be several times greater than the impedance of the coil, the current must be reduced at least in the proportion of the impedance to this minimum resistance. During the rest of that period the resistance is increasing, till at the end it has reached infinity again. The current, already very small, is rapidly cut down till it is too small to produce a visible spark at the break, and the commutator has not been heated up enough at any point to produce arcing.

The same principles hold in the case of machines whose brushes must be shifted, the range of sparkless commutation only being less. There have been some machines, however, which would not run sparklessly for any position of the brushes. This is readily explained on the hypothesis of too high an impedance, for in that case the variation of the current during commutation will be mainly governed by the impedance and reversal E, instead of by the variation of the contact resistances, so that even if complete reversal is exactly attained, the current-density at other parts of the commutation period does not remain constant, with the result that the total energy of commutation is increased. A large part of this energy is concentrated at the beginning and end of the commutation period, thus producing heating at the edges of the segments, with its corresponding melting of the copper and arcing.

These considerations indicate two ways by which sparkless commutation may be assured. First, by increasing the brush contact resistance; and, second, by decreasing the impedance of the coil under commutation. The limitation of the second of these conditions is merely one of economical design, lowering of the inductance below a certain point increasing the cost of the machine. The limitation of the first condition is that of rise of temperature of the commutator. It has been shown that for perfect commutation the current-density is constant and unform throughout the whole period of commutation. Its value is found by dividing the total brush current by the contact area of the segments under a brush. This varies inversely with the brush contact area, and the energy developed therefore varies in the same proportion. The amount of commutator metal to be heated, as well as the radiating surface, also varies inversely with the current-density, so that the rise of temperature probably varies nearly as the square of the current-density provided the commutation be practically perfect. The increasing use of the carbon brush in place of the copper brush is thus explained by the fact the contact resistance of carbon on copper per square inch is much greater than that of copper on copper. Increased resistance is obtained with the carbon brush by reducing its contact area, but this also reduces the metal to be heated in the commutator, as well as its radiating surface, so that the same amount of commutating energy will result in a much greater rise of temperature. By taking these facts into consideration, however, and promptly proportioning the contact areas and inductance, commutating machines may be designed to run as cool with copper brushes as with carbon wherever this may be desirable.

The reasoning so far has been based on the assumption of but one coil being commutated at a time. This assumption will only be true when the brush thickness is equal to or less than the width of one segment, plus twice the thickness of the insulation between segments. In practice brushes are often made to cover a segment and a-half, sometimes two segments, or even more than this without deleterious sparking. This means that the current in two or more coils is being commutated at the same time. At first sight this appears to be an advantage, since it enables us to get the same current-density with less length of commutator, but the time of commutation is increased, so that while the rate of development of energy is not changed, the total amount of energy developed will vary with the time of commutation, and in addition to this the amount of metal to be heated and the radiating surface are both decreased, so that in this respect the change is rather a disadvantage than an advantage. Another important advantage is gained, however, in that the increase in the length of the commutation period decreases the reactance of the coil by decreasing its frequency of commutation, so that the ratio of impedance to contact resistance is decreased, thus tending towards more perfect commutation. This advantage is again limited by the fact that the mutual inductance of two coils commutating at the same time increases the reaction of both.

To sum up, the deleterious effects of sparking are due to excessive local heating of the commutator contact surface, causing the copper to melt, and an arc to be drawn, the segments being thus disintegrated. The causes of deleterious sparking are either too great a departure from perfect commutation or too high a current-density. Perfect commutation can only be practically secured by making the impedance of the coil negligible as compared with the contact resistance. A comparison of the sparking constants of a large number of machines was made before this theory of commutation was evolved. It has been found to explain many cases of sparking which had before been unexplained. It has been found difficult to determine definite safe working constants, on account of the small number of tests that have been made to determine accurately the inductance of the coil under commutation and the effect on each other of two or more coils commutating at the same time.

NOTES ON THE ELECTRO-CHEMICAL TREATMENT OF ORES CONTAINING THE PRECIOUS METALS.*

BY MAJOR-GENERAL C. E. WEBBER, C.B., (RET.) R.E., M.INST.C.E.

The precipitation of gold and silver with the aid of an electric current has a history which may help my audience—many of whom, I think, are more or less acquainted with the subject—to appreciate the present situation of a question which cannot be devoid of interest to our Institution.

If we go far enough back in the subject we shall find that in 1835 to 1840 Becquerel used a saturated solution of common salt for dissolving compounds of silver and lead, and subjecting the solution to the electric current, both to hasten the reactions of the process, and better to utilise the precipitating agent.† In 1843 Prince Pierre Bagration described in the *Bulletin de l'Academie des Sciences de St. Petersbourg* some experiments with finely-divided gold dissolved in an aqueous solution of potassium cyanide under the influence of the galvanic current, by which means he precipitated the precious metal on a copper cathode.

In 1867 Julio H. Rae proposed, in the United States, a method of treating ores containing gold and silver mixed with a suitable solution, such as one of cyanide of potassium in water, by the action or aid of a current of electricity; suggesting at the same time, in addition, the agitation of the solution. Although Rae's proposals are said to have never gone beyond an experimental stage,‡ in his description is found the combination of (1) a circular vessel to contain the ore; (2) a solvent in solution; (3) a stirrer, or agitator, on a vertical shaft, working with a rotatory motion within the vessel, the stirrer being connected with one electrode, and a conducting

* Paper read before the Institution of Electrical Engineers on Jan. 27.

† Prof. Silvanus Thompson has sent me the following extract from the Memorials of Andrew Crosse, published in 1857:—In 1837, "I took a piece of quartzy gold ore from California, which weighed 4,306 grains, and reduced it to coarse powder in an iron mortar," "roasted," and "repowdered" it. "Of this powder I took 1,000 grains and put them into a Wedgwood mortar, having first thrown into it 200 grains of pure mercury. I then partly filled the mortar with extremely dilute carbonate of ammonia, and connected the mercury with the negative pole of a very weak voltaic battery of 12 pairs of cylinders, keeping up the action for five hours. . . I next weighed the mercury, having carefully dried it. Its weight was 205 grains, which, when evaporated in a black-lead crucible, yielded *eight* grains of gold. . . . I tested the residue, . . . so that the above electrical process had only left, after five hours' action, one-seventeenth part of the gold untouched."

‡ Rae (Fig. 1) describes the employment of a jar or vat, A, of an insulating material, which contains a stirrer in the form of a cage, B, carried by a vertical shaft, C, which, resting on the bottom of the jar, is made to revolve on its axis by means of a pulley, D. This stirrer, combined with the plate P, on which the axis of the stirrer rests, and on which the pulverised ore is deposited, constitutes one (the positive) electrode; the other electrode is connected with a metal plate, E, suspended in the vessel above the stirrer.

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metal plate which supports the charge under treatment within the vessel being connected with the other electrode, of a source of electricity.

In December, 1882, Messrs. Breakell and Haycraft patented, in South Australia, a means of treatment of slimes by agitation com-

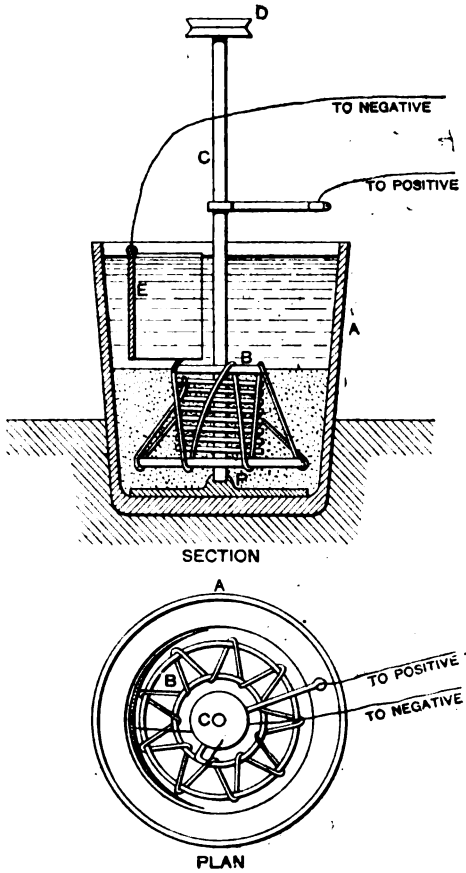

FIG. 1.

bined with an electrical current and amalgamation. In nearly all respects they copy Rae, except that they use no solvent of the precious metals present in the mixture under treatment.* In passing, I must mention Barker's apparatus of 1882 for extracting

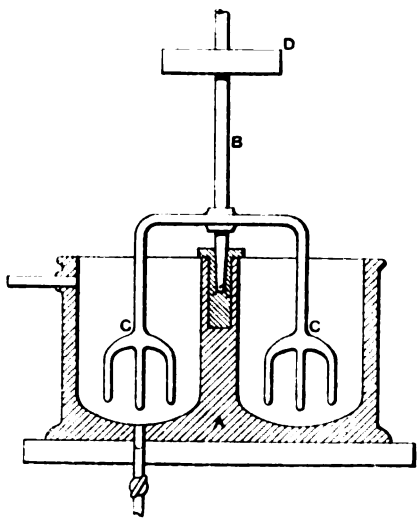

FIG. 2.

gold and silver from the "sands" containing them, in which we find the use of a mercury cathode, combined with stirrers on hori-

* In their apparatus (Fig. 2) A is the vessel, or "pan," in which the operation is performed. B is a revolving shaft, carrying arms or rakes, C C, which is connected by a contact, preferably of mercury, on the top of the shaft, with the positive pole of a battery. The bearing on which the axis revolves is insulated from the vessel. D shows the position of a pulley on the shaft, by means of which it is revolved. The negative pole of the battery is connected with the vessel, which is of iron or such suitable material, so that the vessel itself, as well as the mercury lying at the bottom of it, constitutes the cathode.

zontal shafts which, however, did not constitute the anode. Also Body's process of 1883, which combined a drum-and-ball crusher of ore containing precious metals. These had been previously ground and dissolved in a solution containing ferric salt. The axle of the revolving drum carries carbon anodes, and the walls of the vessel and the balls serve as cathodes, on which the noble metals after solution are deposited electrolytically. Mercury is used, but only for the purpose of collecting the free gold and silver.

I propose to avoid, as far as possible, allusion to the large number of inventions which deal chiefly with electrical amalgamation, but it is difficult not to refer to some of those which use electrical deposition. Thus, when, in 1888, MacArthur and Forrest investigated the chemistry of, and patented their world-renowned process, they seem to have neglected, or, having tried it, discarded, the assistance of electricity in combination with a weak solution of potassium cyanide, because of a greater expenditure of chemicals, which they alleged to be the result, and also because they believed it encouraged the solution of any baser metals together with the gold and silver which might be present in the ore, and involved the extra expense of their separation. I need not here refer to the reasons for MacArthur and Forrest's rejection of electricity, nor to the well-known Siemens & Halske process,* in which "circulation" of the solution by gravity is an essential feature, as I wish to direct your attention more particularly to those processes in which the combination of similar conditions with "agitation" are included.

Following on Rae and Breakell, in 1891 Hannay described and patented in the United Kingdom a process and an apparatus for "extracting gold from minerals containing it, by subjecting the finely-pulverised mineral mixed with a solution of cyanide to electric action and agitation in the presence of mercury." In

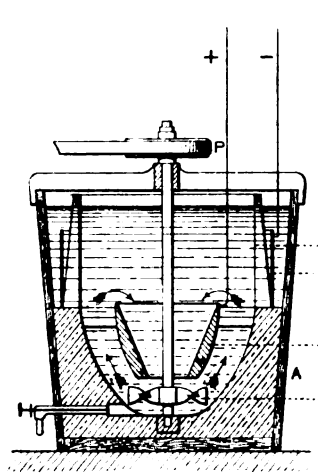

FIG. 3.

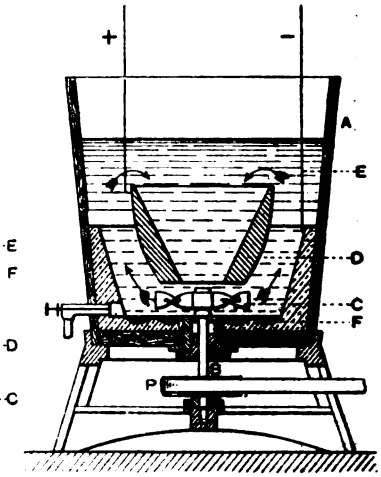

FIG. 4.

this process—which it is not understood was ever put to work on a practical scale, and which it is believed, in common with his predecessors', is not described so that the ordinary intelligent engineering mind could erect the apparatus and work it successfully—there is found the combination of (1) a circular vessel or tank; (2) an electrolyte consisting of a solution of cyanide of potassium, mixed with pulverised ore; (3) a stirrer, or agitator, on a vertical shaft, standing in the middle of the vessel, and acting by rotation on its axis; (4) one electrode—the anode which in this case is a cylindrical block of carbon—being suspended or fixed in the middle part of the vessel. Two examples of the apparatus were published in December, 1891, and in one of them (the later one) we find another condition in combination with the above, which, so far as I can discover, but for the proposal of Breakell and Haycraft in 1882, would be the first example in which the bottom of the vessel described as of "basin shape, containing mercury," as in the case of the ordinary amalgamating pan, is also the cathode. Examination of the description of this cathode will, I think, not satisfy electricians of its practical value without important modifications. The use of solvents or oxidising agents other than potassium cyanide is not proposed, and the strength of the cyanide solution, current, &c, is not given.†

* In 1896 added to, if improved on, by Stuart Croasdale. See *Engineering and Mining Journal* of December 12, 1896.

† There are two forms of this apparatus (see Figs. 3 and 4). In each there is a cylindrical vessel, A, with a revolving vertical shaft, B, turned by a pulley, P. The shaft carries what is called a "propeller," which serves only for the purpose of stirring the liquid contents of the vessel. In each section a hollow cup-shaped block, D, of carbon, is shown, which constitutes the anode, and is connected with the positive conductor from a dynamo. In the example (Fig. 3) the cathode—which is formed of carbon plates, F, within an annular frame, F—is fixed above the propeller. In Fig. 4 the cathode is a body of mercury which lies in the "basin-shaped" bottom of the vessel.

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There exists an interesting description of a process patented in 1893 by Mr. Molloy, M.P., who between 1884 and 1887 had dealt with the subject in a different manner. Although it does not include all the features of treatment to which I wish to confine myself, its chemical reactions are not without interest to our subject. It involves at first sight two stages, but really it has four, namely:—First, the solution of the gold contained in a pulverised ore by means of bromine, chlorine, cyanogen, or other compounds; secondly, the charging a mercury cathode, which forms the bottom of a treatment tank, electrolytically, with potassium or other alkaline metal, free potassium being taken up by the mercury; thirdly, the introduction to the tank of the solution, and its treatment therein; and, fourthly, the recovery of the solvent by regeneration.* The entire absence in the specification of the position of the other electrode, and the description of his apparatus being confined to merely the words "many forms of construction," seem to exclude claims to originality in that respect, there being no attempt to describe something that the ordinary engineering mind can construct or put to work.

In January, 1893, E. D. Kendall applied for, and in August, 1894, was granted, a patent in the United States for a method which claims to be "a method" of treating pulverised gold and silver ores with sodium dioxide and a "suitable cyanide" in a water solution. The quantities of chemicals to the ton of ore are 2lb. of sodium dioxide (Na_2O_2) and 7lb. of potassium cyanide (KCN), but these may vary. The treatment may be by lixiviation, "with or without" agitation. And the precious metals may be separated from the lixivium by "electrolysis or other suitable means." No apparatus or special means are described.

Also, in December, 1893, Carl Pielsticker obtained a patent in New Zealand for the extraction of gold and silver from ores, both in the form of sulphide and in ores in which the precious metals exist in a state of "extremely fine division." The use of this process was chiefly the cause of the well-known litigation between the Cassel Gold Extracting Company, the owners of the MacArthur-Forrest process, and the Cyanide Gold Recovery Syndicate, by which an attempt to monopolise the use of potassium cyanide in all processes of gold extraction throughout the world, broke down. It is for this reason, and as helping to explain the difference between "agitation" and circulation" in a cyanide solution, that my notes include its description. Its essential features may be briefly described as "a process of separating gold and silver from their ores," which consists in treating the powdered ores with a solution of cyanide of potassium, in conjunction with an electric current of low tension used for the purpose of the deposition of the precious metals. In order that the process may go on continuously, he produces a circulation of the liquid through the space between electrodes, which are fixed respectively, the anode at the bottom, and the cathode at the top of a tank.* It is claimed for the use of a current of higher potential specified to be used in the ore tank that "the precious metals are attacked more energetically by a cyanide solution in connection with a current of electricity than without." We are also told that "free gold is certainly more quickly dissolved by cyanide of potassium in conjunction with an electrical current than without one." To recapitulate: This process has, in common with Rae and his successors, the combination of a solution of potassium cyanide with an electric current, by which it assists solution and effects precipitation on a cathode; and, in common with Molloy, it effects the treatment in more than one stage, and by means of "circulation." In this latter respect Molloy and Pielsticker are at one with the process of Siemens and Halske, in contradistinction to the processes in which "agitation" is essential. With reference to my observations further on as to "agitation," it may be here observed that in such processes the density of the sludge at various points in the system of circulation must depend on its rate of motion.

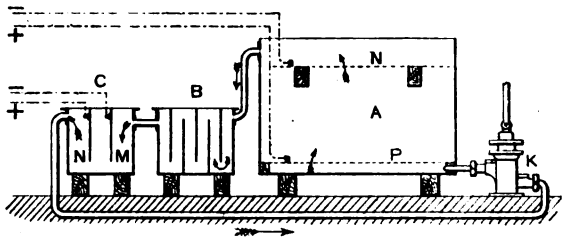

FIG. 5.

Edwards, in April, 1894, described, in the United States, an apparatus very similar to Hannay's, except that the position of the carbon anodes is altered, and they are apparently placed so as to line the sides of the treatment vessel.

In 1894 an invention was produced in the United States, and subsequently patented there and in other countries by Messrs. Pelatan and Clerici, for an electrolytic process and apparatus for extracting gold and silver from their ores and other compounds. The process has been described as a single continuous one—an essential feature—because as such it has proved itself equal to effect in one operation all that can be expected of it. In other words, it receives the pulverised ore in a wet condition, and, after being stirred up, and water, if necessary, added, so as to be in a condition of fluidity to allow of suitable agitation of the particular kind of ore under treatment, and so that the chemicals used in the treatment are properly mixed with the solution, it is introduced into the treatment vat or vats, in which the operation, which I shall again refer to, is carried out until nearly all the precious metals are extracted and absorbed by the amalgam at the bottom of the vessel or vessels. Although a preliminary mixing of the solution in a separate tank may be thus implied, there is nothing to prevent the mixing being carried out in the treatment tank itself. In this we have, I believe, for the first time, a process and apparatus which effectively combines, in a way that can be constructed and worked by a workman of average intelligence, the following:—(1) A vat made of a material, dielectric in its nature; (2) an agitating apparatus of various specific forms, each form calculated to carry out one and the same process—being the result of considerable experience—having an agitator, part of which constitutes the anode in an electrolytic circuit, which is carried so that it can by no means make contact with the bottom or sides of the vat; (3) the presence of a cathode, which covers the whole of the bottom of the vat, made of a metal (preferably copper) plate or sheet, and suitably contained and fixed so as to carry on it a layer of mercury; (4) the use of a graduated current from an electrical generator, having large quantity and low potential; (5) the mixture or sludge under treatment being composed of water in given proportions, ore finely pulverised, potassium cyanide or other solvent of gold and silver, and common salt, with the addition during the process of alkalies or organic acids as may be required. These are the chief features, together with important details of construction to which I shall refer further on, that constitute the Pelatan-Clerici process.

(To be continued.)

* In the first stage, although it is not so described, Molloy must subject the pulverised ore to a process of leaching to obtain his solution, say, AuCn.

The following equation expresses it:—

$$Au_2 + H_2O + O + 4\,KCN\ 2[K\,Au\,(CN)_2] + 2\,KOH.$$

In the second stage, his alkali metal is an alkali salt, *i.e.*, potassium carbonate (K_2CO_3) or a sodium carbonate, &c. No reference is made to the anode used in electrolytically charging the cathode, but the object to be attained is apparently that the mercury in the cathode should take up free potassium, forming an amalgam of these. This addition may be made mechanically as an alternative.

In the third stage, which is that in which the extraction of the precious metals takes place, the solution comes in contact with the previously prepared mercury. It is said that it "rests or passes over" it; so it is not an "agitation," though it may be called a "circulation" process.

Although it is not easy to gather from the inventor's description that he uses electricity in this stage, it is evidently implied, because the reactions in the following equations could not otherwise be effected.

$$2[K\,Au\,(CN)_2] + H_2 = 2\,KCN + 2\,HCN + 2\,Au;$$

$$2\,CNH + 2\,KOH = 2\,KCN + 2\,H_2O.$$

In the first equation we have the action of the nascent hydrogen on the double cyanide of gold and potassium cyanide, producing metallic gold and hydrocyanic acid. The gold is precipitated and absorbed by the mercury, from which it is afterwards released in the usual way.

In the second equation we find that the hydrocyanic acid unites with caustic potash formed from the alkaline metal in the mercury, and re-forms potassium cyanide, which is one of the important features of the invention. The recovery of the cyanide will constitute the fourth stage.

* A is an ore tank (Fig. 5); P is the anode, made of protected iron or carbon; N, the anode also, a perforated plate. The circulation of the liquid is through two other tanks, B and C, besides the ore tank, by means of pipes connecting the whole, and the movement of the liquid through the system is by power working a pump, K. The second tank, B, is used to arrest suspended matter in the solution; and the third, C, is a precipitating tank, in which electrodes are placed vertically, the anode, M, being of carbon, so as to resist the dissolving action of potassium cyanide. The precipitation is on to the cathode, N, in the third vessel of the set. The same solution is circulated round and round, until all it can dissolve in the ore tank has been extracted, and all that the electricity can separate from it in the third vessel has been precipitated. The electricity is taken from the generator through two circuits, and in each a separate duty is performed. In the first tank the sludge, as it may be called, is subject to an electric current, which we are told may be of a higher potential than that in the third tank, where it is preferably limited to 1 volt and ten amperes per square metre of surface of cathode.

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COMMUTATION IN CONTINUOUS-CURRENT DYNAMOS.

We reprint in another part of our issue this week a Paper recently read before the American Institute of Electrical Engineers by Mr. Thorburn Reid, entitled "Sparking: Its Cause and Effects." The author begins his Paper by making what we think is an unwarrantable assertion, or at any rate one which does not hold in this country. He says, in effect, that the part played by the varying resistance of the contact between commutator sector and brush, as the area of contact with a sector changes, has been left out of consideration in the theory of commutation up till the date of his Paper. He also puts forward as new the statement that in a sparking dynamo the worst damage is done before the commutator sector has left the brush, and is due to fusion of the metal at the contact, owing to excessive current-density. During the discussion on Mr. W. B. Sayers' Paper "On the Prevention and Control of Sparking," read before the Institution of Electrical Engineers in 1893, Mr. Housman drew attention to the important effect of the varying resistance of the contact between the brush and a commutator sector due to the changing contact area, and gave experimental data with regard to the value of the contact resistance; furthermore, Mr. Housman added, "what happens when the current-density is too great is that the current is crowded up into the tip of the brush, which fuses and sticks to the commutator." In his reply the author of the Paper referred to pointed out that dependence on the action of the varying contact resistances alone undoubtedly meant, not a non-sparking but a sparking dynamo.

Mr. Reid, however, does full justice to the importance of a definite reversing E.M.F., and shows that for perfect commutation this reversing E.M.F. must be equal and opposite to the impedance E.M.F. of the coil under commutation. Mr. Parshall has also given a formula setting forth this fact.

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Someone has likened the problem of sparkless commutation in a dynamo to that of preventing "knocking" in a steam engine. In the steam engine it is necessary to set the valves so as to secure compression, and to admit live steam to the cylinder, before the crank has reached the dead centre, to a sufficient extent to arrest the motion of piston, slippers, connecting rod, &c., and restart them in the opposite direction; for if the stopping and restarting of these parts against their inertia were left entirely to the action of the crank, the very closest fitting would not long defer disastrous "knocking."

Similarly the reversal of the current in a continuous-current armature must be accomplished inductively in the winding or windings; that is, by opposing a reversing E.M.F. to the impedance E.M.F., for if the reversal be left to the make and break action at the commutator disastrous sparking is the result. Pursuing the analogy further, however, we find that in practice, when variations of load occur, the conditions to be met are dissimilar. A stationary engine usually requires to run at a speed as nearly constant as possible with all loads, and, the speed being the same, the same steam is required to reverse the motion of the parts, whether the engine is running "light" or whether it is carrying load. This adjustment of the cushioning it is safe to say is never realised with any degree of accuracy, and hence in a double-acting engine the practised ear can invariably infer from the sound whether the engine is "light" or loaded. In other words, the inertia is independent of the load, and the problem is to keep the reversing forces constant with varying supplies of steam. The locomotive engine on the one hand, and the constant-current dynamo on the other supply conditions in which the respective divergencies we have cited become coincidences; but these facts will not now detain us. The practical solutions in the case of the steam engine, such as working with the parts always in compression, which is the method adopted in single acting engines; or working with joints comparatively tight, as in the case of some well-known continuously lubricated engines; or Mr. Raworth's ingenious solution, which consists in making a connection rod so that the working strains tend to relieve the grip of the brasses on the crank pin when the former are tightened so as to have no play, have no known parallels in the problem of commutation.

Inductive commutation, as we prefer to call it, with fixed brushes, requires that at all loads the reversing E.M.F. shall be equal to the impedance E.M.F., which means that the reversing field shall increase in proportion to the load, and of course have the correct grade. Mr. Reid contents himself with the statement that this is not attained in practice; in fact, that instead of being increased, the reversing field is invariably diminished by the increase of armature current, and he gives a very clear account of the manner in which sufficiently good collection is secured in practice to make moving of the brushes unnecessary. This, we need hardly say, is accomplished by the aid of carbon brushes, and at the expense of (1) a larger commutator than would suffice, if copper brushes were used and movement allowed with change of load, and (2) with an additional waste of power consequent on the increased contact resistance, and of course increased heating of the commutator and brushes. But while it may be practically impossible in the case of the steam engine to apply steam at all loads in the exact quantity necessary to arrest and reverse the direction of motion of the parts against the inertia, there does not seem to be the same difficulty in the case of the problem of commutation in a dynamo; and furthermore, while in the case of the engine we get over the difficulty quite satisfactorily by working with parts in constant compression in the case of single-acting, and with tight brasses and a film of oil in the case of double-acting engines—neither device, be it observed, involving the waste of any appreciable amount of energy, as we have already pointed out—no such solution presents itself in the case of the dynamo.

The problem of obtaining a reversing E.M.F. proportional to the load on a dynamo would appear to be quite within the range of practice, since the current flowing from the armature inevitably produces, subject to well-known limitations, a magnetic flux proportional to itself. The method described by Mr. J. Fischer-Hinnen in the *Elektrotechnische Zeitschrift*, and reproduced in our issue of January 14th subject to the condition pointed out by Mr. Housman in our correspondence columns the following week—*i.e.*, that the unbalanced part of the field winding consists of series turns—is a variation of a well-known method by which it appears to us perfect commutation should be obtainable, and no doubt has been attained. But probably the series winding, whether put upon the magnet limb or wound on the reversing pole, as originally proposed, and tried by Mr. Ravenshaw, among others, will not only waste as much, if not more, energy than would be wasted by carbon brushes, but, in addition, the cost of the winding, involving, as apparently it must, not only a series winding of large section to avoid excessive losses, but also a considerable increase in the length of the magnet limbs to get it in, would exceed the cost of the additional size of commutator necessary if carbon brushes were used as compared with copper. We agree with the statement made some time ago in our columns by Mr. L. B. Atkinson, that the Ryan method is also capable of securing perfect commutation. But ingenious as it is, the use of a second winding, not only equal to that of the armature but giving in addition a reversed flux for commutation, seems too cumbersome and expensive to be ever adopted extensively. The Sayers armature utilises the magnetic flux generated by itself to perform the commutation, and undoubtedly, therefore, offers another solution of the problem. The commutator coils in this winding take up some space on the armature, and this has to be provided by increasing the depth of the slots in the armature core, and correspondingly increasing the diameter of the armature. The extra cost of this has to be set against the cost of the larger commutator in the case of the machine using carbon brushes. The Sayers arrangement is capable of producing practically perfect commutation, and we believe we are right in saying also an unusually high efficiency, while the carbon brush arrangement is admittedly imperfect and wastes energy.

While on the subject of commutation, we cannot conclude without making reference to Mr. Mordey's recent Paper. The Mordey winding does one of the things referred to by Mr. Reid as being desirable—it reduces the impedance of the coils undergoing commutation; but the reversing E.M.F. is provided by the leading pole of the field magnets, and the reversing flux is therefore subject to diminution by the effect of the armature current, though, as pointed out by Mr. Sayers, this diminution may be less than in some other machines, owing to the use of the chord winding and consequent non-existence of "back turns." It seems, however, that the Mordey winding does not come within the category of arrangements capable of producing perfect inductive commutation with the brushes in a fixed position, since the reversing field is not proportional to the load on the armature. It may be remarked that during the discussion of Mr. Mordey's Paper Mr. W. B. Sayers showed a diagram of a winding used by him, in which the main conductors forming one section of the winding are purposely scattered over a larger surface of the armature than usual, with the object of reducing the impedance of the section during commutation.

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There are some points in Mr. Reid's Paper with which we do not altogether agree; but in our opinion it is a very clear exposition of the subject of commutation in continuous-current dynamos, referring exclusively to the more ordinary types, and is well worthy of careful study by those interested in the subject generally.

REVIEWS.

Students' Guide to Submarine Cable Testing. By H. K. C. Fisher and J. C. H. Darby. (London: "The Electrician" Printing and Publishing Company.)

This book is not an academic treatise, as might be imagined from its title, but a very practical work. The student, in the authors' minds, is evidently one who is qualifying to enter the submarine cable service, or, being already in it, is endeavouring by all available means to make himself more proficient. A man may be a student long after he is earning his living at a profession or occupation, as, indeed, the best men are. He is then studying with the object of making himself more capable in the profession he has taken up, and has no time to waste over a mass of heterogeneous matter, however otherwise interesting it may be. He requires just that information which can be put to use, and which can only be imparted by those who have gone through the work themselves. Such books are rare to find, it is true, but they are thoroughly appreciated by those concerned when they do appear and become known. The work before us is one of this type—written by practical men who are daily engaged in the work about which they write, and who unselfishly, and with no little gift in the way of expressing things clearly, place before the submarine fraternity an up-to-date guide to the practice of testing.

Passing by the first three chapters, which are on shunts and elementary subjects, we come to the measurement of "absolute" resistance, a term now in use—and scarcely a happy one—for the measured resistance of a cable. In such an example, for instance, as on page 96, it would be well to repeat the definition of absolute resistance, or call it by the simpler term, "measured resistance." Absolute conveys the idea of the unchangeable, which cannot apply to the resistance of a submerged cable.

We then come to insulation by deflection with very useful hints, and a short explanation of earth currents and how to deal with them. Wheatstone's bridge is next discussed—the proof of the balance might have been omitted—and in the chapter on the measurement of copper resistance it is shown that neither the Arithmetical, Geometric, nor Harmonic mean can be applied as a correction when measuring resistance by reversals on a Wheatstone bridge with an earth current present in the cable, and the right correction to make—as given in Kempe's "Handbook"—is explained.

The three methods of testing with an earth current present—viz., by "Reversals," "False Zero," and by Mance's method—are clearly explained in this chapter. On page 52 the words "same current," in the twelfth line, should read "different currents." On page 58 there is a very clear explanation of the effects of polarisation and electrostatic charge.

The cream of the work is in para. 54, where the authors embody their experience of the time taken to charge a cable, either in a perfect, broken, or faulty state, by following simple rules. Having taken a rough C.R. test, the rule is applied, and the time in seconds found which must be allowed to elapse between putting on the testing battery and opening the galvanometer circuit to observe balance, and between taking off the battery and observing the false zero on the scale. As this was the one determination required to place the localisation tests of faults and breaks on a certain basis, and further removed from the region of guesswork, it must be acknowledged to be a most valuable scientific and practical result of great utility in submarine cable work, and the authors are to be congratulated on their research.

Simple explanations of capacity and its measurement follow in the next chapter, and in para. 66 we have the limitations given which are to be taken into account when a capacity test is used to check the more usual tests for localisation of a break; and in para. 69 there is a neat explanation of the theory on which these limitations are based. In Figs. 30 and 30A the batteries should be shown reversed, to agree with the letterpress.

In the chapter on battery tests the theorem usually attributed to Pollard is fully enunciated, but for what purpose is not made clear. It only leads to confusion to state that "the effect of joining a wire across the terminals of a battery is to reduce both its E.M.F. and resistance," or, indeed, to speak of such a wire as a shunt when it is really in series with the battery. In fact, the E.M.F. of the battery and its resistance remain unchanged and only the potential difference varies, and that according to the amount of resistance through which the battery is circuited, and this is quite sufficient to deal with the tests given, and to derive the necessary formulæ, as for instance that in para. 81.

In the measurement of galvanometer resistances is to be noticed a convenient way of reducing the current through a galvanometer when making the test on the bridge, by means of which a very high resistance is not necessary. Corrections for temperature follow, in which on page 96 it is shown that it is not reliable, although usually done, to calculate the insulation resistance of a cable at 75°F. from that observed when the cable is laid, taking the mean temperature of the sea as that deduced from the measurement of the copper resistance. We then come to Part II. on the Localisation of Faults, giving full details of the best and latest methods, such as Kennelly's, the loop, the earth overlap, Blavier, &c. In these chapters many most valuable practical hints are given, and the numerical examples of each test are taken from the authors' note-books of figures actually obtained by them when engaged in localising faults and breaks and repairing cables. The book concludes with a chapter on the measurement of the resistance of an earth, useful alike for cable, landline, telephone or lightning conductor work.

Amongst the appendices are diagrams of the connections of signalling instruments, or rather of signalling circuits, including duplex and human relay simplex and duplex, which will be found of great use to cable men.

There is no doubt that the authors have produced a most useful practical book, which will well repay the careful study of cable men and those contemplating entering the service.

H. D. Wilkinson.

Die Elektrischen Beleuchtungs-Anlagen mit besonderer Berücksichtigung ihrer praktischen Ausführung. By Dr. A. R. Von Urbanitzky. (Vienna, Budapest, and Leipzig: A. Hartleben, 1898.)

This work of 234 pages, which forms the eleventh volume of the "Elektrotechnische Bibliothek," deals very fully with all that appertains to electric lighting from central stations, the wiring of houses, &c., but the subject of mains and the methods of laying them is not included within its scope. The subject-matter is classified under convenient headings and sub-headings in the usual careful manner to which we are accustomed in German technical books, and the 113 illustrations are excellent. A perusal of the work, however, does not lead one to believe that it would be of much practical value to the average English student, as the conditions prevailing in Germany appear to be so different to those under which electric lighting work is carried out in this country. But an electrical engineer desirous of knowing something of the methods and apparatus used in German electric lighting will find the book repay perusal, and he may possibly imbibe some fresh ideas from it.

The author commences with a consideration of the factors which have to be borne in mind when planning a central station, and justly contends that as the economic is the most important, no general rule can be laid down, and no source of power can be considered the most suitable, though, as a rule, steam power will be found to be so, since water power is only available in a few localities, and even then the cost of the works which may be necessary before it can be made available may render water more expensive than steam. The motive power having been decided on, the next question which

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arises is the form in which it shall be utilised, and here questions of space, and the conditions under which the station will have to supply current will have to be taken into account, and the economic problem becomes so much the more complex. On board ship, for instance, space is usually the most important factor. The area to be supplied with the current, and the nature of the demand for it, will usually decide whether the dynamos to be installed shall be of the direct or of the alternating type, and whether accumulators shall be employed or not. The arrangement of the plant is next dealt with, and the methods of distributing the current. Then follows a chapter describing very fully the leading types of arc and incandescent lamps, and their relative merits for different purposes of lighting, together with some of the theoretical considerations involved in arranging them so as to obtain the best illumination. A chapter is devoted to the wiring of houses, and from this it would appear that it is a common practice in Germany to have the electric light leads visible, so that in what the author terms "elegant apartments" decorative leads and fittings are recommended for employment. The book concludes with a chapter on measuring instruments, resistances and switches, &c.

PURIFICATION OF THE ELECTROLYTE IN COPPER REFINING.

Much mystery has been made concerning the methods for the purification of the electrolytes which are used in modern copper refineries. The common assumption by copper refiners of possessing esoteric information is partly responsible for this, but a larger and more permanent cause is the very variable character of the material refined. It is evident that the soluble impurities derived from the crude copper anodes, which eventually find their way into the electrolyte and there accumulate, will differ according to the nature and amount of the minor constituents of the crude copper; thus it comes about that general methods, based on single examples, are likely to be inapplicable in the same degree and for the same reason as many published analyses of anode sludge, fluctuating in composition with every alteration of the raw material, are misleading. It is not to be supposed that it is in any way difficult for a competent chemist to devise a satisfactory method for treating an electrolyte so as to recover whatever constituents are worth retrieving, to eliminate those which are worthless or noxious, and to restore the solution to a working condition, but it is nevertheless useful to have recorded the details of such methods as have been approved by practice. Therefore in this article we have translated from the German the essential portions of a paper by Titus Ulke, which appeared in a recent number of the *Zeitschrift für Elektro hemie*, and have made such critical comments on the statements there set forth as seemed necessary.

In the first place the systematic control of the composition of an electrolyte for copper refining is requisite, both in order to avoid the deposition of foreign metals at the cathode whereby the quality of the copper would be impaired, and also to maintain the strength of the electrolyte at its proper point. The copper content of the electrolyte tends to increase, because the copper at the anode dissolves rather more quickly than it would if its rate of dissolution were strictly proportional to the current. This is due to the fact that copper exposed to the joint action of air and sulphuric acid slowly dissolves, irrespective of its function as an anode; copper containing oxide will, of course, dissolve faster than the metal free from this body and dependent for its oxidation on the presence of atmospheric oxygen. The proportion of copper thus dissolved to the quantity of copper dissolved electrolytically will be greater the smaller the current-density and the more vigorous the circulation and consequent aëration of the electrolyte. Spontaneous evaporation—not to be neglected when the electrolyte is used slightly warm; *e.g.*, at 30°C. to 40°C. = 86°F. to 104°F.—also tends to increase the concentration of the electrolyte, and thus from these several causes it comes about that there is a continual tendency for the quantity of copper sulphate in the tanks to augment, until an elimination of a portion of it is a necessity. It is evident from this that the purification of the electrolyte should be accompanied by a withdrawal of a portion of its main constituent, copper sulphate.

At the great copper refinery of the Baltimore Copper Company, a definite portion (about one-fifth) of the electrolyte is removed from time to time to be worked up for copper sulphate, and a suitable (but not necessarily equal) amount of pure copper sulphate solution is added so that the content of the electrolyte in impurities is diminished, and, at the same time, the strength of the electrolyte in copper sulphate is adjusted to its normal value. The importance of this regulaiation lies in the fact that in a large refinery containing a multitude of small units of plant, it is essential for smooth working that the conditions of current-density, resistance of solution and the like should be maintained as nearly uniform as possible. It is for this reason that any process of purification which would regenerate the electrolyte continuously instead of periodically would present many advantages.

Using this method, the Baltimore Copper Company produce a considerable quantity of copper sulphate, which is sold with profit to the Western Union Telegraph Company. The final liquors are precipitated with iron scrap to recover the last portion of copper, amounting to 2 to 8 per cent.

A similar system is in use at the Balbach Works, Newark (U.S.A.), where a portion of the electrolyte is concentrated for the recovery of the sulphates of copper, iron and nickel, and the mother liquor is finally boiled down in order to obtain arsenious acid and sulphuric acid. This description is decidedly vague. An ordinary copper electrolyte is not likely to contain nickel in quantity sufficient to allow of its recovery as sulphate, for although it is true that nickel is a constant concomitant of commercial copper, yet it is also true that it is usually present in quantities not exceeding 0·2 to 0·3 per cent. Further, the recovery of the sulphuric acid by any practicable boiling down process is sufficiently dubious. The natural extension of the idea of the precipitation of the copper by means of iron to the recovery of the whole of the copper by this means, has not led to any valuable result. The precipitated copper is comparatively impure, and the ultimate product, ferrous sulphate, is of very small market value.

At the works of Guggenheim Bros., Perth Amboy, a process is in use approaching the ideal already set forth of a continuous purification of the electrolyte. The method is a modification of that due to K. and H. Borchers, in which the liquid of each individual tank is circulated and at the same time aërated by a jet of air at a pressure of 3 or 4lb. per sq. in. blown into a vertical tube open at the top and bottom to allow the electrolyte to enter below and to be ejected above, impelled thereto by the effective alteration of head produced by the injected air. The electrolyte, clarified from its impurities, is little liable to deposit foreign matter on the cathodes; such mechanical contamination, due merely to the use of a turbid electrolyte, and in no way connected with the electrolytic separation of metals other than copper at the cathode, may be highly injurious to the quality of the copper ultimately obtained, and should be strenuously avoided. When the Borchers process was first described extravagant eulogy was bestowed on it. In particular it was said to cause the elimination of iron and arsenic from the electrolyte, and to remove all necessity for circulation of the electrolyte from vat to vat in the usual manner. These claims cannot be admitted, but nevertheless aëration and internal circulation of the electrolyte of each vat are useful, and yield excellent results when supplemented by occasional circulation of the liquid from tank to tank. In spite of this continuous partial purification the electrolyte at Perth Amboy needs periodical replacement. The liquor is run into lead-lined vats, and boiled with scrap copper with free access of air, so that the copper may be dissolved, the free acid neutralised, and the solution so enriched in copper sulphate that it can be readily crystallised to yield this salt. The copper sulphate is deposited on lead strips hung across the crystallising tank. The mother liquor contains almost the whole of the antimony and arsenic, together with a small quantity of copper. The latter is precipitated by iron plates,

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on which the arsenic is also deposited as soon as the copper has been thrown down. Ultimately a black precipitate, containing as much as 60 per cent. of arsenic is obtained. This may be worked up either for crude copper or for the production of arsenic compounds, such as Scheele's green, Paris green and white arsenic. In the Chicago Copper Refinery the bulk of the copper sulphate is recovered by crystallisation, and the mother liquor is boiled down to a point at which both copper sulphate and arsenious acid crystallise out. The mixture is extracted with just enough water to dissolve the copper sulphate, which, being thus fairly freed from arsenic, is returned to the vats.

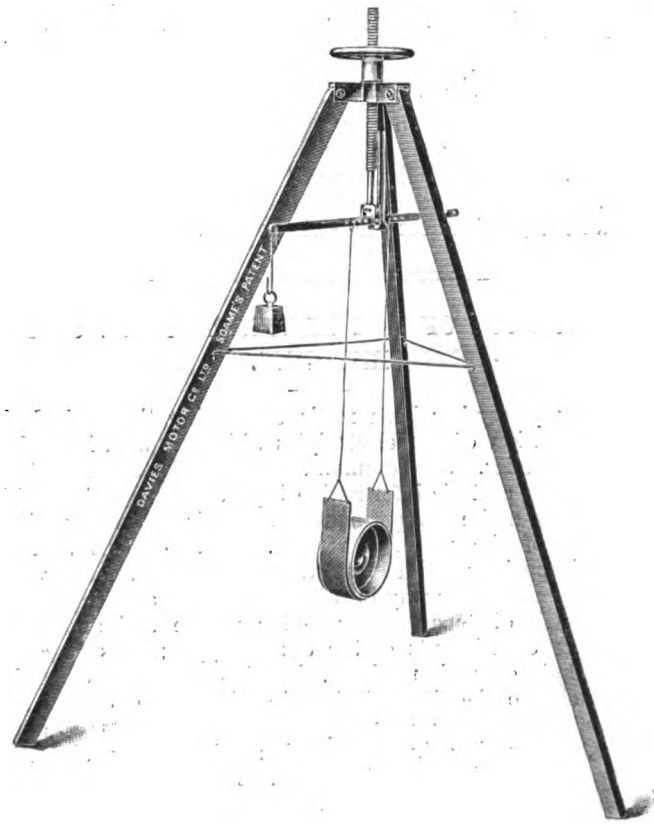
In the foregoing cases a part or the whole of the electrolyte is worked up for copper sulphate, and this purified, recovered salt is returned to the process. Other methods have been proposed for the direct elimination of the chief impurities in the electrolyte, and its restoration to a proper working condition without recourse to crystallisation of the whole quantity of copper sulphate. These include boiling the liquor with metastannic acid to precipitate arsenic, filtration of the liquor through a layer of cuprous oxide, which is a base strong enough to precipitate most foreign metals as hydroxides, and oxidation of some of the impurities, notably iron, by aëration, and consequent precipitation of certain other impurities, *e.g.*, arsenic as ferric arseniate. All these methods singly and conjointly have met with very poor success. Purification by means of tin added to the copper before it is cast into anodes, in the proportion of 2·5lb. per ton (say, 0·1 per cent.), has also proved of only moderate utility. When the copper is very arsenical the tin in dissolving appears to retain the arsenic in the anode sludge, when it is less objectionable than in solution in the electrolyte; the presence of tin in the anode also makes the deposited copper smooth. These advantages, however, are not sufficient to make the application of the process generally remunerative.

One of the best methods of purification consists in electrolysing the liquors from the depositing vats with a current-density so high that all impurities save iron are deposited pell-mell with the copper. The operation is carried out in purifying tanks, of which a set of 12 is allotted to about 280 depositing vats. The cathodes in the purifying tanks are of sheet copper, and the anodes are of lead. The process needs a somewhat large expenditure of current, and produces a good deal of impure copper; but it has the advantage that the copper is recovered as metal, which, though impure, is often more saleable than is copper sulphate. The electrolyte, purified as regards arsenic and antimony, impoverished in copper, and still containing iron in solution, is brought up to strength with fresh copper sulphate, and returned to the depositing vats, its purification and return being repeated until the iron accumulates to an inconvenient extent, when the liquor is finally worked up for copper sulphate.

The variety of these methods makes it abundantly evident that there is no "best" or even standard process of purifying copper electrolytes, and that the merits of every suggested procedure must be considered not only from a chemical and technical point of view, but also with regard to local demands for bye-products, such as blue vitriol and crude copper, and to local abundance of supplies of raw materials, such as sulphuric acid, scrap copper, and the like. A process torn up by the roots, and transplanted to a distant site with different local conditions, is not likely to prosper.

A MOTOR-TESTING BRAKE.

The accompanying illustration shows a handy form of Prony brake, suitable for taking the brake-horse-power of small motors. It is of simple construction, and consists of a steel lever working on knife edges, which can be raised or lowered by the hand wheel at the top of the brake. Holes are drilled in the lever at equal distances from the centre, corresponding to the ordinary sizes of pulley in use. The centre of the brake is placed over the centre of the pulley, and from the two holes corresponding to the diameter of the pulley under test is suspended a piece of webbing, which passes round the pulley. When the pulley is running, a weight, say, from ¼lb. to 30lb. is suspended on the end of the arm as shown. The whole is then raised by turning the hand wheel, tightening the belt on the pulley until sufficient friction is put on the belt to raise the arm to a horizontal position and keep it floating there; the speed of the pulley being taken at the same time. A constant is given with the brake which, multiplied by the speed and the weight, gives horse-power direct. The size of the pulley does not enter into the equation so long as the distance between the holes in the arm is equal to its diameter. No lubricant is generally



required, but it is advantageous sometimes to use a little black-lead. The brake, as shown, is made by the Davies Motor Company.

ELECTRIC POWER IN GRAIN ELEVATORS.

An interesting application of electric power is to be found at the recently-built "Great Northern" elevator in Buffalo. This elevator is the highest yet built of the huge structures familiarly known in the United States and Canada as "grain elevators." The example set by the employment of electric power in this instance should have a cheerful significance to the Niagara Falls Power Company, as there are numerous great grain-storage structures within reach of the Ohio-street transformer station of the Cataract Power and Conduit Company, who act as the distributing agents for Niagara power in Buffalo.

The "Great Northern" elevator stands adjacent to the Blackwell canal; it is 396ft. long by 150ft. wide, and has a height of 177ft. The materials used in its construction are exclusively stone, steel, and brick, so as to render the building fireproof. Its foundations rest on piles driven down to the solid rock about 40ft. below the water-line. The storage capacity of the elevator is about 3,000,000 bushels, and is provided for by large cylindrical steel bins. Thirty of these are each 39ft. in diameter, 85ft. high, and have a capacity of 80,000 bushels. There are also 18 that are 15ft. 6in. in diameter, 85ft. high, with a capacity of 18,000 bushels each, besides which there are 18 small shipping tanks, 9ft. 9in. in diameter, and about 60ft. high. The steel used in the construction of the bins

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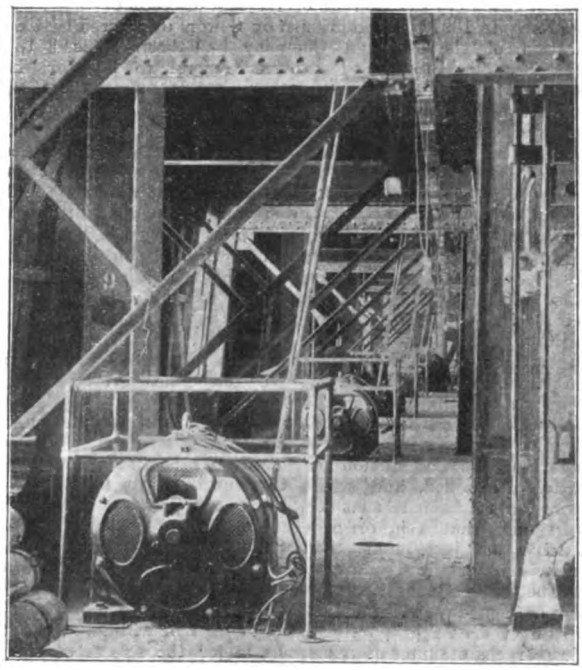
varies from ¼in. to ½in. in thickness. The roof is of corrugated iron. From the east end of the ground floor an electric passenger elevator, run by a 10 H.P. motor, communicates with the scale floor, while from the west end of the floor a spiral stairway of steel leads to the upper floors. In the north-west corner of the ground floor the electrical equipment is installed. In the centre of this floor there is a 50 H.P. motor, which operates a cable passing under the building and out into the yards, for the purpose of facilitating car-shunting and traversing the "marine towers" on the side of the canal. The same motor gives power to dust-collector fans, the dust-collector and sweeping arrangements of the elevator being very complete.

The main part of the elevator is equipped inside with 10 grain elevator legs, which are about 177ft. high, and carry two rows of buckets, and are capable of handling about 15,000 bushels of grain per hour. Each leg is provided with a hopper and scales, which weigh the grain before it goes into storage.

The motors for operating the legs are placed in a row on the south side of the floor over the bins. They drive on to speed-reducing gears in the top of the cupola or roof by means of rope-drives. The illustration gives a view of these motors. A 100-H.P. motor is also installed in this line of motors near



Polyphase Motors in a Grain Elevator at Buffalo.

the middle, and is used for operating fans and dust collectors. There are two conveyor-belts in use in this grain elevator, said to be the largest belts of the kind; they are each 60in. wide, and about 740ft. long. The motors operating them, standing at the west end of the building, are two in number, reversible, and of 20 H.P. each. The belts are provided with Robinson's patent reversible, self-moving trippers. Their capacity is about 40,000 bushels per hour each.

The elevator fronts on the Blackwell canal, the dock between being 24ft. wide. There are two railway tracks of the standard gauge, on which are operated three steel "marine towers," each having a marine leg or arm capable of elevating about 20,000 bushels of grain per hour. Each elevator tower is provided with a 100 H.P. motor supplied with two-phase current from three "trolley" wires running the entire length of the outside of the building at a height of about 40ft. from the ground. Shoes are used instead of trolley wheels to collect the current. These elevator towers are moved back and forth along the dock at will on the same principle as cars on a cable line, by means of the wire rope already referred to. As is well known, the power developed by the Niagara Power Company is transmitted to Buffalo at 11,000 volts. For distribution in Buffalo it is transformed down at the transformer station in Ohio-street to about 2,200 volts. At this pressure the power is supplied to the Great Northern elevator. Two transformers, each of a capacity of 600 H.P., are installed in the elevator, and these step down the pressure again to 440 volts.

Four cables, each having a section of 0·7854 sq. in., run from the transformers to the switchboard. The latter is of white marble, and has nine panels. Two of the motors are controlled from the switchboard. All the motors are of the Westinghouse two-phase induction type, six pole 440 volts, and run at 500 revolutions per minute.

For the particulars of this interesting plant we are indebted to Mr. Orrin Dunlap, of Niagara Falls.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Jan. 28, 1898.*

The Synchronograph Tests on the British Telegraph Lines.—Messrs. Crehore and Squier, on the evening of January 19th, read a Paper before the Franklin Institute at Philadelphia relating to the tests of the synchronograph on the telegraph lines of the British Government. These gentlemen have submitted a report of these tests to the Postmaster-General of the United States, and the Paper was based on that report. The tests were made over routes of varying lengths from the General Post Office, London, where both transmitters and receivers were located. The longest loop tried was 1,097 miles—from London to Glasgow and back by different routes. It was found in the course of the trials with the different apparatus that it was possible to operate the Wheatstone receiver without alteration by the synchronograph transmitter, and a test was made over the longest line to compare the efficiency of the two transmitters when operating the same receiver under identical line conditions. The surprising result was discovered that the synchronograph would operate a Wheatstone receiver approximately three times as fast as the Wheatstone transmitter on any line, provided the mechanical limit of the receiver is not already reached. One of the most important results of the trials has been to emphasise the probability that the sine wave possesses superiority over other forms of wave for any speed, slow or fast. One of the reasons for going to England, the authors stated, was to become conversant with the method of conducting the telegraph and telephone business in conjunction with the general postal service in a country where these three departments are under the control of the Government. The Paper described the various experiments in detail, and forms an interesting, if not valuable, contribution to the literature of this subject.

Power Transmission Plant in British Columbia.—The plant of the West Kootenai Electric Light and Power Company, for the transmission of electric power from Kootenai Falls to the town of Rossland, B.C., is now nearing completion, and it is expected that electrical energy will be transmitted over the lines not later than February 1st. The power-house is located about eight miles from Nelson, on the Kootenai River. Water is conducted to the reservoir from the river by a canal-way 22ft. deep, cut out of solid rock for a distance of 640ft. The dam is 32ft. high. From the fore-bay water is carried to the turbine wheels by three steel penstocks, two of 9ft. diameter and a third 10ft. There are two twin horizontal-type water wheels, each of which will develop 1,250 H.P. The turbines are directly connected to the generators. The gates for regulating the water supply are electrically governed. The generators have been purchased from the Canadian General Electric Company, and are of the three-phase revolving field type, giving a voltage of 1,040 when operating at 180 revolutions per minute. The exciters for these generators are operated by two special turbine wheels. The initial pressure will be raised by means of step-up transformers from 1,040 to 20,000 volts. The high pressure is conducted to the sub-station at Rossland over a three-wire line 31 miles long. At

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Rossland a distributing switchboard and a series of transformers reduce the pressure from 20,000 to 2,080 volts. From the sub-station electric power will be conducted to the various mines, which will utilise alternating-current motors for their driving power.

Electric Cars on the Brooklyn Bridge.—After many trials and tribulations electric cars have commenced to run over the Brooklyn Bridge. The loop at the New York end connecting the tracks on both sides of the bridge is not quite completed, but the work is sufficiently advanced to permit the passage of a limited number of cars. The work of widening the roadway at this end of the structure is being carried forward as rapidly as possible, and when it is completed regular service on the trolley lines will be commenced. This line will be a very great convenience to people living in Brooklyn, as it will be possible for a great many of them to board a car at or near their front doors and be transported direct to New York, whereas now a break in the continuity of the trip is necessary at the Brooklyn end of the bridge. During the evening hours, when the rush is in the other direction, the residents of Brooklyn will find it equally convenient to be taken right to their homes without the objectionable transfer of cars under the present system.

CORRESPONDENCE.

SYNCHRONISING ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. Kensit's notes on "Synchronising Alternators" in *The Electrician* last week the following sentence occurs:—"Usually the load on any machine can be adjusted by varying the excitation only." Would Mr. Kensit be good enough to explain how the engine gets the extra amount of steam to do the increased work demanded from it—say by increasing the excitation of the alternator? I do not know of any mechanical governor that will alter the steam supply to an engine without a change in its velocity; this being the case, since the alternator cannot alter its angular velocity relatively to the others and keep in phase at the same time, how does the engine obtain the extra steam necessary to meet the increased load? If Mr. Kensit during his extended experience with alternators has discovered a governor that will act in this way, I am sure a description of it would prove very interesting.—Yours, &c.,

Feb. 8, 1898. H. H. N.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I see that in copying out my article "Notes on Synchronising Alternators," which appeared in *The Electrician* last week, I have, by the omission of a sentence, quite altered the sense in one place. In the part referring to Fig. 3, on page 148, line 18, after the words, "Then run up No. 2 alternator to speed," it should read: "Withdraw No. 2 fuses and insert the 'bus plug." I trust, however, that what was intended is too obvious to have led to any misapplication. It is, of course, necessary to have No. 2 up to speed for the second part of the experiment, though this might be deferred until the first part had been carried out.—Yours, &c.,

Feb. 8, 1898. H. E. M. KENSIT.

LEGAL INTELLIGENCE.

The Telephone Service of the City of London.

Mr. Justice Wright, Sir F. Peel, and Viscount Cobham, sitting as the Railway and Canal Commissioners, at the Royal Courts of Justice, yesterday (Thursday), heard and decided the important question which has arisen between the Postmaster General and the authorities of the City of London, regarding the use of the underground channels for the telephone service of the metropolis. The Solicitor General (Sir R. Finlay, Q.C.) and Mr. Cassely appeared for the Postmaster General: Mr. Cripps, Q.C., and Mr. C. Lyttelton Chubb represented the Corporation.

Under the Telegraph Acts, 1863 to 1892, it was urged for the City authorities that the now deceased Commission of Sewers had power to grant or to withhold their consent to the placing and maintaining by the Postmaster-General of telegraph lines under the street of the City. The Postmaster-General in July, 1897, required the consent of the Commissioners to the placing and maintaining of a line or lines of underground telegraphs in Newgate-street, St. Martin's-le-Grand, Cheapside, St. Paul's Churchyard, Queen-street, Old Change, Knightrider-street, Lambeth-hill, and Queen Victoria-street, and under such other streets as lay on the route and between the respective points or places. The Commissioners of Sewers attached to their consent the notice that the line or lines of telegraphs should not be "laid for the use of the National Telephone Company, unless the Telephone Company were prepared to provide an improved service at a reduced cost." The Postmaster-General objected to the condition, and the matter was brought before Mr. Commissioner Kerr, who, as reported in *The Electrician* for December 3, decided that the condition ought not to be attached to the consent of the Commissioners, and he ordered that the Postmaster-General should be at liberty to place and maintain the line or lines of underground telegraphs as described. The Commissioners gave notice to the Postmaster-General that they were dissatisfied with the award and required that the difference should be referred to the Railway Commissioners in accordance with Sec. 4 of the Telegraph Act, 1878. The Postmaster-General submitted that the Commissioners of Sewers had no valid and sufficient ground for being dissatisfied with the award; that the condition attached by the Commission of Sewers to their consent was unreasonable and improper; that the order of Mr. Commissioner Kerr was reasonable and just; and that it was right and proper that the underground telegraphs should be placed and maintained as required. This was the matter which the Railway and Canal Commissioners were now asked to decide.

Mr. CRIPPS, Q.C., for the City of London Authorities, stated that about the month of April, 1896, the National Telephone Company, a trading concern, incorporated under the Companies' Act of 1862, and carrying on the business of a telephone company for the profit of its shareholders, applied to the Commission of Sewers for permission to place pipes and wires in use in their business under certain streets in the City of London, and the Commission of Sewers in the exercise of its legal discretion refused their consent. Early in 1897 the Commission of Sewers discovered that when the application of the National Company had been refused the Company had applied to the Postmaster-General to lay for them the pipes and wires which they desired to lay, and that the Postmaster-General in response did, in fact, lay certain pipes and wires, and, without the knowledge of the Commissioners of Sewers, made them over to the use of the National Company upon certain terms. When applying to the Commission of Sewers to be allowed to lay the pipes and wires the Postmaster-General did not disclose to them that they were intended for the National Company, or were, in fact, intended to be used otherwise than by the Postmaster-General in connection with the Post Office for the purposes of the public telegraph service. Upon discovering that these pipes and wires had been laid by the Postmaster General for the use of the National Company, the Commission of Sewers gave notice to the Postmaster-General that they had refused to consent to the Company's laying pipes and wires under the streets, in consequence of the refusal of the Company to make any concessions for the public benefit, either by providing an improved telephone service, or reducing its charges, and also that the Commission of Sewers objected to the pipes and wires being laid down by the Postmaster-General for the use of the National Company without their consent. It was under these circumstances that the Commission of Sewers attached to their consent the condition mentioned, and which they now sought to maintain. The Corporation contended that this condition was a reasonable and proper one, that the order of Mr. Commissioner Kerr was not reasonable or just, and that it was not in accordance with the provisions of the Telegraph Act, 1863, that the Postmaster-General should be at liberty to lay lines of underground telegraphs for the use of a private company without the consent of the public body which had power under the Telegraph Act, 1863, to give or withhold consent to the placing or maintaining of telegraphs under the streets of the City of London

For the Postmaster-General the allegations of the Corporation were controverted, and he contended that, even if the facts had been as stated, the condition attached by the Commission of Sewers to their consent would have been unreasonable and improper.

Mr. CRIPPS, continuing, said the really important point between the parties was this—that the Postmaster General was seeking to lay down wires for the National Telephone Company, and to lay them down as under the rights of the Postmaster General, in that way getting into his hands a right of control which the Corporation would have otherwise exercised towards the National Company as a private company. The question was a purely legal one, of course, and turned upon the construction of certain Acts of Parliament and also upon a Treasury Minute which fixed the relationship between the Postmaster General and the Telephone Company. But he did not think that a Treasury Minute could in any way effect the rights of the parties under the Acts of Parliament. It was not a question of legislative agreement; it was merely an arrangement entered into between the Postmaster General and the National Telephone Company. So far as the third party was concerned, the Treasury Minute did not in any way affect the position of the Corporation. The Minute referred to set forth that an arrangement between the Postmaster General and the National Company was necessary in the interest of the public telephone service. By the agreement the postal authorities were to lay wires at an agreed rate, but he (Mr. Cripps) repeated that the legislative rights of third parties could not be affected by any such arrangement. The Postmaster General was not entitled to lay down wires for the benefit of a private company.

The PRESIDENT asked whether the Postmaster General did any telephone work.

The SOLICITOR GENERAL said the Postmaster General had the monopoly, and that the National Telephone Company held a licence from

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him to carry on their business. The Postmaster General laid the trunk lines, and the main Exchange of the Telephone Company was connected with them. It had been found that it led to complications to transmit local (London) messages and country messages at the one Exchange, and the object of laying the additional wires was to provide a readier means of communication with towns in the country.

The PRESIDENT: Is there any other telephone company working in London?

Mr. CRIPPS: No, I do not think there is.

The PRESIDENT: Does the Postmaster-General receive any telephonic message from the office of any member of the public?

The SOLICITOR-GENERAL said telephonic messages were received and forwarded to the exchange desired by subscribers, and in this way a large telephonic business was done by the Post Office.

Mr. CRIPPS pointed out that the National Company retained its own business entirely. Of course it was agreed that it was of great advantage to have better communication between the local exchanges and the trunk lines; but the Postmaster-General had laid down these particular wires for the benefit of a private company, to whom, under an agreement, he had given up his monopoly rights as regarded telephonic communication.

The PRESIDENT asked whether the Postmaster-General could establish call offices outside London.

The SOLICITOR-GENERAL replied that under his monopoly the Postmaster-General could establish as many as he chose, either in London or elsewhere.

The PRESIDENT then referred to the "Postal Guide," and said that a private person could apparently ask the Postmaster-General to lay down a wire for his use.

Mr. CRIPPS said the important distinction in this case was that it was a private company, working for profit, for whom the wires had been laid. The Corporation had no desire to interfere with any right of the Postmaster-General to promote the public telephone service, but there had been a feeling in the City that the Telephone Company had not done its duty, and they had, therefore, exercised their right to withold their assent to the roads being broken up, their object being to secure an improved telephone service; and he submitted that the Postmaster-General had no greater rights in this direction than were possessed by the Corporation.

The SOLICITOR-GENERAL contended that the condition which the Corporation had annexed to their consent was unreasonable. The trunk lines had been acquired by the Postmaster-General under the monopoly created by the Telegraphs Act, and local work was done by licencees under him, subject to his right to undertake those local services if he thought fit. It would be a waste of public money to acquire these trunk lines if they were not to be put in communication with local branches. He need hardly say that the greater part of the communication over the trunk lines would not be by persons going to the Post Office for the purpose of speaking over the trunk lines, but by persons having access to the local offices established by companies for local purposes. A subscriber had a wire at his office, and communicated through the exchanges of the Telephone Company with a subscriber who also had a wire. That communication was conducted over the whole system of trunk lines or exchanges, and the Post Office and the National Company could not be split up for the purpose of dealing with the latter only. The local offices were worked under licence from the Postmaster-General, and the whole was one working system as contemplated under the Act of 1892, when the trunk lines were acquired by the Post Office. As the laying of the lines involved the breaking of the streets, the Postmaster General had to get the consent of the road authority, and it was only in that capacity that the Corporation had any jurisdiction at all. The position which they were endeavouring to assume in this instance was absurd, for in their letter they objected to the wires being laid unless the Telephone Company were prepared to provide an improved service at a reduced cost, in accordance with the evidence given before a Select Committee of the House of Commons in 1896! That Committee had not reported to the House, and the Corporation were asserting a right to take into their own hands the enforcement of what they considered the effect of the evidence given before the Select Committee, and to determine the reasonableness of the charges and conditions under which the telephone service was to be carried on. The condition which the Corporation had attached to their consent was quite beyond their authority.

The PRESIDENT gave the decision of the Court. He said the Corporation of London had not raised their objection in any captious or unfriendly spirit, but had brought it forward as the supreme road authority to see, as far as they could, whether companies using the public streets for private purposes should be made to supply the public on reasonable terms. In seeking to attain that object they had exceeded the powers conceded to them by the terms of legislation. Their objection was not of a class which street authorities should be enabled to raise. Their objections should be such as concerned them as the road authority. Here the objection did not concern them, and was clearly an unreasonable one. To dictate that the Postmaster General should not allow a Company to use the junctions with the trunk wires, in order that they might be brought to grant an improved service to the public was going far beyond any objection the Corporation could legally raise, and was one which must not be sanctioned by the Court.

Judgment was then given for the Postmaster General without costs, the President stating that there was no costs in that Court, save where it was considered that something had been promoted or resisted in a vexatious spirit.

House-to-House Electric Light Supply Company.

A petition for the reduction of the capital of this Company was sanctioned by Mr. Justice Romer in the Chancery Division. The Company was formed in 1868, with an original capital of £350,000, which had been reduced to £200,000. Amongst the shares issued by the Company were 100 Founders' shares which it was desired to get rid of, and the scheme of the petition was that the Founders' shares should be surrendered to the Company, and that holders should subscribe for a certain number of Ordinary and Preference shares which were part of the origina capital of the Company, leaving the capital at £199,500 instead of £200,000.

Brown v. I.E.S. Accumulator Company, Limited.

This case came before Mr. Justice Romer in the Chancery Division, on a motion for judgment in default of defence. The Company was incorporated in 1895, and the plaintiff was the holder of Debentures in respect of which the Company had made default. New and Mayne, Limited, were also made defendants. His lordship made the usual order in a Debenture holder's action.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Offic not later than first post Thursday morning. New Catalogues Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97.' A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

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"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory; Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES.' Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net, 2s. 9d. post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is now binding, and will be delivered to subscribers as quickly as possible. All copies on order should be received by the early part of next week. Many new features of interest to the profession will be introduced, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, will be brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898, and contains about 150 additional pages over last year's book.

Tenders Invited.—Portsmouth Corporation invite tenders for the supply and erection of additional Lancashire boilers, feed pumps, mechanical stokers, coal conveyor and elevator, economiser, steam, feed, condensing, water and other pipes, chequer plating, and sundry ironwork. Specifications and forms of tender can be obtained after the 14th inst. from the Superintendent of the electric light station, Gunwharf-road, Portsmouth, or at the offices of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great

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George-street, London, S.W. Further particulars appear in an advertisement elsewhere, and tenders must be sent in to the Town Clerk (Mr. Alexander Hellard), Town Hall, Portsmouth, by 4 p.m. on Tuesday, the 22nd inst.

Tenders Invited.—The Wallasey Urban District Council invite tenders for the supply of (*a*) engine, alternator and exciter; (*b*) two Lancashire boilers and one water tube boiler; and (*c*) condensing apparatus. Some further particulars appear in an advertisement elsewhere, and copies of the specifications may be obtained from the engineer (Mr. J. H. Crowther), Gas and Water Works, Great Float, near Birkenhead. Tenders, addressed to the Chairman of the Gas, Water and Electricity Committee, must be delivered at the office of the clerk to the Council (Mr. H. W. Cook), Public Office, Church-street, Egremont, Cheshire, by 4 p.m. on Thursday, March 17.

——— From our advertisement columns it will be seen that the Electric Lighting Committee of the County Borough of Salford require tenders for the supply of electric cables. Specifications, &c., may be obtained from the electrical engineer (Mr. C. Turner), Walmes-road, Broughton, and tenders (addressed to the Chairman of the Committee) must be delivered at the office of the town clerk (Mr. Samuel Brown) Town Hall, Salford, by 10 a.m. of Friday, the 18th inst.

——— Tenders are required by the Vestry of St. John, Hampstead (London), for the supply of oils, carbons, lamps, and other stores for the Vestry's electric light station. Some further particulars are given in an advertisement on another page, and forms of tender, &c., can be had of Mr. Arthur P. Johnson, Vestry Clerk, Vestry Hall, Hampstead, to whom tenders have to be sent in by 4 p.m. Wednesday, 16th inst.

——— The Vestry of St. Pancras (London) invite tenders for the supply and erection of dry-back marine boilers (11ft. diameter, 13ft. 6in. long) with superheaters and brickwork seatings. Copies of specifications, &c., may be obtained at the electricity department office, 57, Pratt-street, Camden Town, N.W. Some further particulars are given in our advertisement columns, and tenders must be sent to the Vestry Clerk, Mr. C. H. F. Barrett, Vestry Hall, St. Pancras, by noon of Tuesday, the 22nd inst.

——— The Corporation of Belfast require tenders for the wiring of the new police cells, Chichester-street. Specifications may be obtained from Mr. Victor A. H. McCowen, electrical engineer, Marquis-street, Belfast. Some further particulars appear in our advertisement columns, and tenders must be delivered at the office of the town clerk (Sir Samuel Black), City Hall, Belfast, by 10 a.m. on Wednesday, March 9.

——— The Lighting Committee of the Pembroke Township Commissioners invite tenders for the supply and erection of (*a*) Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor; (*b*) high-speed steam dynamos and accessories, oil filter, steam exhaust, feed, blow-off and sundry pipes, valves, feed water and storage tanks, &c.; (*c*) overhead travelling crane; (*d*) switchboards and instruments; (*e*) accumulators; (*f*) trenching, cables, &c.; (*g*) arc and incandescent street lamps and lamp posts; (*h*) meters. Specifications, &c., may be obtained at the offices of the consulting engineer (Mr. Robert Hammond, M.I.E.E.), Ormond House, Great Trinity Lane, London, E.C., after the 12th inst. Our advertisement columns contain further particulars, and tenders, addressed to the Secretary to the Township Commissioners (Mr. J. C. Manly), Town Hall, Ball's Bridge, Co. Dublin, must be delivered on or before Saturday, March 5th.

——— The Electrical Committee of the City and Council of Bristol invite tenders for the supply of 214 arc lamp posts. Some further particulars appear in an advertisement elsewhere, and specifications can be obtained from the City Electrical Engineer (Mr. H. Faraday Proctor), Temple Back, Bristol.

——— The Watford Urban District Council require tenders for the supply and erection of (*a*) generating plant, boilers and fittings, economiser, feed pumps, &c., alternators and exciters, &c.; (*b*) switchboard and connections; (*c*) overhead travelling crane; (*d*) conduits and mains; (*e*) public lighting, including adaptation of existing public lamps; (*f*) transformer sub-stations, switch gear, &c.; (*g*) electric lamps and posts. Plans, &c., can be obtained at the offices of Mr. W. C. C. Hawtayne, consulting engineer to the Council, Mansion House-chambers, 20, Bucklersbury, London, E.C., and tenders must be sent to Mr. H. Morton Turner, Council Offices, Watford, by noon of the 16th March.

——— The Vestry of the Parish of Hammersmith, London, will on Wednesday, Feb. 16, not later than 6.30 o'clock p.m. receive tenders for the supply of general stores for the electricity works, for a period of 12 months ending March 25, 1899. The specification, &c., can be had on application to Mr. G. Gilbert Bell, resident engineer, 57, Fulham Palace-road, Hammersmith, and tenders have to be sent in to Mr. W. P. Cockburn, vestry clerk, Town Hall, Broadway, Hammersmith.

Tenders Invited.—The Carlisle Corporation invite tenders for the erection of an electricity supply station building. Tenders to the City Engineer and Surveyor by 10 a.m. on 25th inst.

——— The Redditch Urban Council invite tenders for gas-producing plant for 230 H.P.; double-cylinder gas engines, total power 350 H.P.; alternators, total output 230 kilowatts; concentric lead-sheathed armoured cables; ten 20-kilowatt alternating current transformers; switchboard and instruments; counter-shaft, pulleys, ropes and belts. Tenders must be sent to the clerks to the Council (Messrs. Browning and Hobson) by Feb. 14.

——— The Corporation of St. Helens invite tenders for plant, &c., in connection with the supply of electricity for traction purposes. Tenders to Mr. W. J. Jeeves, town clerk, Town Hall, St. Helens, by Feb. 21.

——— The Vestry of St. Mary, Islington, require tenders for electrical and engineers' stores, &c. Tenders to the Clerk, Vestry Hall, Upper-street, Islington, N., by the 24th inst.

——— The Weaver Navigation Trustees invite tenders for the construction and erection of electric power plant for lighting and working the new swing bridges at Northwich, current being supplied by the Northwich Electric Supply Company. Tenders to the Clerk, Weaver Navigation Office, Northwich, by March 5.

——— The Ryhope and Silksworth Industrial and Provident Society (Limited) invite tenders for the supply of a battery of accumulators, &c. Tenders to the Committee, Ryhope Colliery, by 6 p.m., 11th inst.

——— Tenders are invited by the Municipal Authorities of Segorbe (Castellon), Spain, for the concession for the electric lighting of the streets for 5 years. Particulars from, and tenders to, El Secretario del Ayuntamiento de Segorbe (Castellon), by the 25th inst.

——— The Italian Naval Authorities of Spezia invite tenders until the 16th inst. for the supply of a number of 100 c.p., 25 c.p., 16 c.p., and 12 c.p. incandescent lamps. Particulars from, and tenders to, La Direz. Torpedini e Materiale Elettrico 1°dip. Marittimo, Spezia, Italy.

——— Tenders are invited until the 25th inst. by the Prussian State Railway Authorities at Erfurt, for the supply of 70,600 arc lamp carbons. Tenders to the Königliche Eisenbahn Direction (23, Bahnhofstrasse), Erfurt.

Offers Invited.—The Secretary of State for War requires offers (accompanied by competitive designs) for the supply of portable electric search-light apparatus. The offers must be sent not later than Wednesday, April 27, addressed to the Director of Army Contracts, the War Office, Pall Mall, S.W.

Tenders Accepted.—The following tenders for the supply of electric lighting plant has been accepted by the Belfast Harbour Commissioners:—

Wilson Hartnell (Leeds)—2 dynamos.
Williamson and Joseph (London)—1 switchboard and 100 isolating switches.
Charles A. Müller (Bradford)—100 arc lamps.
T. Scott Anderson (Sheffield)—100 lamp masts.
British Insulated Wire Company (Prescot)—cables and junction boxes.

——— The tender of Mr. C. A. Hemingway has been accepted for the electric light wiring of the Abbey Mansions (north block), Victoria-street, London, S.W., at £838. 12s. Eight other tenders, ranging from £910 to £1,656, were sent in. Mr. Morgan Williams, C.E., is consulting engineer for the work.

——— The tender of Messrs. Spagnoletti & Crookes has been accepted for the electric light wiring at the new warehouses of Messrs. Welch, Margetson and Co., Moor-lane, London, E.C., for the sum of £72. 12s., the lowest of five tenders. Consulting engineer, Mr. Morgan Williams, C.E.

——— The tender of Messrs. Willans and Robinson (Limited) has been accepted by the Bradford Corporation for the supply of two steam engines for their Valley-road electricity works, at £4,590. The tender of Messrs. Siemens Bros. for the supply of two dynamos at £2,800 and a spare armature at £600 has also been accepted.

——— The Bootle Corporation have accepted the tender of Messrs. Thomas Parker (Limited) for the supply of electric lighting plant for the Council's proposed electricity works. There were 24 tenders submitted, but it has been decided to give the whole of the contract for the equipment of the station to Messrs. Thomas Parker.

——— The St. Pancras (London) Vestry have accepted the tender of the Fowler-Waring Cables Company for the supply of cables and mains for the extension of the electric light to Queen's-crescent, Malden-road, and Prince of Wales's-road at £4,196. 5s. 10d.

——— The Newport Town Council have accepted the tender of Mr. C. D. Phillips, of Emlyn Works, Newport, for the supply of temporary plant for the electric lighting of Wentwood Waterworks at £305. Thirty-seven tenders were submitted.

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Tenders Accepted.—The Burnley Corporation have accepted the tender of Messrs. G. E. Belliss & Co. for the supply of two combined engines and E.C.C. dynamos, at £4,888. Contracts for the extension of the engine-house have also been let to J. Foster and Co. (iron founders' work), Owens and Co. (plumbers and glaziers' work), W. Stanworth (slaters' work), and T. S. Radcliffe (painters' work).

——— The Hull Town Council have accepted the tender of the Société Anonyme des Acieries d'Angleur for the supply of steel tramway rails at £6. 7s. per ton. The other tenders submitted were: The Johnson Company, Lorain, U.S.A., £6. 13s.; Pennsylvania Steel Company, £6. 14s. 9d.; A. and F. Mannelle (a German firm), £6. 11s. 6d.; A. Penny and Co. (Continental), £6. 14s. 10d.; Leeds Steelworks, £7. 9s.; Dick, Kerr and Co., £7. 10s.; and the Barrow Hematite Company, £8. 10s. per ton, of whom it will be seen only the three highest were British.

——— The Staffordshire County Council have accepted the tenders of Messrs. Mavor and Coulson for supplying generating plant for the electric lighting of the Cheddleton Asylum at £6,240, and of the Walsall Electrical Company for wiring and fitting the buildings at £3,195. 16s. 6d. Four tenders were submitted for the generating plant and three for the wiring and fitting, and the accepted tenders were the lowest submitted.

——— At the meeting of the Bradford Corporation on Wednesday, the tender of the Westinghouse Electric Company was accepted for the equipment of the new electric tramways between Bolton and Great Horton, at an inclusive sum of £14,664. Alderman Cowgill stated that the tender of the Westinghouse Company was the lowest, but the most important consideration with the Committee had been the wide experience and high reputation of the Company. Alderman Priestman read a letter from Messrs. Dick, Kerr and Co. protesting against the acceptance of the tender on the ground that the Westinghouse Company did not comply with a clause of the specification requiring that certain apparatus should have been manufactured by the General Electric Company of America. The difference between the tenders was only £402, and if Messrs. Dick, Kerr and Co. had known that the Committee would have considered any alteration, they could have considerably reduced their figures. The minutes were, however, adopted.

Appointment.—Mr. John Peel Nelson, A.I.E.E., of Chelmsford, has been appointed Electrical Engineer to the Municipal Council of Shanghai.

Appointments Vacant.—The Crown Agents for the Colonies invite applications for the position of Electrical Engineer for the working of an electric lighting plant in Lagos, West Coast of Africa. Salary £25 per month, and the appointment will be for six months. Our advertisement columns contain further particulars, and applications will be received by the Crown Agents for the Colonies, Downing-street, Westminster, S.W., up to the 15th inst.

——— The Corporation of Birkenhead invite applications for the position of resident electrical engineer. Salary £300 per annum. Further particulars are given in an advertisement elsewhere, and applications must be sent in to the town clerk (Mr. Alfred Gill), Town Hall, Birkenhead, by Friday, the 18st inst.

Vacancy.—An engineer is wanted by the Oxford Electric Company to take charge of a shift in central station. See advertisement elsewhere.

New Works.—The Mica Insulation Company are establishing a factory at Stanstead, Herts.

Obituary.—Mr. Hugh M. Mathieson, of the firm of Messrs. Mathieson and Co., of Lombard-street, London, a gentleman who took a considerable interest in matters electrical, expired on Tuesday last. He was a Director of the Electrical Copper Company (Limited), and Chairman of the Rio Tinto Company.

Business Notices.—Messrs. H. M. Brigg, B.A., and R. C. Graham Clark, A.I.E.E., have recently commenced business as electrical engineers at Johannesburg, and ask that manufacturers' price lists may be sent to them, addressed P.O., Box 758, Johannesburg, S.A.R.

——— Messrs. Pritchett and Gold have transferred their accumulator manufacturing business to the new works at Feltham, Middlesex, to which address all communications in connection with Pritchett accumulators and accessories should be addressed. The firm's electrical engineering and contracting business continues to be transacted at 31, Soho-square, London, W.C.

——— Mr. T. Scott Anderson, M.I.E.E., desires us to notify that his consulting engineering practice is carried on separately from the new firm of Scott Anderson and Beit. Mr. Anderson is reporting to the District Council of Kilnhurst upon the proposed lighting of the district electrically.

——— The firm of Ubach Hermanos y Campdera, consulting and contracting electrical engineers, has been recently constituted at Barcelona.

Dissolutions of Partnership.—Messrs. Gilbert James Lloyd, Richard Francis Read, and Arthur Alan Jenkins, electrical and mechanical engineers, All Saints' Chambers, High-street, Bristol (trading as Lloyd, Read and Jenkins), have dissolved partnership. Mr. G. J. Lloyd will carry on business under the style of Lloyd and Co. Messrs. Read and Jenkins will carry on business in partnership. Messrs. Gilbert James Lloyd and Richard Francis Read (trading as Lloyd and Read, electrical and mechanical engineers, at 63, Broad-street, Bristol), have also dissolved partnership.

——— Messrs. Wm. Ackroyd and Wm. Best, manufacturers of miners' safety lamps, Hembrigg Works, High-street, Morley, Yorks., have dissolved partnership.

Bankruptcies.—In the bankruptcy of John Dewhurst, electrician, &c., 52, North End-road, West Kensington, London, the first meeting of creditors will take place on 17th inst., at Bankruptcy-buildings, London, and the public examination on March 9.

——— A first and final dividend of 3s. 9d. will be payable on and after Monday next, at the Official Receiver's office, 4, Pavilion-buildings, Brighton, in the bankruptcy of Geo. Thompson, electrical engineer, 115, Queen's-road, Brighton.

——— The trustee in the bankruptcy of Thos. Maddren, electrician, 32, High-street, Cardiff (late of 47, Castle-arcade, Cardiff), has been released.

Liquidation.—Creditors of the Crompton-Howell Electric Storage Company (Limited) must send particulars of their claims to the liquidator, Mr. R. H. Marsh, Ethelburga House, Bishopsgate-street Within, London, E.C., on or before March 25 next.

Deed of Arrangement.—Leonard Wise, electrical engineer, &c. (trading as A. Thorogood, Wise and Co.), 83, Newman-street, Oxford-street, London, W., and "Roselea," St. Ann's-road, Green Hill, Harrow, has executed a deed of arrangement. The liabilities are returned at £1,372. 18s. 11d., assets £246. 11. 2d. Mr. T. L. Rayner, 86, Eden-street, Kingston, is trustee.

National Telephone Company's Exchanges.—We are informed that all this Company's exchanges are now open day and night, including Sundays and holidays, with the exception of one or two very small places in South Wales and Ireland, where arrangements have not yet been completed. These will, however, be shortly brought into line with the other exchanges. It is pointed out also that practically all towns now have the advantage of trunk communication, and where this is the case Sunday and all-night communication is also available.

Sturtevant Fans.—We have received from the Sturtevant Engineering Company an interesting and well got-up catalogue, illustrating the Sturtevant High-Pressure Centrifugal Fans. These fans are designed for all purposes when high-pressure blast is to be maintained, or where air or gas is to be forced long distances; among the applications being the promotion of forced draught for boilers, cupola furnaces, and forges, of blast for sand-blast processes, and pneumatic tube delivery systems. The catalogue contains much useful information and data in the form of tables and curves respecting air under pressure and the friction of air in motion through pipes, and also a comparison of the relative efficiencies of centrifugal fans and so-called rotary blowers, in which a good case is made for the former.

Gear-Cutting, Milling, &c.—The Crypto Works Company (Limited), of 29, Clerkenwell-road, London, E.C., notify that they are in an especially favourable position for executing orders for gear-cutting, milling, screwing, or similar work, and have special facilities for executing repetition work.

Electric Traction Supplies.—We are informed by the representatives of Messrs. Felten and Guilleaume that recently they have successfully introduced a copper rail-bond which is claimed to be superior to any other design. The principal advantage of the "Neptune" bond is that, after the heads of the bond are put through the web of the tramway rails they are expanded by steel pins driven in from the same side of the rails, as that from which the bonds are inserted. This is an important advantage when electric traction is adopted on existing horse, cable, or steam tramways, as the roadway need be opened on one side only of the rails for the purpose of bonding, effecting thereby a considerable economy. Many thousands of these bonds are already in use, and are said to have given the greatest satisfaction, the contact with the rails being the best obtainable. Messrs. Felten and Guilleaume's sole agents in this country are Messrs. W. F. Dennis and Co., of 23, Billiter-street. The firm is already well known in connection with cables for low and high-pressure work, together with feeder boxes and appurtenances for distribution systems.

Postal Telegraph Factory-Staff Dinner.—Mr. Martin F. Roberts, Superintendent of the Postal Telegraph Factory, at Mount Pleasant, presided over the 4th Annual Staff Dinner, on Saturday last, the occasion being the anniversary of the transfer of the telegraphs of the Kingdom to the State in 1870. The guests included:—Mr. J. C. Lamb, C.B., C.M.G., Mr. H. C. Fischer,

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C.M.G., Mr. J. Ardron, Mr. C. E. Stuart, Mr. A. F. Varley, Mr. J. W. Eames, Mr. W. Roberts, Lt.-Col, P. G. Von Donop, R.E., Prof. W. H. H. Hudson, Dr. Mumford and Dr. Walmesley. Mr. J. C. Lamb in reply to the toast of the "Chief Office," referred to the increased work caused by the transfer of the telephone trunk lines to the Government, and to the efforts the Department was making to improve the telephone trunk service, which he hoped would result in the public getting a more efficient service over the trunk lines. Mr. A. Brooker, proposing "Electrical Engineering," spoke of the pioneer work which had been done in the past by Telegraph Engineers, who had laid the foundation on which all the newer branches of electrical work had been built. Mr. J. Ardron, in the unavoidable absence of Mr. W. H. Preece, replied and referred to the progress which had been made in electrical science as applied to telegraphy, "which was largely due to officers of the Engineering Department of the Post Office." Other toasts included "The Visitors" (coupled with the names of Mr. H. C. Fischer and Lieut.-Col. Von Donop) and "The Chairman." Not the least enjoyable feature of the gathering was the excellent rendering of vocal and instrumental music by members of the Factory-Staff.

Independent Condensing Plants.—Messrs. Cole, Marchant and Morley are publishing an illustrated pamphlet describing their special make of condensing plants.

Catalogue—Messrs. Alley and MacLellan, of Sentinel Works, Glasgow, have sent us a copy of their new catalogue of "Sentinel" high-speed steam engines. The engines of this firm are to be found in numerous electric supply stations in the United Kingdom. The "Sentinel" engine is of the well-known Westinghouse type, and is a vertical, inverted, enclosed engine, built for either compound or simple working. The catalogue gives a lengthy and illustrated description of the engine. A section is devoted to the "Principles of Steam Economy," and another to a description of the "Repair System" adopted by the firm. There are numerous excellent illustrations of the various patterns of "Sentinel" engine, besides a number of tables of dimensions and data.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 2 to Feb. 8, with the ports of destination :—

Argentina—Buenos Ayres, £1,124 (including £300 telegraph poles). *Australasia*—Albany, £55; Auckland, £44; Charters Towers, £120; Melbourne, £610; Napier, £13; Sydney, £550 (including £18) telegraph material); Wellington, £26. *Ceylon*—Colombo, £160. *China*—Shanghai, £33. *Egypt*—Alexandria—£592 (including £387 (telegraph cable). *France*—Boulogne, £118. *Germany*—Hamburg, £276. *Gibraltar*, £257. *Holland*—Amsterdam, £137 (incuding £30 telegraph apparatus) Flushing, £23; Rotterdam, £110 (telegraph material). *India*—Bombay, £118; Calcutta, £345. *South Africa*—Cape Town, £1,794; Durban. £266 (including £17 (telegraph material); East London, £366; Port Elizabeth, £386 (including £267 telegraph material). *Spain*—Malaga, £210. *Sweden* Gothenburg, £148; Stockholm, £1.850. *West Indies*—Trinidad, £27. Total, £9.758, against £14,420 in the corresponding week last year (Feb. 3 to Feb. 9).

Aberdeen.—As the tramways will shortly pass into the hands of the Corporation the question of the advisability of adopting electric traction on the lines is occupying the attention of the Council, and with a view to enlightening members on the advantages of electricity as a motive power they have been supplied with copies of the report recently prepared by the deputation of the Douglas (Isle of Man) Town Council, which recently visited the Continent in order to investigate the latest and most improved systems of traction in continental cities.

Award.—The Sheffield Corporation have awarded Mr. John Spencer, of the Globe Tube Works, Wednesbury, a premium for the design submitted by him for the poles for their electric tramways. The Sheffield Corporation has decided to place an order for a considerable number of these poles with Mr. Spencer's firm.

Ballymena (Ireland).—The Township Commissioners have passed a resolution in favour of establishing electricity supply works. The Provisional Order will expire in July next, and members are anxious to be in a position to supply current before that date. The Clerk has been instructed to obtain information from other towns where electricity works are in operation.

Beckenham.—The Urban District Council have decided to undertake the supply of electric current in the district. Electricity works are to be established at an estimated cost of about £36,000.

Barrow.—The Barrow Steel Works Company have under consideration the advisability of laying down an extensive electrical plant for the lighting of the whole of their premises, and also for supplying current to electric motors for working some of the machinery in the works.

Bethnal Green (London).—The Vestry have instructed Prof. Henry Robinson, M.I.C.E., to prepare a report on the electric lighting question, at a fee of 40 guineas.

Bolton.—The report of the Borough Electrical Engineer states that there are 350 customers on the electric light department's books, an increase of 62 per cent. for the year. The lamp connections have increased by 69 per cent. During the year 430,452 units were generated, against 231,104 in 1896.

Bournemouth.—At the last meeting of the Town Council a communication was received from the Secretary of the British Electric Traction Company, who are promoting a scheme for the construction of a light railway from Poole to Christchurch, *via* Bournemouth, and to Winton, asking the Council to reconsider their decision to oppose the scheme. The other local authorities interested have sanctioned the proposal.

Bradford.—At the meeting of the City Council on Tuesday, tenders for the supply of electrical plant for the Valley-road Station were accepted, and a sub-committee was appointed to visit Continental stations supplying current for lighting and traction purposes in order to obtain information for the guidance of the Council.

Bristol.—The Bristol Tramways and Carriage Company are promoting two Bills in Parliament, one for the construction of additional lines and the extension of their system, and the other for power to introduce electric traction on the existing tramways. The Sanitary Committee recommend that both Bills be opposed, and this attitude has been endorsed by the Corporation.

Burton-on-Trent.—As in the case of Dublin, the Town Council of Burton-on-Trent appear to be experiencing some difficulty with their electric lighting cables. At the meeting of the Council on Wednesday, the chairman of the Gas and Electric Light Committee (Ald. Lowe) stated that they had communicated with about thirty other cities and towns where electricity works were in operation, and they had (he said) ascertained that in almost every case where cables of the type used at Burton-on-Trent were employed there had been more or less serious breakdowns. A deputation of the Council had been to London, and had a conference with Mr. Frank Bailey (engineering director of the Metropolitan Electric Supply Co., and engineer to the City of London Electric Lighting Company), who had given them some valuable information, and they hoped to be able to get Mr. Bailey to visit Burton, and to advise them on the best way out of their difficulties with the cables. He had advised the substition of cables manufactured by the British Insulated Wire Company, and this was estimated to cost from £5,000 to £6,000.

Cardiff.—At a meeting of the Electric Lighting Committee, on Thursday last, the electrical engineer (Mr. N. Appelbee) presented a report on the mains question, in which he recommended that the arc light cables be replaced by cables of newer pattern, and that the lamps be connected in accordance with the latest requirements of the Board of Trade. The cost of the change was estimated at £430.

Chester.—At the meeting of the Chester United Gas Company, the Chairman stated that during the past year there was a diminution of gas rental compared with the previous year, and this was owing to the increased use of the electric light in the district. The electric light had taken away from them a considerable amount of custom in the very heart of the city, where gas was supplied at the lowest rate. Notwithstanding this competition by the electric light, the total number of customers had increased, as had the number of users of automatic meters.

Darwen.—The Town Council are to apply to the Local Government Board for sanction to borrow £30,000 for electric lighting purposes.

Devonport.—The Town Council have decided to engage the services of Prof. Kennedy as consulting electrical engineer in connection with the proposal to establish electricity supply works in the town.

Dorking.—At the last meeting of the District Council a resolution in favour of erecting electricity supply works in the town was adopted, but no decision was arrived at as to whether the work should be undertaken by a company or by the Council. Two schemes have been submitted, one by Edmundson's Electricity Corporation (Limited), and the other for a municipal supply by Mr. F. Warden-Stevens.

Dublin.—The Corporation have received the sanction of the Local Government Board to the borrowing of £20,000 for renewing the electric light cables, which have been a source of so much trouble and annoyance. A deputation waited upon the Corporation on Monday for the purpose of obtaining sanction to the doubling of the electric tram line between Talbot-street and Nelson's Pillar.

Dundee.—The Gas Committee of the Town Council have authorised the erection of four arc lamps in High-street, Lochee. Current is to be supplied from the plant at the public baths.

Durham.—Edmundson's Electricity Corporation are erecting an electric lighting installation for the Cathedral and College, and the Council have authorised the Company to lay mains for the supply of current to private consumers.

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Edgware.—The Parish Councils of Edgware and Little Stanmore are making investigation into the cost of lighting the parishes electrically.

Edinburgh.—The Lord Provost's Committee are considering the question of constructing an electric tramway from Preston-street, Edinburgh, *viâ* Dalkeith-road, to Joppa and Portobello, returning by Meadowbank and Waterloo-place.

Electric Motor Carriages.—Mr. T. B. Murray, of Glasgow, gave a lecture on Monday before the members of the East of Scotland Engineering Association on "Electric Motor Carriages." The lecturer stated that to Edinburgh belonged the distinction of having produced the first electric carriage, built by a Mr. Davidson about the year 1842.

Exeter.—In view of the rapid increase in the demand for electric current, the Electric Lighting Committee have decided to recommend the City Council to further increase their borrowing powers by £2,000.

Exhibition.—The *London Gazette* contains the names of the Royal Commission formed to see that British industry and art are properly represented at the exhibition to be held in Paris in 1900. The Commission, headed by the Prince of Wales and the Duke of York, includes the following: Sir James Kitson, Sir Charles Rivers Wilson, Sir Daniel Cooper, Mr. W. H. Preece. C.B., Prof. T. W. Thiselton-Dyer, Mr. E. Windsor Richards, the Presidents of the Royal Institute of British Architects and the Institution of Civil Engineers for the time being, Mr. J. S. Forbes and Sir Albert K. Rollit.

Glasgow and West of Scotland Engineering College.—Mr. George Weir, who recently resigned his Directorship of the above college on his departure for Australia, has presented the electrical engineering laboratory with a Sullivan "Universal" galvanometer.

Godalming.—At the meeting of the Town Council last week it was decided to proceed with the scheme for the erection of electricity supply works in the town.

Great Grimsby.—The sub-committee which was recently appointed to collect information on electric lighting matters has presented its report. The stations at South Shields, Newcastle-on-Tyne, Leeds, Manchester, Brighton, Shoreditch and Westminster were visited, and the report states that in all these places the electricity works have proved a decided success. The committee accordingly recommended that steps be taken to provide municipal electricity supply for Great Grimsby. The Public Lighting Committee have endorsed this recommendation, and have decided to engage Prof. Kennedy as consulting engineer. The sub-committee have also been authorised to meet the representatives of the local Tramways Company, and to endeavour to arrange terms for a supply of current for working the tramways electrically.

Great Orme's Head Tramway.—The Llandudno District Council have decided to sanction the application for powers to construct the Great Orme's Head Electric Tramway, on condition that no Sunday trains are run without the consent of the Council, and that the line be worked all the year round if the dividend amount to 7½ per cent. or over, or for eight months if the dividend amount to 5 per cent.

Greenwich.—The District Board of Works have given their consent to the application of the Woolwich and South-East London Tramways Company for authority to use electric or other mechanical traction on their lines.

Hampstead (London).—The Vestry have decided to apply to the London County Council for a further loan of £40,000 for electric lighting purposes.

The Vestry have now come into collision with the Post Office on the question of underground wayleaves. The Vestry have refused to allow the postal authorities to lay an underground pipe at Cricklewood, except on condition that it shall not be used by the National Telephone Company or other than the Post Office Department.

Hastings.—A lengthy discussion took place at the meeting of the Town Council last week relative to the proposals to construct a system of tramways in the town and district. The Roads Committee reported in favour of the scheme promoted by the Hastings, Bexhill and District Light Railways (Electric) Company, on certain conditions. The Council finally decided to consider the whole question in Committee.

Hull.—The Corporation have decided to apply to the Board of Trade for permission to borrow £27,000 for the construction and equipment of electric tramways.

Infirmary Lighting.—A Committee has been appointed by the Governors of the Whitehaven and West Cumberland Infirmary to consider and report upon the cost of the electric lighting of the Infirmary.

Islington (London).—Owing to the great demand for electric current in this district, the Vestry have decided to put down additional plant at the generating station at an estimated cost of £12,000. The Electric Lighting Committee report a profit of £4,432 on the past year's working, against £1,615 in the previous year. In 1896 the number of units sold was 298,000, and the revenue £7,573, and in 1897 504,000 units were sold. In 1896 the working cost was £5,958, about 4¾d. per unit, and in 1897 it was £7,858, an increase of £1,900 (equal to 31 per cent), while the cost per unit fell to 3¾d. With an increased cost of production of 31 per cent., the output increased 69 per cent., and the revenue 62 per cent. The gross profit in 1896 only amounted to 21 per cent. on the revenue, but last year it rose to 36 per cent.

Leatherhead.—The County Council have withdrawn their opposition to the application of the District Council for a Provisional Order for the district.

Leeds and Bradford Light Railway.—The Calverley District Council have decided to support the application for powers for the construction of a light railway between Bradford and Leeds; and the Leeds Chamber of Commerce, on Wednesday, adopted a resolution in favour of the construction of a tramway along the high road between Leeds and Bradford.

Leyton.—The question of the erection of a transformer substation in the Leytonstone district is being considered by the Electric Lighting Committee. The engineer (Mr. H. Collings Bishop) has reported in favour of the proposal. The Council have offered to supply current to the West Ham Guardians for lighting the workhouse buildings at 3½d. per unit. A deputation is to be sent to Brighton for the purpose of inspecting and reporting upon the system of incandescent electric lighting in that town.

Limited Liability Undertakings.—Official notice, dated Jan. 28, appears in the *London Gazette* that the following concerns will be struck off the roll of limited liability companies at the expiration of three months, unless cause is shown to the contrary:—

Birmingham House-to-House Electricity Company (Limited).
Burglar and Fire Alarm Company (Limited).
Electrical Accessories Company (Limited).
Dalziel's Atlantic Telegram Company (Limited).
Electric Light and Power Share Trust (Limited).
Exeter Electric Light Company (Limited).
Irish House-to-House Electricity Company (Limited).
Lancashire and Cheshire House-to-House Electricity Company (Limited).
Manchester House-to-House Electricity Company (Limited).
Midland House-to-House Electricity Company (Limited).
Nightingale Automatic Electric Machine Company (Limited).
Northern House-to-House Electricity Company (Limited).
Pacific Telegraph Company (Limited).
Railway Electrical Fog Signal Syndicate (Limited).
Railway Electric Reading Lamp Company (Limited).
South of England House-to-House Electricity Company (Limited).
Universal Arc Lamp Syndicate (Limited).
Western House-to-House Electricity Company (Limited).
Wrexham and District Electric Supply Company (Limited).
Mechanical Inventions Syndicate (Limited).
Metallurgical Syndicate (Limited).
Taverner's French Patents (Limited).

Liverpool.—The Lighting Committee have authorised the city electrical engineer to proceed with a portion of the scheme for the extension of the mains provided for in the estimates of the current year. The work includes a trunk main from Paradise-street, *via* Hanover-street, to Ranelagh-street. Mains are also to be laid in the residential district of Wavertree, Smithfield-road, Allerton-road, and Green-lane. Mains are also to be laid to the Mossley-hill district, *via* Penny-lane, Sefton Park district, *via* Greenbank, in Byrom-street and Scotland-place. Various other minor extensions are also to be made, the total estimated cost of which is £16,947.

London County Council.—We give elsewhere the resolution which was discussed at Tuesday's meeting on the subject of a municipal telephone service for London. Mr. Benn, who moved the adoption of the Highways Committee's report, said that some members shrunk from municipalising the telephone service, but the result of such an enquiry as suggested in the resolution would be to get valuable evidence which could not otherwise be obtained. If the Council adopted the resolution it would not commit itself to a municipal service, for it was only a form to ask for a license, so as to get an enquiry and have the case judged on its merits. The matter was really pressing, for they had arrived at a crisis in the history of the telephone service. Mr. Beachcroft moved an amendment asking that the Select Committee appointed by the House of Commons in 1895 to consider and report on the telephone service should be reappointed. What was really wanted in London (said Mr. Beachcroft) was not merely a reduction in the charges, but that the trunk lines should be brought into conjunction with the town lines. He was quite certain it would be best for the Government to take the matter up, as they had the telegraph. He believed that ultimately those who were responsible for the trunk lines would be responsible for the town lines, and any agitation, he hoped, would be directed to that end. He did not think the Committee had dealt fairly with the

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Telephone Company, for although some months ago the Council had agreed to certain conditions with the Company for the laying of underground lines, yet the Committee had added two further conditions as to a reduction in charges and payment of wayleaves, and had not reported to the Council. Mr. H. Clark said that if they passed the resolution they would be committing themselves to municipalisation. Earl Russell (Chairman of the Highways Committee) said he had declined to move the report of the Committee. He thought an inquiry in London would lead to nothing, but such an inquiry as that suggested by Mr. Beachcroft was one upon which facts could be elicited. They knew that the National Telephone Company, in buying up rival companies, had made a lot of watered capital, but it must be remembered, when talking of the charges, that the Company had not long to run. Personally, he would like to see a municipal service, and next to that a Government service. Dr. White, speaking as a constant user of the telephone, said he was not dissatisfied with the way the business was done, and he did not think that subscribers wanted a municipal service. When the business was not paying, no one wanted to take it up. He thought the Government could give the best service. Ultimately the original resolution was adopted by 44 to 31.

Ludworth (Durham).—The Parish Council are dissatisfied with the price and the quality of the gas now supplied for the lighting of the district, and are making inquiries into the practicability of lighting the district electrically, and of utilising the water of the river Goyt in the generation of current.

Luton.—At the Town Council meeting last week it was decided to distribute copies of Mr. Albion T. Snell's report on the electric lighting question. The report extends to 22 pages, and goes very exhaustively into the question of electricity supply by local authorities and companies. The three-wire system with a pressure of 460 volts between the outers with 230 volt lamps, is recommended. The total cost of the installation is estimated at £20,000. The report will be discussed at the next meeting of the Council.

Middleton.—The Earl of Jersey, Col. Boughey, and Mr. Gerald FitzGerald, the Light Railway Commissioners, held an inquiry at Middleton, on Saturday last, into the application of the British Electric Traction Company, for an Order authorising the construction of a light railway in the district. Mr. Sydney Morse appeared for the applicants. There was no opposition to the application, except as to a short length of line in the Oldham district. Mr. Morse stated that it was proposed to construct a line over eight miles long, at an estimoted cost of about £52,000, between Rhodes and Middleton, and from thence to branch off in two directions, through Chadderton to Oldham, and through Castleton to Rochdale. It was proposed to employ the overhead trolley system on the ordinary gauge, so that they could eventually connect up with the Oldham tramway system. The Oldham Town Council opposed the application to construct a portion of the line (about 300 yards long) which would lie within their borough boundary. For the Council it was stated that when the present lease expired "they might decide to carry on their own tramway system." Mr. S. Sellon, the engineer to the applicant Company, also gave evidence, and in reply to a question, said there would be no difficulty in extending the line westward from Rhodes to the Manchester tramway system.

Newcastle-on-Tyne.—A meeting of the Special Electric Lighting Committee of the Corporation was held last week, when Councillor Flowers brought forward the question of the utilisation of the waste power of the refuse destructor at Byker in the generation of electric current. After discussion, it was decided to ask the city engineer to prepare a report as to the number of arc lamps which would be required to illuminate the principal streets, and as to the power that would be required to generate electric current for those lamps. Before taking any definite steps in the matter the Committee will await the decision of the new Tramways Committee as to the system of traction to be adopted on the local tramways.

Pembroke (Dublin).—The Township Commissioners have decided to apply to the Local Government Board for sanction to borrow £33,000 for the purpose of establishing electricity supply works. It will be seen from our advertisement columns that the Commissioners are inviting tenders for the supply of generating plant.

Sheffield.—We are able to announce that the Corporation have at last arrived at an amicable arrangement with the Sheffield Electric Light and Power Company for the purchase of the latter's undertaking. At Wednesday's meeting of the City Council the Parliamentary Committee presented a report in which the terms of the purchase were fully set out. According to the agreement the shareholders are to receive £220 of Two and a-Half per Cent. stock for every £100 spent by the Company. The total expenditure of the Company is £124,472, of which £118,500 is to come under this arrangement, and £5,972 is to be repaid at 5 per cent. interest. The Company take the profits of the last year, and are to receive 10per cent. until completion of purchase. The profit on the working of the tramways for the half-year to December, was £5,483. 18s. 5d. The Council have decided to purchase a site for a tramway power station at Kelham Island.

South Africa.—The *British and South African Export Gazette* announces that a scheme has been brought forward for the electric lighting of Kokstad, Cape Colony, and that it is probable that electrical engineering firms will shortly be invited to tender for the supply of the necessary plant.

The question of installing the electric light in the railway workshops at Mafeking is under the consideration of the Railway Department, and the extension of the system to the town is also being discussed.

Two large alternating current dynamos have been supplied by the General Electric Company (of America) to the Buluwayo Waterworks and Electric Light Company.

Steamship Lighting.—Messrs. W. H. Allen, Son and Co., Queen's Engineering Works, Bedford, writing on the subject of electric lighting on board ship, inform us that they have installed over 7,000 lights on steamships during the past year, the vessels being engaged in the Atlantic and Eastern routes, and including the "Cymric," "Briton," "Alexandra," "Tambamarn," "Derbyshire," and "Milwaukee," representing some of the finest ships afloat. The electric light has also been installed by the same firm on board a number of torpedo boat destroyers, as has electric plant for heating, driving of ventilating fans, hoists, winches, and engine-room and deck auxiliary machinery.

St. George's, Hanover-square (London). It will scarcely be credited that in 1898 there is still a West-end parish in London in the dismal darkness of gas; but such is the case. St. George's, Hanover-square, of all places in the world, has yet to see the advent of the electric light. Bounded on all sides by well-lighted thoroughfares, after dusk the parish is one of the most dangerous in the Metropolis. An enterprising effort on the part of Mr. G. W. Smith, one of its vestrymen, to induce his fellow vestrymen to vote a modest £1,000 to the improved lighting of Piccadilly was discussed at a recent vestry meeting; but though Mr. Smith charmed never so sweetly it was unsuccessful, and the motion was lost. It is a consolation, however, that one of the members (Mr. Everett) went so far as to admit that "the electric light is the light of the future." This is evidently the case so far as St. George's, Hanover-square, is concerned.

Taunton.—The Electricity Department of the Town Council continues to prosper. At Tuesday's meeting it was reported that applications for electric current were coming in, and in order to meet this demand the Electric Lighting Committee recommended that additions and extensions be made to the generating plant and mains, at an estimated cost of £10,000. The Mayor (Ald. Potter), Chairman of the Committee, proposed the adoption of this recommendation. He said they would soon be obliged to refuse orders, as they had not sufficient plant at the works to enable them to supply current. The report was adopted, and it was decided to apply to the Local Government Board for sanction to borrow £10,000.

Telegraphing through Space.—At the Royal Dublin Society last week, Prof. O. Lodge delivered a lecture on wireless telegraphy to a large and attentive audience, which, according to report, contained many members of the clerical cult. The lecture proved of absorbing interest, and at its termination Prof. Lodge received an ovation.

Telephone Municipalisation.—At the meeting of the Huddersfield Corporation on Tuesday it was announced that a notification had been received from the Postmaster-General refusing to grant the Corporation a licence for setting up an independent telephone service in the town, and so the Huddersfield scheme for telephone municipalination has been abandoned. A sub-committee has been appointed to consider the terms of an agreement with the National Company as to the placing of their wires underground. A settlement of this point has been in abeyance pending the decision of the Postmaster-General on the application of the Corporation for a telephone licence.

The Engineering Dispute.—A somewhat noticeable feature of the recent dispute in the engineering trades was the absence of any financial support being voted to the Employers' Federation from the combinations of masters in various trades established throughout the country. There is no gainsaying that the master engineers were fighting the battle of employers generally in the line they considered it right and proper to adopt in the dispute with their men over the eight hours' question. There are dozens of wealthy employers' associations well able to vote considerable sums, but it is doubtful whether the actual money was required. There can be no doubt, however, that votes of sympathy with the course adopted by the Engineering Employers' Federation would have strengthened its hands during the contest, and would have acted as a set-off against the active

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sympathy of the trades unions in support of the men's cause. However, it is never too late to make amends in such a matter, and this week the Federation of Master Bleachers and Dyers of Manchester have subscribed a sum of £500 to the Master Engineers' Federation "as a mark of sympathy with the objects for which they have contended."

Col. Dyer, the President of the Federation of Engineering Employers, on Wednesday, at a gathering of the members of the United Club, discoursed on "the relation of capital and labour, with special reference to the late engineers' strike and lock-out," and in the course of his remarks declared that the north-east coast had been for some years worried to death by constant aggressions on the part of the trades union members. This led to the establishment of an association of federated employers, and that combination had by the very justice of its claims proved a great success. It had consolidated the employers in the engineering trade, and had formed a bond of union of all the conflicting interests which had kept employers apart in the past. His own view of a trades union was that it was established to prevent workmen from being oppressed, to raise their wages as much as possible consistent with state of trade of the country, and to obtain for every workman as good conditions of labour as possible.

Torquay.—At Monday's meeting of the Town Council the Consulting Electrical Engineer (Mr. W. H. Trentham) reported that the electricity works were now so far advanced as to be ready for the trial run; the arc lamps would then be tested, but he would not fix any definite date for the formal opening of the works.

Wallasey.—At the meeting of the District Council on Thursday last Mr. Ellery, Chairman of the Gas and Electric Lighting Committee, announced that their electric lighting installation, although only established about a year, had made a substantial profit during the past 12 months. On the recommendation of the Parliamentary Committee it was decided to promote a Bill in Parliament enabling the Council to take over the local tramways, and to work the same by electric or other mechanical power.

Workhouse Lighting.—The Belfast Guardians have decided to obtain a report upon the advisability of lighting the workhouse electrically.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

An extraordinary general meeting of the shareholders of this Company was held at Winchester House, Old Broad-street, E.C., on the 4th February, for the purpose of confirming as a special resolution the resolution passed at the extraordinary general meeting of the Company held on the 20th ult.

The Secretary (Mr. George Draper) having read the notice,

The CHAIRMAN (the Marquis of Tweeddale) said: Gentlemen, I have now to move the following:—

"*That the following resolution, approved at the extraordinary general meeting of shareholders on January 20th, be and is hereby confirmed, as a special resolution:—*

"*That this meeting, having considered the Bill proposed to be introduced into Parliament in the ensuing session, intituled 'A Bill for the Conversion of the existing Preference shares of the Eastern Telegraph Company (Limited), and for other purposes,' hereby approves the same, subject to such additions, alterations, and variations as Parliament may think fit to make therein, and as the Directors shall approve.*"

I fully explained at the meeting which was convened for the purpose on January 20th last the object which your Directors have in view in promoting a Bill before Parliament. My remarks on that occasion have been fully circulated amongst the shareholders by means of the Press, and I do not think that it will be necessary for me to add to them to-day. I am glad to be able to say that assents have come in very freely; they amount already to 1,000, and they are coming in daily. We have received only two dissents from shareholders, holding respectively 20 shares and 16 shares, but they give no reason whatever for their dissent, and we can therefore hardly consider them serious. They are probably like children who, having got a good thing, think they ought to ask for more. I mentioned with regard to future issues, both of Debentures and Preference shares, that in the event of our issuing any substantial amount of fresh capital it would be offered to the shareholders in the first instance. I understand that an inquiry was made at the last meeting as to the price at which they would be issued. Of course, that is hardly a point that it is possible to deal with now. We cannot say to-day at what price Debentures or Preference shares may be issued at a future period. That will depend, of course, upon the price—the market price—of the day and other conditions. I need hardly say that I think that the Ordinary shareholders may calculate upon the price being fixed at such a figure as will be attractive to them, and which I think will meet with every satisfaction. With these few observations, gentlemen, I beg to move the resolution which I have just read to you.

The VICE-CHAIRMAN (Mr. John Denison Pender): I beg to second that resolution.

The CHAIRMAN declared the resolution carried unanimously, and said that the Bill would now go before Parliament, and the result laid before the shareholders at the half-yearly general meeting.

The proceedings then terminated.

St. James' and Pall Mall Electric Light Company (Limited).

The ordinary general meeting of this Company was held on Tuesday, at the offices, Carnaby-street, Golden-square, Mr. Eustace J. A. Balfour presiding.

The GENERAL MANAGER AND SECRETARY (Mr. F. J. Walker) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said: The resolution now before the meeting is—

"*That the report and accounts for the year ended December 31, 1897, as submitted by the Directors, be received and adopted, and that the dividends recommended therein be declared and paid on February 17, 1898.*"

In asking you to pass this resolution, gentlemen, I will briefly go through a few points, and I will ask any shareholder who may have questions to ask, to afterwards put them to me, and I will do my best to answer them satisfactorily. The working, as you will have seen by the accounts, has been, on the whole, very satisfactory. At the end of the year we had 126,000 8-c.p. lamps connected, being an increase of about 18,000 for the twelve months, and there is reason to believe that with the growing popularity of electricity, both for lighting and power purposes, this rate of increase will be not only fully maintained, but largely exceeded. Recognising that such an increase will be best obtained by reducing from time to time the price to consumers, the Directors have put in force from January 1st a new rate, by which 6d. per unit is charged for the first £100 of the annual bill and 4d. per unit for the rest, while all electricity for motive purposes is charged at 3d. a unit.' The St. James' Company now stands ahead of all other metropolitan companies as regards its works-cost and its total cost per unit sold, and the Board ventures to think that that is a creditable position for a company which is by no means the biggest in the metropolis. On the profits of the year the Directors propose a dividend of 14½ per cent. We see at once that that dividend will excite a certain amount of criticism from local authorities and the individual consumer, but in reply to this I want to point out that the average price of 5d. per unit, which we shall receive for the current year, is a fair and reasonable one, and considerably below the statutory price, and it is also below the charges made by most other metropolitan concerns. The ordinary and, in fact, the total capital of this Company is exceedingly small for the output as compared with that of other companies, and the Directors hold that the shareholders are entitled to a fair return as the result of careful expenditure and good management. Yet, in a way, the dividend of 14½ per cent. is fictitious, for, under the Articles of Association, the founders' rights compel a division of the whole of the surplus profits, without allowing for any reserve, which is a very necessary item in a business of this description. Happily for all parties, an agreement with the founders, subject to your approval to-day, is practically settled, and we shall then be at liberty to provide a proper reserve fund, which will render the credit and dividends of the Company more stable. I think it should be clearly understood that we have a lease of life of only 33 years from this year. The investment, therefore, is rather like a leasehold investment, in which you would not only expect a fair return for your money, but would also expect to be able to put by such a sum as at the end of 33 years would leave you where you stood before you made the investment. It should also be borne in mind that although we have very little in the way of precedent as to the price at which a concern of this kind should be purchased, yet what little we have—that of the London County Council and the Tramways Company—goes absolutely against the probability of our receiving anything at all for the goodwill of the concern. It would merely be the valuation of the buildings, plant, machinery and property. Therefore it should be recollected that a 14½ per cent. dividend does not represent the true earnings of the Company. It appears on the face of it to be a very large figure, but if we were able, as we shall be, I hope, in future years, to deduct from that the capital redemption fund, I do not think any local authority or any of our consumers would have any just ground for complaint. And, at the same time, of course, the shareholders will be benefited to exactly the same extent as at present. The extension of the Carnaby-street station will be shortly completed, and the Company will then have a total horse-power of over 6,000, with mains of sufficient capacity to carry the full output, and it is anticipated that, with this provision, the Company's work can be carried on from the existing station for a further two winter seasons. The Directors attribute a large portion of the success of this Company to the fact that it has been their policy to keep its resources in the way of plant, etc., well ahead of requirements. They have thus been enabled to carry out alterations to, and extensions of their sytem without interference from strikes or other delays, and without disturbance to their supply, or increase in the normal cost of working. Following out this policy, it has become necessary to provide at once for further extension of the Company's works, so that it may be ready before our present resources are overrun. The Directors have, therefore, secured a valuable freehold site in every way suitable for the most economical generation of electricity, and they are now considering carefully the best methods of dealing with this extension in the interests of the shareholders. As the negotiations are necessarily of a very delicate nature, the Directors trust that the shareholders will be satisfied with this statement and with the knowledge that in all future issues of capital, the policy of the Directors in giving preferential treatment to the shareholders will be continued, and that before raising any large amount of capital they will take the opportunity of putting the scheme more fully before the shareholders. I do not think I have anything more to say now, but I shall be happy to answer any questions which shareholders may desire to put to me.

Mr. LATIMER CLARK, F.R.S. (Vice-Chairman) seconded the resolution.

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Mr. Foster observed that it was proposed to issue 20,000 £5 shares, of which 12,000 were to be issued at par to the holders of the Founders' shares. To whom would the remaining 8,000 be issued, and at what price and when? Another question he wished to ask was this. He saw that by the Articles of Association the Directors were entitled to take 10 per cent. on the interest paid, which came to £3,000. They had, however, taken only £2,500. Was it proposed to make that a precedent?

The CHAIRMAN: The answer to Mr. Foster's first question is that this is not an issue, but a creation of shares, and apart from those given to the founders, the allotment is governed by this article: "Subject to any direction that may be given by the meeting that sanctions an increase of capital, all new shares shall be offered to the members in proportion (as nearly as conveniently can be) to the existing shares held by them, and such offer shall be made by notice specifying the number of shares to which a member is entitled," and so on.

Mr. FOSTER asked if that would apply to new shareholders.

The CHAIRMAN: That applies to all who are shareholders at the time of the issue. We cannot get out of that. Then as to the question of fees. The Directors were entitled, as Mr. Foster observes, to £3,059—that is the figure, I think—but they have, as a matter of fact, only put down £2,500. I do not, however, wish to pledge the Directors in any way to making that a precedent.

Mr. BOURN desired, if he were in order, to ask a question with reference to the debentures. He remarked that in March a circular was issued convening a meeting to consider the possibility of reducing the interest on the Four per Cent. Debenture stock to 3½ per cent. The proposal was not carried, but he wished to know what the intentions of the Board were in reference to the Debenture stock. It seemed a little illogical that the stock should be issued at a premium, and then within two years the holders should be applied to to reduce their rate of interest. The suggestion was made that the stock, of which about £50,000 had been issued, should be purchased and re-issued, but it seemed that that could not be done. He understood at the last meeting that it was the intention of the Directors to drop the matter, but perhaps the Board would say what they proposed to do?

Mr. WALTER LEAF said that as the Chairman was absent from the meeting when the matter was under discussion he had asked him to answer the question. The Board's reason for wishing to reduce the interest on the Debenture stock was a simple one, namely, they thought the Company was paying too much for its money. That, he considered, was shown by the fact that the Westminster Company's issue of 3½ per cent. Debentures was subscribed four times over. In view of their extensions, and also of the question of the founders' shares, the Board felt it advisable, after careful consideration, to drop the matter for the moment. So soon as they saw their way with regard to the new extension site they would be prepared to deal with the question of the debentures, but they preferred at present to go on paying a little too much rather than make alterations they did not see their way to regard as final.

The resolution was carried unanimously.

Mr. LEAF then moved—

"*That Sir John H. Morris, K.C.S.I., and Mr. Bennett Fitch, M.Inst.C.E. be and they are hereby re-elected Directors of the Company.*"

Mr. SAMS seconded, and it was unanimously agreed to.

On the motion of Mr. MANNINGTON, seconded by Mr. FOSTER, the auditors, Messrs. Deloitte, Dever, Griffiths and Co. were reappointed for the ensuing year at a fee of 75 guineas.

The CHAIRMAN: This concludes the business, but I should like to say, and I am sure you will endorse it, that we feel very thankful to the Staff for the way in which they have worked during the past year, especially Mr. Walker, our general manager, and Mr. Dobson, our chief engineer. I am sure the Company could not have two better men, and men who would work harder in its interests than they do.

An extraordinary general meeting of the Company was afterwards held at which resolutions, passed on the 18th ult. were confirmed. These resolutions authorised the issuing of further capital, &c.

A vote of thanks to the Chairman and Directors, and also to the Staff, for their services during the year, having been passed, on the motion of Mr. FOSTER, seconded by Mr. SAMS, the proceedings terminated.

Anglo-American Telegraph Company (Limited).

The ordinary general meeting of this Company was held at Winchester House on the 4th inst., under the presidency of Mr. Francis A. Bevan.

The Secretary (Mr. T. H. Wells) having read the notice calling the meeting, the report of the Directors was taken as read.

The CHAIRMAN: It now becomes my duty to make a few observations, and they will be but few, for, as I daresay you have observed, the report itself contains very little; and "Happy is the country that has no history." However, what we have to tell you on this occasion, we are glad to say, is of a cheerful nature. For the first time since 1884 we are able, I am glad to say, to declare a dividend of 3 per cent. upon our Ordinary stock, which means the full dividend of 6 per cent.—the maximum dividend to which the holders are entitled—on our Preferred stock. I think that this is a matter of congratulation, especially when we take into account that it does not arise from any spasmodic increase of traffic, but is the result of a steadily growing traffic, which has been increasing during the last four or five years. Let me give you the figures of the revenue of the Company for the last four years. The amount then was £284,000, next year it was £307,000, the following year it was £326,000, and this year it is £354,000, which shows an increase of £70,000 in the four years; while during the same period the expenses have remained practically at the same figure—namely, £111,000. The shareholders, therefore, have reaped the full benefit of this increase of £70,000. But, gentlemen, notwithstanding this large increase of revenue, we should not have been able to pay the 3 per cent. dividend unless we had been helped by a considerable amount from the earnings of our repairing ship, the "Minia." In the first half of this year the "Minia" earned for us £8,455, and in the past half-year—the half-year with the accounts of which we are dealing to-day—it earned £2,820, making a total for the year of £11,275, and I would impress upon the shareholders that but for that windfall, as I may call it—for we cannot always calculate on making that amount, or anything like it, from our repairing ship—we could not have paid this dividend of 3 per cent. The shareholders will be glad to know that the current year has begun well, and that the receipts for January are a record over every other January since 1885. We cannot predict, but surely, with the increase of business generally, we may believe that this current half-year will be a good one. Comparing this half-year with the corresponding period of 1896, our total net increase of receipts has been £9,253. The increase in the expenses was only £371, but the increase in the cost of the repair of cables amounted to £469; therefore but for that increase there would actually have been a decrease in our expenses. Then, we brought forward to this half-year £6,704 more than in the same half of 1896, so we have available for dividend over that period £15,590. The dividend in the corresponding half of 1896 was 29s. per cent.; what we now propose is 33s. 6d. per cent. That makes an increase of £15,750—rather more than the figure I have just given you, so that we carry over £159 less than in the corresponding period of 1896. I think you will consider this statement very satisfactory. I now come to the renewal fund, and again I would remind you that your Directors attach very great importance to this fund, which, in their opinion, is not as yet at all equal to what it should be, taking into consideration that your cables are every year getting older, and that the two oldest cables are 24 and 23 years old. If, therefore, you had to replace one of those cables you would have at once to spend a very large portion of your renewal fund. Now, during the past year we have only added to this fund £33,000, for although we have, according to our usual practice, taken £24,000 from the revenue, and the interest amounts to another £20,000, we have had to spend on repairing our 1880 cable nearly £11,000, so that the net result so far as the renewal fund is concerned is that we have only added £33,000 to it. It now amounts nominally to £706,000 odd, which is only about 10 per cent. of the capital, and I venture to express the hope that no shareholder will suggest to us that we should in any way cease from maintaining that reserve fund, but that, on the contrary, our shareholders will back up their Directors in continuing to add to that fund. With respect to investment of it, a portion of it constitutes our working capital, and some of it is invested in our leasehold premises at 71, Old Broad-street. We have now over £600,000 invested, and the market value of the securities is considerably in excess of that sum. Still, looking at all the circumstances—the age of our cables, and that we have no other reserve for any special purpose—I trust you will agree with me that this fund is by no means too large. In my own opinion it is not nearly large enough. I am glad to be able to say that our cables are all in good working order, except a very short cable on the other side, which broke down since we have printed our report; but this is a matter really of no moment, and when the proper time comes it can be mended without difficulty. I am also able to say that our traffic has never been carried better than at the present time, and that the staff has never been more efficient. Since I had the pleasure of meeting you last I have had the opportunity of visiting the station at Valentia, and I was very much pleased with all I saw there. One of the oldest men in our employ—Mr. Graves—is the superintendent there, and a most valuable man he is. He has got together a staff of very efficient workers, and all that I saw there of the work gave me great satisfaction. I think it is only right to bear this testimony to the shareholders, because it is really owing—or in great part owing—to the efficiency of our staff that we are able to maintain our traffic, and therefore increase our dividend. I do not think I have anything more to tell you. Nothing special has happened in the past half-year, except this gradual steady improvement of traffic, which we hope will continue. I shall be happy to answer any questions which any shareholder may desire to put to me, so far as I can do so consistently in the interests of the business. He concluded by moving the adoption of the report and the payment of the dividends therein recommended.

The DEPUTY-CHAIRMAN (Sir Gerald FitzGerald) seconded the motion.

Mr. FRY said that he had always been a great supporter of the renewal fund, which he thought was the backbone of the Company, having carried them through many difficulties. The Chairman had said that it was the opinion of his colleagues and himself that the fund was not yet adequate. He (the speaker) did not wish in any way to traverse that statement, because he assumed that the Directors were advised by experts. He spoke as a deferred stockholder. He believed that the value of the investments forming the renewal fund was about £780,000. If it was necessary to have a larger sum than that, then the increase ought to be arrived at by a quicker process than hitherto. Years ago the late Chairman stated that the sum ought to get up to £1,000,000.

Mr. E. CLARK said that he represented more immediately the deferred stockholders. He held £50,000, and since he acquired it he had been growing grey. It must be obvious to the Directors that each class of stockholder had their individual rights, and there must come a time when the deferred stockholders would ask what the Directors were going to do for them. In the past, so soon as there had been a possibility of the deferred shareholders getting what was called "a look in," the chance passed away, the money being transferred out of their control to the renewal fund. They had paid the full dividend on the Preferred stock, and he thought it was only due to the deferred stockholders that their rights should be considered.

Mr. JOHN NEWTON said he thought the position had now arrived when the Directors would find that they would have to engage in the fight whichhe prognosticated when the sub-division of the stock was propose-

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He thought that the Directors should now deal with the question of going back again and making one stock. If the deferred stockholders insisted on their rights and combined together to enforce them, they would be a very formidable power: but the preferred stockholders had rights as well as the deferred. He himself held the undivided stock, because he thought that that was the proper stock.

The CHAIRMAN, in reply, said that the Board did not recognise "individual rights," as they were called, so much as some of their shareholders The Directors represented the whole of the shareholders; they had to look to the good of the Company generally, and their policy was to carry out what would be for the good of the shareholders generally, irrespective of the particular rights of one class against another. Personally, he was of Mr. Newton's opinion, that it was a very great mistake ever to have split the Ordinary stock at all, but this proceeding was forced on the Board by the shareholders themselves. He did not quite understand what Mr. Fry wanted them to do.

Mr. FRY said that if the Directors were determined that the renewal fund should be a larger sum than it was at present, the increase which the Directors thought was necessary ought to be arrived at in a more rapid manner than had hitherto been the case.

The CHAIRMAN said he understood that what Mr. Fry meant was that they should pay a less dividend to the shareholders and put a larger sum to the renewal fund until they arrived at whatever the sum might be that was determined on. £1,000,000 had been mentioned. He did not know if Mr. Fry's opinion would meet with the views of most of the shareholders, but he thought that if the Board adopted such a policy they would encounter a good deal of opposition. He thought they came to some general agreement that they should put to the renewal fund a sum of £24,000 a year plus the interest on the investments forming the fund. The fund went on increasing, although not so fast as some might like. If things went on as well as they were going at present, and they had no large repairs, they would soon be approaching the amount at which they thought the renewal fund ought to stand. The Board had the matter continually under their consideration.

Mr. NEWTON said he thought the shareholders generally would like to hear what the Directors' view was respecting the amount that the Company should have as a reserve. Some years ago £1,000,000 was mentioned, but that was based on the cost of laying a cable across the Atlantic, which was considerably larger then than it was at present.

The CHAIRMAN said that he did not think that the Board had had any occasion to change their policy, or to alter the figure at which they thought the renewal fund should stand. It was true that cables could be laid more cheaply now, but on the other hand their cables were much older. They were also bound to maintain their full number of cables. At present they had no intention of adding more than they had hitherto done to the renewal fund, but the Directors must be left with a free hand in the matter. It was possible that a cable might break, and they might then have to add more to it. Replying to other shareholders he stated that he wished he knew what the "life" of a cable was. A good deal depended on the ground it might be lying on and on other circumstances. They had been informed by a letter from Paris, which they received that morning in connection with the litigation there, that the case was going to be heard in April or May. It was true that the "Minia" had earned some money for them this year.

The motion was then adopted, and resolutions were afterwards passed re-electing the retiring Directors—Sir Gerald FitzGerald and Mr. Charles Burt—and the auditors, Mr. Joshua Dean and Mr. John Gane, F.C.A.

A vote of thanks to the Chairman, Directors, and Staff closed the proceedings.

Waterloo and City Railway Company.

The eighth half-yearly general meeting was held yesterday at the Waterloo Station, Mr. Wyndham S. Portal presiding.

The SECRETARY (Mr. F. J. Macaulay) having read the notice calling the meeting—

The CHAIRMAN, after stating that the number of proprietors was 723, against 669 at the end of the previous half-year, said: The accounts, as they stand, give satisfactory results as to our rate of expenditure in the past and the principal outlay in the future. We have received now the whole of our share capital of £540,000, out of which we expended £360,605 up to June last, and a further £113,170 during the past half-the year, making total at December 31st last £473,776. This sum includes £25,000 for interest paid to the shareholders during construction of the line, as authorised by our Act. The principal item of expenditure during the six months (£80,037) is made up of £76,765 paid to the contractors of the works, and £3,272 to the engineers for their services. Here I may remark that one of our engineers, whose services we extremely value—I refer to Mr. Galbraith—is too unwell to be with us to-day. I am sure we all sympathise with Mr. Galbraith, and hope he will speedily recover. We have, however, Prof. A. B. W. Kennedy here, and he will be ready to give any additional information that may be required. The next large item in the expenditure of the half year is that of £24,839 for the electrical equipment of the railway. The total estimated further expenditure is £103,200, to meet which we have capital powers available to the extent of £237,890. The amount of the final call on the shares, due on Oct. 1st last, has been received. It is very satisfactory to find that there are no arrears in respect of that call. As the shares are now paid up the Directors recommend that they be converted into general capital stock. The stock will then be in a more convenient form, and more marketable. He then read the engineers' report, which accompanied the directors' report (and which appeared in our last issue, page 502), adding that he had received a letter that morning from Mr. Galbraith containing the following paragraph:—"The proprietors are probably aware that the permanent exit at the City is by an incline rising from the low level platforms up to the level of the Central London subways, 15ft. below Mansion House-street. It is to be regretted that the Central London Company's subways will not be ready by the time the Waterloo and City Railway is finished, but to bring the railway into use at the earliest possible date a temporary exit will be constructed to the foot pavement at the corner of Walbrook, Queen Victoria-street, and other exits will be hereafter brought into use by the Central London Company as they are from time to time completed." Continuing, the Chairman said: Of course we are disappointed at not starting the new year with this line open, but the delay is due to no fault of ours, nor of the contractors, nor of anybody else. It certainly is not the fault of the Central London Railway, who are doing all they can to help us to the City. The fact is the underground pipes and culverts have created difficulties and delays which were quite unavoidable. These difficulties are now gradually disappearing, and we hope and believe that our allies, the London and South Western Railway, will be able to bring the line into use at the middle or end of next month. The rolling stock has all been delivered and a complete train will be ready in a few days. The Board have every confidence that the line would prove of great service as a means of comfortable and expeditious communication between the South-Western system and the City, as well as a safe investment for all those financially interested in it. I have nothing further to say, except to congratulate the engineers and contractors, and all those concerned in this important undertaking, on the success that has so far attended their labours, and I trust that the same good fortune will continue up to the time that the works are actually completed. He then moved—

"*That the Directors' report and statement of accounts for the half-year ended December 31st last be, and the same are hereby received and adopted.*"

Lieut.-Col. the Hon. H. W. CAMPBELL seconded the motion.

Mr. BEAVIS asked whether at the end of the current half-year the shareholders would receive interest on their capital as heretofore, or partly interest and partly dividend derived from the working of the line, in the case of there being any.

The CHAIRMAN replied that on July 1st next the shareholders would receive their half-year's interest at the rate of 3 per cent. as usual.

The motion was then agreed to.

The CHAIRMAN then moved—

"*That the whole of the share capital of the Company, now fully paid up, and representing a nominal value of £540,000 be, as from March 1, 1898, converted into a general capital stock of the same nominal value, and divided amongst the shareholders according to their respective interests therein, under the powers and subject to the provisions of the Companies Clauses Consolidation Act, 1845.*"

The Hon. H. W. CAMPBELL seconded, and the resolution was carried.

The retiring Directors (the Hon. H. W. Campbell, Mr. A. E. Guest, and Mr. A. F. Govett) were re-elected; and Mr. W. H. Wilkes Notman was re-appointed auditor.

The proceedings terminated with a vote of thanks to the Chairman.

Dublin United Tramways Company (Limited).

The ordinary general meeting of this Company was held at Dublin on Tuesday, the Chairman (Dr. Carte, J.P.) presiding.

The CHAIRMAN said the results of the past half-year's working were most satisfactory, as they showed increased receipts, economic working, and freedom from accidents. Passengers showed an increase of 1,221,502, representing £5,028, the average fare being 1·39d. for the horse system, and 1·0d. for the electric. During the half-year they carried 242,142 parcels at an average of 2½d. The receipts from this traffic were £2,366, and the profits £683. In November last electric traction was introduced on the Clontarf line from Annesley bridge to Dollymount, with satisfactory results. The speed authorised was ten miles per hour, and no hitch had occurred. The new power house at Clontarf was built on the most up-to-date system, with best equipments. The speed restrictions imposed by the Board of Trade very seriously affected the receipts on the Dalkey system. They had applied to Parliament for power to increase the speed, and they expected to obtain in the coming session the same regulations for the Kingstown and Dalkey line as were approved for the Clontarf line. The delay in extending the electric system to Nelson's Pillar from Haddington-road, on the Dalkey line, and Annesley-bridge on the Clontarf line, had been unavoidable owing to the difficulties they had had in arranging with the Corporation. Matters were now, however, settled, and within the next few weeks they hoped to have the electric cars working in to the city. The Rathmines to the Sea line was far advanced, and no time would be lost in affording the public the facilities for which they have so long waited. The Board of Works were favourably considering the proposal to run a line into the Phœnix Park from Parkgate-street, and past the Zoological Gardens to North Circular-road gate. They had applied for an Order in Council to admit of additional lines being constructed in the city and suburbs, and they had offered to take over the electric lighting of the city. They would, the Directors believed, be in a position to carry out this proposition with advantage to the company and to the ratepayers.

Fish Oil and Guano Syndicate (Limited).

At a meeting of this Syndicate, held in Dublin, the future prospects of the Company were put before the shareholders by Lord Lurgan, who presided. After dealing with the general position his Lordship referred to the Syndicate's patented material "Volenite," which had been discovered by Mr. Lamplough, their advising chemist in London. The Directors, in view of the importance attaching to the discovery of Volenite, came to the conclusion that it would be far better to have it tested as thoroughly as it could be, so that they might know exactly where they were. The Directors were aware that in hard Volenite they had a valuable asset, and he believed they were justified in postponing the issue of the Volenite Company until

the real market value of the property was ascertained. They had sent samples of Volenite to several eminent electricians in London, Manchester, Liverpool, &c., and they all admitted that, if the Syndicate possessed what they they thought they did, they had secured the invention of the age. Some of these electrical firms had applied for large quantities of their pliable material. The tests to which they were subjecting the material would take some time. Volenite had now been brought to a perfected article, ready for the market, and only awaited the erection of the necessary machinery for turning it out in large quantities. Mr. Lamplough reported that he has produced an article that is not only flexible, but that can be worked almost identically the same as india-rubber; that was to say, it could be moulded into any shape, and either vulcanised hard as ordinary ebonite, or left in a cured, flexible condition, similar to india-rubber sheeting, possessing qualities in some cases far superior to the india-rubber, which becomes quite useless for making high-pressure steam joints, whereas flexible volenite will do this and remain quite unaffected at 400° F. This particular use for the new material was of great value on account of the pressing demand for a jointing to withstand the intense heat of modern high-pressure steam machinery, and although there were many steam packings on the market, none appear to have answered, and in making high-pressure joints engineers were still forced to revert to the days of Watt and Stevenson and red-lead putty. A communication had been received from Mr. Nisbett, of the British Insulated Wire Company, Limited, who referred in high terms of the value of volenite, which he had tested severely without any sign of breakdown. In Mr. Nisbett's opinion the material was at least as good, and probably better, for most purposes than ebonite, and would prove a good insulator for general electrical work. They had negotiated the sale of some of their patents and were in treaty in regard to others, and also in regard to certain works for the manufacture of their specialities on the Continent. It was desirable that the capital should be increased to £250,000.

A resolution to this effect was carried unanimously, and a dividend at the rate of 100 per cent. declared on the Ordinary shares, payable on Feb. 14.

Cuba Submarine Telegraph Company, Limited.

The following is the report of the Directors of this Company for the half-year to Dec. 31 last:—

The gross receipts amount to £19,167 7s. 9d., and the gross expenditure to £6,602 10s. 9d., leaving a sum of £12,564 17s., which, added to the balance of £3,317 9s. brought from last account, leaves £15,882 6s. to the credit of revenue. £4,827 17s. 1d. has been added to the reserve fund, together with £1,274 7s. profit on investments realised, while £17,830 4s. 10d., part cost of the new Manzanillo-Santiago Cable and £271 19s. 3d. for repairs have been charged to this account, leaving a credit balance of £106,000. The dividend on the Preference shares will absorb £3,000 and leave £8,054 8s. 11d., out of which the Directors recommend the payment of a dividend on the Ordinary shares at the rate of 6 per cent. per annum, free of income tax, the balance, £3,254 8s. 11d., being carried forward.

The traffic receipts show a decrease of £9,662 17s. 9d. compared with the corresponding period of last year, due principally to the loss of the French Company's traffic, which is now conveyed by that Company's new line between Hayti and New York, as previously explained. The Directors regret that, owing to the falling off in the receipts, a reduction in the rate of dividend on the Ordinary shares has become necessary. In consequence of the establishment of the new line between Bermuda and Jamaica—subsidised by the British Government on the basis of a charge of 3s. per word between the United Kingdom and Jamaica—the Cuba Company have been compelled to accept reduced rates which will result in a considerable loss of income.

The new cable between Manzanillo and Santiago is now being laid, and on the completion of this work the vessel will proceed to the repair of the Cienfuegos-Santiago 1881 cable. The other sections of the Company's cables have continued in good working order throughout the half-year, with the exception of some slight repairs to the harbour length at Santiago.

Westminster Electric Supply Corporation, Limited.

The report of the Directors of this Company for the year 1897 states that the business of the Corporation continues to make satisfactory progress. The supply of current which, on Dec. 31, 1896, was provided for the equivalent of 249,318 lamps of 8 c.p., had increased by Dec. 31, 1897, to the equivalent of 290,561, and at the present time there are on circuit the equivalent of 292,883 lamps of 8 c.p., and applications have been received for a further 10,886 The length of roadway in which mains have been laid now exceeds 44 miles, making about 180 miles of ways, into which upwards of 152 miles of copper (strip and cable) have been drawn.

The extension of the central stations, rendered necessary in consequence of the increase in the business of the Corporation, has been proceeding during the year, and the additional buildings and plant are now nearly completed. The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue, and the Directors consider that, although the economical working of the Stations has been greatly affected by building operations, it is satisfactory to note that there is no increase in the cost per unit generated.

The Directors had approached the holders of the Founders' shares, and had agreed with them a scheme for cancelling these shares, but on further consideration it was found that difficulties might arise thereafter, and an amended scheme was proposed, in accordance with resolutions passed at special meetings of the shareholders called for that purpose. Owing to the way in which the Directors were met by the holders of the Founders' shares those shares have ceased to exist, and all the shareholders are now on the same footing.

The net revenue of the year amounts to £59,461 3s. 10d. An interim dividend at the rate of 8 per cent. per annum for the half-year to June 30 last has been distributed. The balance credit is £34,013 17s. 5d., and the Directors recommend the payment of a dividend at the rate of 16 per cent. per annum, less income tax, for the past half-year, making 12 per cent. for the year, carrying forward £3,119 4s. 1d.

The Directors, having considered the question of provision of future capital, gave notice to pay off the present mortgage debentures bearing interest at the rate of 5 per cent and 4½ per cent. per annum on March 1 next, and have created new First Mortgage debentures of £25,000, bearing interest at the rate of 3½ per cent. per annum. Of this amount £200,000 has been issued, and after providing for repayment of the old debentures, the balance will be expended in further plant and machinery and the extension of existing stations. The issue of these debentures was subscribed four times over.

Cambridge Electric Supply Company, Limited.

The annual report of the Directors of this Company to 31st Dec. last to be presented to the meeting of shareholders to be held at the offices, Cambridge, on Friday, the 18th inst., is as follows:—

The prospects of the Company continue to be satisfactory. During the year 1897 there has been added to the Company's mains the equivalent of 2,562 8-c.p. lamps, making the total 21,195. The number of units supplied has been 221,507 an increase of 23,992 (or 12 per cent.) The total cost of coal has been diminished by 5½ per cent. 42 new consumers have been added, making the total 329. The capital expenditure has been £5,872. 11s. 4d.; 2,027 yards of main conduit pipe and cable have been laid down, making the total 15,298 yards. To insure the continuity of supply in the event of an accident to any one line a duplicate system of distribution has been nearly completed, and a large amount of the cable laid has been for this purpose.

During the year the mains have been considerably extended, and preparations have been made to further extend the mains.

After paying all charges, placing £400 to the reduction of preliminary expenses, and £300 to depreciation account, there is a balance of £2,460. 19s. 10d., which, added to £278. 19s. 7d. brought forward, makes £2,739. 19s. 5d. An interim dividend of £953. 9s. 10d. and interest on debenture and temporary overdraft, £48. 1s. 8d., have already been paid, leaving a nett balance of £1,738. 7s. 11d., out of which the Directors recommend the payment of a dividend of 3½ per cent., making, with 2½ per cent. already paid, 6 per cent. for the year, absorbing £1,445. 11s. 1d., and leaving a balance of £292. 16s. 10d. to carry forward.

National Telephone Company (Limited).

The report of the Directors of this Company for the half-year to Dec. 31st, 1897, will be submitted to the shareholders at the general meeting to be held at Cannon-street Hotel, London, on Thursday next, at 1 p.m. The report states that the income for the half-year amounts to £50,7602. 17s. 3d., compared with £439,978 2s. 4d. for the corresponding period of 1896—an increase of £67,624. 14s. 11d. The working expenses amount to £283,085. 12s. 11d.—compared with £245,278. 13s. 9d. for the same period of 1896—an increase of £37,806. 19s. 2d. The net result for the half-year (after deducting Post Office royalties £46,059. 16s. 8d.) is a profit balance of £178,457. 7s. 8d., compared with £154,982. 8s. 4d. for the corresponding period of 1896—an increase of £23,474. 19s. 4d. The rentals carried forward for unexpired terms of running contracts amount to £473,586. 17s. 10d., compared with £414,714. 9s. 8d. at the same period last year.

Out of the available balance of £156,435. 8s. 5d. the Directors recommend the payment of a dividend at the rate of 6 per cent. per annum, less income tax, on the First and Second Preference shares, 5 per cent. per annum, less income tax, on the Third Preference shares, and 6 per cent. per annum, free of income tax, on the Ordinary shares, and to transfer £40,000 to reserve, carrying forward £10,034. 3s. 5d.

Capital Expenditure.—£267,375. 1s. 3d. has been expended on capital account during the half-year, partly in the erection of 5,633 additional exchange and private lines and partly in the construction of underground lines in substitution for overhead wires in several important places, Manchester being mentioned in particular. The financial burden cast upon the Company is considerable, but the Board have faced it in the confident belief that greatly increased efficiency will lead to a corresponding extension of the use of the telephone. In Belfast, Birmingham, Blackburn, Bradford, Bristol, Dublin, Dundee, Leeds, Liverpool, Nottingham, Portsmouth, Sheffield and other leading cities and towns, the underground works are being proceeded with rapidly. The report refers to the election to a seat on the Board of Sir H. H. Fowler, M.P., in the place of Alderman J. Thompson.

NEW COMPANIES, STATUTORY RETURNS, &c

ELECTRIC WORKS COMPANY (LIMITED).—This Company was registered on Feb. 1, with a capital of £10,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and manufacturers of and dealers in electrical apparatus, and to construct, lay down, fix and carry out all necessary cables, wires, dynamos, engines, accumulators, lamps, meters and works. The first subscribers are: W. M. M. Forwood, C. O. Grindrod, A. E. Haptie, F. W. Lintern, A. Ruckley, R. Smith and J. T. Downes.

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PERTH ELECTRIC LIGHTING COMPANY (LIMITED).—This Company was registered on Feb. 1, with a capital of £1,000 in £1 shares, to carry on at Perth, and elsewhere in the colony of Western Australia, the business of electricians, electrical and mechanical engineers and contractors, suppliers of electricity and manufacturers of electrical apparatus. The subscribers are: E. Pope, J. Doyle, Sir James D. Mackenzie, Bart., G. T. Bean, H. J. Dixon, J. J. Daynes and F. R. Wolseley.

WARRINGTON AND DISTRICT ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—This Company was registered on Jan. 31, with a capital of £2,000, in £1 shares, to enter into an agreement with Mr. Charles L. Clarke, electrical engineer, and to carry on the business of suppliers of electricity, electrical engineers and contractors, mechanical engineers, and manufacturers of electrical fittings and accessories. The first subscribers are: R. W. Francomb, W. H. Robinson, J. Cannell, R. Curran, A. Polley, H. W. Francomb, and C. L. Clarke, electrical engineer.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26 1/8d. per oz. (Feb. 10). Consols (2¾ per cent.) 112⅛—112⅜ for money, 112 11/16—112 13/16 for account; 2½ per cent. 105⅞—106¼ (Feb. 10). Stock Exchange Settling Days: Consols, March 1; Stocks and Shares Continuation Days, Feb. 22 and March 9; Ticket Days, Feb. 23 and March 10; Pay Days, Feb. 24 and March 11.; Mining Share Carry-over Days, Feb. 21 and March 8.

BENGAL TELEPHONE COMPANY (LIMITED).—A dividend at the rate of 7 per cent per annum for the year 1897 has been declared.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY (LIMITED.)—The report of the Directors of this Company, to be presented at the ordinary general meeting to be held at Bristol, on Thursday next, srates that the gross receipts for the half-year amount to £69,483. 5s. 1d., and the working and general expenses and renewals are £52,623. 9s. 2d., leaving a net balance of £16,859. 15s. 11d., which is to be appropriated in paying interest on the 4 per cent. Mortgage Debenture Stock (£2,260. 0s. 9d.), and a dividend of 6 per cent. per annum (free of income tax) for the half-year ended Dec. 31 (£8,750). The balance (£5,849. 15s. 2d.) is to be carried to reserve and renewal funds. The receipts from the Tramways department show an increase of £9,494. The total number of passengers carried during the six months was 11,060,817. The extension of the electric line from Eastville to Staple Hill was opened for public traffic as far as Fishponds on Sept. 28, and throughout to Staple Hill on Nov. 4 last. The Light Railway Commissioners held their local inquiry into the Company's application for the St. George and Hanham Light Railway Order, which was opposed by the Corporation of Bristol. The opposition was, however, unsuccessful, and the Commissioners have announced their decision to grant the Order.

BRITISH ELECTRIC TRACTION COMPANY (LIMITED).—The Electric and General Investment Company have this week offered for subscription a first issue of 10,000 Six per Cent. Cumulative Preference shares of £10 each in the British Electric Traction Company, Limited, the price of issue being £12. 10s. per share. The list closed yesterday (Thursday).

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS COMPANY (LIMITED).—Applications have this week been invited for £250,000 Five per Cent. Debenture stock and £200,000 "A" Six per Cent. Cumulative Preference shares in this Company, which has been formed to acquire and amalgamate the concessions, lines, and properties of the Buenos Ayres and Belgrano Tramways Company (Limited), and the concession recently granted to Mr. Charles Bright, of Buenos Ayres, for an electric tramway between that city and Belgrano, together with the lines constructed or in course of construction.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The revenue return of this Company for the quarter ended Dec. 31, 1897, is as follows: Gross revenue from sale of current for public lighting (after deduction of allowances) £3,119, against £2,970 in the corresponding period of last year; private lighting, &c. (after deduction of allowances), £59,796, compared with £53,399; estimated revenue from other sources, £2,000, against £1,000, making a total of £64,915 against £57,369, an increase of £7,546. On Dec. 31 there was an equivalent of 296,012 8-c.p. lamps connected, being an increase of 17,850 during the quarter, against an increase of 19,045 in the corresponding quarter of 1896. The transfer books and the registers of members of this Company will be closed from the 16th inst. to March 2 inclusive.

EASTERN TELEGRAPH COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company will be held at Winchester House, Old Broad-street, E.C., on Tuesday, the 15th inst., at 12:30.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—The Directors of this Company have resolved that a payment on account of the dividend of the current year be made at the rate of 5 per cent. per annum, less income tax, on the "A" shares of the Company, in respect of the half-year ended Dec. 31, 1897. This will work out at 1s. 6d. per share on the partly-paid £5 shares (£3 paid) and 2s. 6d. per share on the fully-paid £5 shares. Dividend warrants will be issued on the 24th inst.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED).—The Directors of this Company recommend a dividend at the rate of 12 per cent per annum on the Ordinary shares (including the interim dividend of 3 per cent. paid in September).

KIDDERMINSTER AND STOURPORT ELECTRIC TRAMWAY COMPANY.—The half-yearly general meeting of this Company will be held at the offices, Donnington House, Norfolk-street, Strand, London, W.C., at 3 p.m. on Thursday, the 24th inst.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The half-yearly meeting of this Company was held on Tuesday at Liverpool, Sir W. B. Forwood presiding. In moving the adoption of the report, the Chairman congratulated the shareholders upon the progress which the Company had made. With a dividend for the past half-year of 3½ per cent. per annum they had paid 3¼ per cent. on the year, and carried forward a balance of £2,878. During the year they had also paid £2,000 to the Tramway Company, with whom their agreement terminated on Jan. 10 last. Partly owing to the Dingle extension there had been an increase in the passenger traffic of 545,000 on the half-year, and of 1,078,000 on the year. Last year they carried 8,736,000 passengers, and seeing that in the first twelvemonths after the opening of the railway the passengers numbered 5,400,000, he considered that the rate of progess was eminently satisfactory. The ratio of expenditure to revenue was 64·54 per cent., but eliminating what they carried to renewal and contingent fund, and what they paid the Tramway Company, it worked out at 56 per cent. of the revenue, which was a reasonable figure. They endeavoured to maintain the line and the electrical equipment at the highest point of efficiency. They had now to the credit of renewal and contingent fund £20,100, and they were adding to it every year. The traffic to the Dingle was growing at a satisfactory rate. Arrangements had been made which would obviate any defects in the lighting of the Company's carriages in future.

SCARBOROUGH ELECTRIC SUPPLY COMPANY (LIMITED).—The Directors of this Company recommend the payment of a dividend of 5 per cent., less income-tax, for the past year. The gross profit on the year's working was £2,044, against £1,617 in 1896.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have ordered £120,000 Four and a-Half per Cent. registered debentures (No. 1 to 1,200) of the Direct West India Cable Company (Limited) to be quoted in the official list.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—Subject to audit, the Directors of this Company propose to pay a dividend of 10 per cent. (£1. 4s. per share), making, with the 5 per cent. already paid, 15 per cent. for the year 1897.

TRAMWAYS UNION COMPANY (LIMITED).—In the report which has just been issued by the Directors of this Company, it is stated that the formal sanction of the Madrid Municipality for the conversion of the horse tramways into electric lines on the overhead trolley system has been obtained, and the work of conversion is now in active progress.

UNITED ORDNANCE AND ENGINEERING COMPANY (LIMITED).—The prospectus is now issued of this Company, which incorporates the business of Easton, Anderson and Goolden (Limited), and has a share capital of £550,000, and First Mortgage Four and a-Half Debenture stock of £250,000.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ending Feb. 4 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,856.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Feb. 5	3,488	+510	...	...	...
Bristol Trams & Carriage	,, 4	2,276	+372	5	11,829	+ 2,534
City & South London Ry.	,, 6	1,063	- 60	6	6,456	- 155
Dover Tramways	,, 5	101	...	22	2,469	...
Dublin United (Southern)	,, 4	383	- 7	5	2,103	+ 73
Liverpool Overhead Rly.	,, 6	1,283	+ 42	6	8,130	+ 528
Sheffield Tramways	,, 6	939	+130	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Feb. 2.	Price Wednesday, Feb. 9.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 5. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	3/0	Central London Ordinary	9¾ 10¼	9¾ 10¼	2 13 6	June and December	10¼	10
146,105	10	1/9½	Do. (66 paid)	5½ 3	5½ 6	2 17 7	,, ,,	6 7/16	5 13/16
2000,000	Stock	2¾	City and South London Railway Con. Ordy.	69 71	69 71	2 14 10	January and July	71	70½
8,419	£10	5%	Do. 5% Perpetual Preference	15½ 16	15 16	3 2 6	,, ,,	...	...
£135,701	Stock	4¾	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	138½	...
54,000	10	¾	Waterloo and City Ordinary	13½ 13⅝	13½ 14	2 2 10	June and December	14	13 11/16
37,500	10	3%	Liverpool Overhead Railway Ordinary	11 5/16 11 7/16	11½ 11⅝	2 12 7	February & August	—	—
10,000	10	5%	Do. 5% Preference	16 16½	16 16½	3 0 7	,, ,,	—	—
125,000	Stock	4%	Do. 4% Debenture	108 110	108 110	3 11 5	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Feb. 2.		Price Wednesday, Feb. 9.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 5.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£923,960	Stock	14/0	Anglo-American	62	64	62	64	4 13 9	Feb., May, Aug., Nov.	68⅝	67½
£3,038,020	Stock	23/0	Do. Preferred	112	113	112½	113½	5 5 9	" "	114½	112
£3,038,020	Stock	5/0	Do. Deferred	13	13½	13½	13⅝	..	—	13⅝	13⅛
£ 37,400	£100	4%	*African Direct Telegraph (Red)	100	104	100	101	3 16 11	January and July	—	—
£25,000	10	..	Amazon Telegraph	6	7	6	7	..	—	..	—
130,000	10	3/0	Brazilian Submarine	16⅜	17½	16⅜	17¼	4 1 2	Mar., June, Oct., Dec.	17	—
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	112	116	4 6 2	June and December	—	—
10,000,000	$100	$3½	Commercial Cable Capital Stock	187	192	187	192	4 3 6	Jan., Apr., July, Oct.	—	—
£353,586	Stock	4%	Do. 4 per Cent. Debenture Stock	106	108	106	108	3 14 1	" "	107½	106½
16,000	10	8/0	Cuba Submarine	8	9	8	9	8 17 10	February and August	8½	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	—
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	—	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	—	—
£80,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	..	—
60,710	£20	3/0	Direct United States Cable, 1877	10½	11	10¾	11¼	5 15 7	Jan., Apr., July, Oct.	11	..
400,000	£10	2,6	Eastern	18	18½	18	18⅛	3 10 3	" "	18⅞	18⅛
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	19	20	19	20	3 0 0	" "	19⅛	..
£1,302,615	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock (red.)	131	134	131	134	2 19 11	May and November	133½	133½
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension	18½	19½	18⅜	19½	3 13 8	Jan., Apr., July, Oct.	19⅛	18⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	130	133	130	133	3 0 2	February & August	—	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99	103	99	103	4 17 3	January and July	..	..
£121,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99	103	99	103	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 16 2	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞	111⅞	108⅞	111⅞	3 12 1	May and November	..	..
189,227	10	1/9	Globe Telegraph and Trust	12	12½	12	12½	3 14 0	Jan., Apr., July, Oct.	13⅜	12
180,042	10	6%	Do. 6 per Cent. Preference	17½	18½	17⅜	18½	3 5 9	" "	18⅛	17⅜
151,000	10	5/0	Great Northern of Copenhagen	27	28	27	28	3 11 5	January, April, July	..	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	101	104	101	104	4 17 7	March & September	..	—
17,000	25	12/6	Indo-European	52	55	52	55	4 10 11	May and November	54⅜	54½
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	108	111	108	111	5 10 1	March & September	—	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105	108	105	108	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	8	9	8	9	4 8 11	April and October	8	..
3,381	£100 Cert.	6%	Submarine Cables Trust	140	145	140	145	4 2 9	" "	—	—
15,609	10	6/0	West African Telegraph	4	5	4	5	5 0 0	..	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 14 4	March & September	..	—
30,000	10	..	West Coast of America	¾	1½	¾	1½	..	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	107	106½	107	3 14 9	June and December	..	..
88,321	10	1/0	West India and Panama	½	¾	½	¾	..	May and November	—	—
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7½	8	7½	8¼	7 5 5	" "	8½	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	—	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 2	January and July	—	..
64,256	15	3/0	Western and Brazilian	10½	10⅝	10½	11	2 14 10	May and November	10⅝	10⅜
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	8	7⅜	8	3 15 2	" "	7⅝	7⅜
33,129	7½	1/6	Do. Deferred Ordinary	3½	3¾	3½	4	..	" "	3⅞	3⅝
£382,220	—	4%	Do. 4 per Cent. Debenture Stock	103	107	105	107	3 14 1	June and December	106½	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	—	—
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	—	..
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3	3½	3	3½	5 14 4	August	—	—
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	1/16	1/16	1/16	..	July	..	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2⅛	8 0 0	October	..	—
484,597	5	3/0	National	6⅞	7	6⅞	7	4 5 9	February & August	7	6⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 10 7	" "	16⅛	16
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14	16	14	16	3 15 0	" "	16	—
20,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6	6½	6	6½	3 16 11	" "	6 1/16	6 1/16
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104	109	104	109	3 4 0	June and December	106½	104½
171,604	1	0/4	Oriental	⅝	¾	⅝	¾	6 13 4	April and October	..	—
58,000	5	5/0	United River Plate	4	4½	4	4⅛	5 11 1	July	—	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	106	101	106	4 14 6	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	10½	11	1 ¾		—	March	..	—
£50,000	5	..	Do. (New Issue) £3, 10s. paid	..	..	..		..	..	..	—
50,000	£10	14/0	City of London Electric Lighting (fully paid)	29½	30½	28½	29½	2 7 5	February & August	3 ⅛	29
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17⅛	18½	17½	18½	3 4 10	January and July	18	17⅝
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	132½	131
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	14	15	14	15	2 3 6	February & August	14⅝	14½
20,000	5	2/3	Do. 4½ per Cent. Preference	6½	6⅞	6½	6⅞	3 6 8	" "	6⅞	..
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	—	—	January and July	—	—
£26,000	5	2,6	Chelsea Electricity Supply Ordinary	11	11½	11½	11¾	3 3 10	March	11⅝	1 ½
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	112	114	112	114	3 14 7	June and December	—	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	15⅜	16¼	15⅜	16⅛	..	..	16¼	15⅜
20,000	£10	6/0	Do. 6% Cumulative Preference	15⅜	16¼	15⅜	16⅛	3 13 10	March & September	16¼	16 1/16
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	10½	11½	10½	11½	..	..	11	10¼
10,000	£5	7%	Do. 7 per Cent. Preference	11½	12	11½	12	2 18 4	March & September	12	11⅞
111,000	£5	..	London Electric Supply Ordinary	4½	5	4⅜	4¾	..	..	..	—
48,050	£5	..	Do. Preference	6½	7	6⅜	7⅛	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	20	21	20	21	2 12 4	April and October	20¼	20 1/16
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	19½	21½	19½	20⅜	..	" "	19 1/16	—
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	..	—
6,452	10	8/0	Notting Hill Electric Ordinary	18	19	18	19	2 2 1	March	..	..
275,000	1	—	Rand Electric	1½	1⅝	1½	1⅝	..	—	—	—
£125,000	Stock	5%	River Plate Elec. Ltd., 5% 1st Mor. Deb.	90	95	90	95	5 5 3	..	..	..
150,000	$100	$2	Royal Electric Company of Montreal Shares	145	147	145	147	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 4 1	April and October	..	..
19,980	5	3,6	St. James and Pall Mall Electric Ordinary	18	19	18½	19½	3 14 4	February & August	18⅞	18⅝
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	10⅝	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	101	104	104	107	3 15 2	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	18	19	18	19	3 3 2	March & September	18⅜	18
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	5%	Brush Electrical Engineering	2⅛	2⅜	2⅛	2⅜	—	—	2 1/16	2 1/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2⅜	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109	113	109	113	4 0 9	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 6 2	June and December	—	—
10,000	£10	..	British Aluminium Ordinary	..		—		—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference	..		—		—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	8	9	8½	9⅛	5 5 3	June and December	9	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	103	111	108	111	4 1 3	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1	1⅛	1	1⅛	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	2⅝	2½	2⅝	—	—	—	—
£2,850	100	—	* Do. 5% First Mortgage Debentures (red.)	86	91	86	91	5 6 5	January and July	—	—
99,261	5	1/9⅔	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3	5 10 0	February & August	2⅛	—
17,139	5	2/9⅔	Do. (£5 paid)	4½	5½	4	5	5 10 0	" "	4⅛	4⅜
£200,000	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.)	103	105	103	105	3 16 2	June and December	..	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅜	3	2⅜	3	3 10 0	February & August	2⅛	2⅛
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3⅝	3½	3⅝	4 3 4	August	..	..
91,166	1	10/0	Elmore's Patent Copper Depositing	½	⅝	½	⅝	..	..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	21½	22½	22½	23½	4 5 1	February & August	23	..
3,000	10	7/0	Do. 7 per Cent. Preference	19	20	19	20	3 10 0	" "	19⅝	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 10	" "	..	—
80,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	22½	23½	22	23	4 6 11	" "	22 1/16	22⅝
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	103	107	3 14 9	March & September	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	39	42	39	42	4 2 5	March and July	40½	40
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July	—	—
£22,500	£5	5.6	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	8⅜	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	6½	7¼	6½	7¼	4 2 9	" "	7⅛	7
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	106	108	106	108	3 18 6	May and November	—	—

* In calculating the yield on this security, allowance has been made

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NOTES.

A PORTION of Major-General WEBBER'S Paper, read before the Institution of Electrical Engineers, has already appeared in our columns, and on this, which consists essentially of abstracts of patent specifications though doubtless useful to intending litigants, we do not propose to comment at length. As regards the latter part, which we print this week, somewhat closer criticism may be useful. This portion of the Paper is concerned with the description of the Pelatan-Clerici process, which is stated to be single and continuous and (modestly enough) "to effect in one operation all that can be expected of it." It is well to recollect that in gold extracting processes expectation should not be pitched too high. The description of the process is somewhat involved, but as far as we can discern, the method consists in treating ore mixed to a pulp with water by means of chlorine produced by the electrolysis of common salt and subsequently extracting the gold from the ore thus treated by the use of potassium cyanide. These operations are carried out in a vessel with a revolving anode and a mercury cathode. In the first part of the process not only is chlorine given off at the anode for the purpose of opening up the ore, but sodium is liberated at the cathode and acts as a "quickener" to the mercury, which may thus more readily amalgamate with free gold, or with gold deposited from the electrolysis of its chloride previously formed at the anode.

THE Pelatan-Clerici process is therefore a pleasing blend of most known processes of gold extraction. There is mercury to amalgamate free gold, chlorine to open up refractory portions of the ore, and cyanide to dissolve finely-divided gold. Then, as subsidiary features, the mercury is "quickened" in the most approved way by sodium prepared *in situ*, the cyanide solution is provided with its needed oxidant in the form of electrolytic chlorine, and the deposition of the gold from its extracting liquid is effected by electrolysis. Surely here is a bewildering congeries of advantages. And yet—and yet—one doubts. One seems to remember something known in *materiâ medica* as "incompatibles," and wonders whether the outcome of the numerous ingredients of this particular recipe will exhibit any incongruities such as the commingling of these is wont to evoke.

THERE is one other reflection, and that of ultimate significance. Given that this amalgamation-cum-chlorination cum-cyaniding process can be got to work, what is its cost? Figures were given in the course of the discussion which we hope may be found generally applicable. In the Paper itself this fundamental question was untouched. We can imagine the greeting which would await an inventor who should show that there is one process of gold extraction which is absolutely unexceptionable, extracting 100 per cent. from any ore. Nor is such a process a mere fanciful conception. It exists, and we will divulge it without fee or reward. Let there be taken sundry parts of ore, sundry of litharge, also of soda ash *quant. suff.*, carbonaceous matter a pinch; let the whole be fused; scorify and cupel the button of auriferous lead resulting and the gold is extracted in full. It is true that this is the common method of assay, and that its cost as a means of gold extraction is prohibitive; but if he were to communicate it, our hypothetical inventor would have fulfilled his bargain, and would be justified in retiring with the spoils as gracefully as public and transitive expression of opinion might permit. In a position precisely similar stands any inventor who ignores the question of cost. No amount of ingenious artifice, no subtle combination of seeming incompatibles can save such a one from the pitiless criticism of the balance-sheet.

LAST week we announced that, by an arrangement between the Institution of Electrical Engineers and the Physical Society, there would be published monthly a number of abstracts of papers and articles on electrical and other physical subjects. Mr. SHELFORD BIDWELL, in his Presidential Address before the last named Society last Friday, alluded to the new arrangement, and we heartily agree

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with him in the opinion that by the co-operation of the two scientific bodies a better class of publication should be produced, at less cost, than when each institution compiled its own abstracts independently. The scheme, indeed, is an excellent one and, if properly carried out, should benefit members of both scientific associations; the only matter for surprise, if not regret, is that in neither case were members made acquainted with it until it had become *un fait accompli*—especially as the recent annual general meeting of the Institution afforded an excellent opportunity to ventilate the matter.

THE first number of *Science Abstracts*, the title of this new publication, is now in our hands. It is a neat, paper-covered magazine, of exactly 50 pages, containing some 104 abstracts from British and foreign electrical and physical periodicals. These latter are classified under ten headings, of which two relate to electrical theory and science, and four to electrical engineering and practice, the remaining four sections dealing with branches of physics not of a directly electrical nature. The first batch of abstracts is not particularly up to date, but this defect is, however, excusable in a first number, and will probably be remedied as time goes on. We notice that the staff of abstractors for the new publication is substantially the same as that which formerly compiled the Physical Society abstracts, the only important change being the appointment of Mr. W. R. COOPER to the new post of sub-editor.

THE report issued by the Directors of the National Telephone Company was presented to a meeting of shareholders yesterday, and it is interesting to note how the profits derived from this great "telephone monopoly" are divided between the shareholders and the Post Office. After deducting 10 per cent. of the gross receipts for rentals, &c., for Post Office royalties, setting aside an adequate sum to reserve, and paying dividends of 6, 6, and 5 per cent. on the 1st, 2nd, and 3rd Preference shares, a 6 per cent. dividend remained for the Ordinary shareholders—hardly an excessive one. Possibly the telephone service would be cheapened if the system were owned by the Government; for it should be pointed out that a sum equal to nearly half that divided among the Preference and Ordinary shareholders is now paid as royalty to the Post Office. Any other Company or Corporation licensed by the POSTMASTER-GENERAL would have to submit to the same burden of 10 per cent. on the gross receipts. Opponents of the National Telephone Company can, of course, contend that the proportion of the working capital to the whole is not as large as it should be; that too much has been expended in buying out rival concerns; and that still more has been sunk in systems which have since become obsolete, and have necessarily been rebuilt. But it must be remembered that the National Company, and the companies from which it is formed, have done all the pioneer work in this country, and it is hardly to be expected that such work will be done gratuitously by an industrial concern. It is worthy of notice in this connection that no less than £267,875 has been spent by the National Telephone Company during the half-year in the erection of additional exchange and private lines, and in the construction of underground in place of overhead wires in several districts.

BEFORE leaving the question of pounds, shillings and pence we will express our regret that, as stated by Mr. HANBURY in the House of Commons on Monday, the expenses of the inter-urban telephone service, conducted by the Post Office department, are not kept distinct from those of the telegraphs. In the case of the profit and loss account of its telephone exchanges this might be reasonable, as it has there to deal with direct competition; but no such reason holds in the case of the trunk lines, and an independent analysis of these accounts would be both useful and instructive.

THE case for municipal telephony does not appear to be making much headway. The result of the inquiry at Glasgow has not yet been made known, but in the meantime the Huddersfield Corporation has made application for a telephone licence, and has been refused. The latter town is now considering the National Company's proposal, made some months ago, to reconstruct the telephone network on the underground metallic circuit system if way-leaves and proper facilities are granted. The Company propose that the Corporation itself should undertake the laying of the wires, charging the Company with the full cost of the work; and the Company offers to pay the Corporation in addition a royalty of five shillings annually per subscriber. A number of other towns are intending to apply for licences as soon as the Glasgow decision is made known. The London County Council, on the other hand, as announced in our issue last week, apparently intends to apply for a licence without waiting to hear this decision.

THERE is a splendid field for British-made electric traction plant in America, as every electrical manufacturer in this country well knows; but the field nearer home, consisting in our own tramways, is by no means insignificant, and many of these sorely need electrical equipment in order to turn them into satisfactory paying concerns. A return recently submitted to the House of Commons by Mr. RITCHIE shows the state of development of the street and road tramway industry up to June 30th last. According to this document there were in operation at that date 1,031 miles 31 chains of tramways in the United Kingdom, 663 miles 48 chains being owned by companies and 367 miles 63 chains by municipal and other local authorities. The nett increase upon the aggregate at the corresponding date in the previous year was only 22 miles. The total capital outlay on working lines amounted to £11,400,173, and for lines constructed the outlay reached £14,865,110. An aggregate of 788,500,000 passengers were carried during the year. Notwithstanding the developments in various systems of mechanical and electric traction, no less than 37,342 horses are employed on tramways, and this number shows an increase of nearly 5 per cent. upon the previous year. This is an encouraging figure for electric traction engineers, showing, as it does, that the public finds it increasingly difficult to dispense with tramcars, in spite of the dreary slowness inevitable when these are drawn by horses. Some day the public will awake to the fact that those 37,342 tram-horses are a mistake.

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From the report given in our City Notes this week of the meeting of the Tramways Union Company (Limited) it will be seen that the conversion of horse tramways into trolley lines has resulted in many parts of the world in a large increase in traffic and in more profitable returns. It may be objected that, though this has happened in foreign countries, a similar beneficial change would not necessarily take place here. To this criticism we can only reply that it is the conviction, not only of engineers who have studied the matter, but also of experienced tramway experts, who are quite disinterested as regards any particular means of traction, and who have made extensive trials of both horse and trolley, that the replacement of the former by the latter in British tramways results in a much larger and more profitable turn-over.

Erratum.—In Major-Gen. Webber's Paper, p. 519 of our last issue, an = should be inserted between 4KCN and 2, in the first equation of the first footnote.

Appointments.—Mr. Edward May has been appointed Controller of the Central Telegraph Office in the room of Mr. H. C. Fischer, C.M.G., retired; and Mr. Thomas Barlow has been made Deputy-Controller.

Electric Power in the Russian Navy.—The St. Petersburg correspondent of *The Times* states that the Russian Admiralty has decided upon the installation of electric power in all warships, for the purposes of raising ammunition and loading and working the guns.

New Cable.—Reuter's agency states that the Spanish Minister of the Interior has approved of the laying of a cable between Spain and Havana. The project (it is said) now awaits the consent of the Spanish Colonial Minister. We have been unable to obtain any verification of this announcement in London.

Royal Society.—The following were among the Papers down for reading yesterday: "On the Connection between the Electrical Properties and the Chemical Composition of Different Kinds of Glass," by Prof. A. Gray, F.R.S., and Prof. J. J. Dobbie; and "On the Magnetic Deformation of Nickel," by Dr. E. Taylor Jones.

Cable Interruptions and Repairs.—

	Date of Interruption.		Date of Repair.
Ceara—Maranham	Dec. 23, 1897	...	Feb. 17, 1898.
Curaçao—La Guayra	Jan. 5, 1898	...	Feb. 15, 1898.
Bolama–Bissao	Jan. 28, 1898	...	Feb. 14, 1898.
Emden—Vigo	Feb. 7, 1898	...	—
Lataki—Cyprus	Feb. 10, 1898	...	—

The Paris Exhibition of 1900.—Replying to Sir H. Vincent in the House of Commons on Monday, Mr. Curzon said that it was proposed to ask Parliament for a grant of £75,000 to provide for the expenses connected with the British section. The German Government had sanctioned a grant-in-aid of five million marks, or about £250,000. The United States Government had made a Treasury estimate of $350,000, or about £70,000. In Italy nothing had yet been officially settled as to the exact amount to be devoted to this purpose.

The Académie des Sciences.—Among the prizes awarded by the Académie des Sciences for the year 1897 are the following:—The La Caze prize (physics) to Dr. Lenard for his work in connection with cathode rays, the Gaston Planté prize to M. André Blondel for his well-known research work in various directions, the La Caze prize (physiology) to Prof. Röntgen for his great discovery, and the Montyon prize (medicine and surgery) to MM. Rémy and Contremoulin, and MM. Marie and Ribaut for collections of X-ray photographs.

The Inter-urban Telephone Service.—In the House of Commons, on Monday, Mr. Provand asked the Secretary to the Treasury what were the working expenses of the inter-town telephones, and how much the inter-town wires had earned since the date on which they were taken over from the National Telephone Company to December 31, 1897. Mr. Hanbury stated in reply that the capital expenditure—partly estimated—to December 31, 1897, was £1,190,000. This sum included the amount paid to the National Telephone Company. The gross earnings up to the same date amounted to £200,832. The working expenses, being included in those of the telegraph service, could not be separately stated.

Physical Society.—By the invitation of the Rev. T. C. Porter, of Eton College, the meeting of this Society, which would ordinarily have been held on Friday, February 25th, will be held at Eton College on Saturday, February 26th, at 4 p.m. Mr. Porter will describe the following:—(1) A new theory of Geysers; (2) A new method of viewing Newton's Rings; (3) Experiments bearing on the Sensation of Light; (4) A method of viewing Lantern Projections in Stereoscopic Relief; (5) Winter observations on the shadow of the Peak of Tenerife, with a new method for measuring approximately the Diameter of the Earth; (6) Temperature of the Water of Niagara. Fellows of the Society will also have the opportunity of seeing Mr. Porter's laboratory, and the arrangements for teaching science at Eton College.

Presentation.—On Tuesday last Mr. H. C. Fischer, C.M.G., vacated the position of Controller of the Central Telegraph Office, which he has held since the purchase of the telegraphs by the Government in 1870. Mr. Fischer was presented by the members of his own staff and of all the departments of the Post Office with many interesting and costly presents, the contributors being representative of all branches of the telegraph and postal service in London, the suburbs and the provinces. The gifts included one from the officers of the late Submarine Telegraph Company who were transferred to the Post Office service on the taking over of the Company's lines in 1889. Mr. Fischer's retirement has been the occasion of a unanimous expression of regard, not only from the Postmaster-General, the Secretary to the Post Office and the heads of departments, but from every member of the Postal Telegraph staff, the general feeling of regret at his departure being warmly expressed in the communications which have accompanied the various presents.

Water-Power Utilisation in British Columbia.—The Kootenay copper and gold mining district in British Columbia is seriously hampered by the cost of power, the only available fuel being wood, and the forests in the neighbourhood of the district itself have already become almost depleted. To supply cheaper power, says the *Engineering and Mining Journal*, a large electrical generating plant is reported as being installed where the Pend d'Oreille River empties into the Columbia River. Here a fall of 206ft. is available by means of a short flume, with a sufficient body of water to generate many thousand horse-power, the annual variation in flow being small, owing to the enormous storage capacity of the large lake, Pend d'Oreille. An old placer-mining plant, with about 1,000 H.P. of water wheels in place, is being converted into a generating station. To this will be added 3,000 H.P. more, the whole being distributed to the mines round about, to be used for mining machinery and the electrolytic refining of copper. The plant will be situated in a mining district, and distribution lines will radiate in every direction. The longest line contemplated at present is some 22 miles in length.

"Running on the Shunt."—As is well-known, in meters of the Elihu Thomson type a shunt coil is added to the field magnet to compensate for solid friction and thus diminish the starting current. If this adjustment is made too delicately, however, the meter is inclined to start "running on the shunt," if subjected to vibration such as often occurs in consumers' premises. The *Industrie Electrique* of February 10th contains an account of an experimental investigation made by Mr. E. O'Keenan, of the Compagnie Parisienne de l'Air Comprimé. Mr. O'Keenan finds that by the simple expedient of mounting the meter on four rubber legs screwed to a bracket, instead of following the usual practice of screwing it against the wall, the effect of vibration

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is considerably diminished, and the compensating pressure coil may be adjusted to very nearly counterbalance the solid friction and bring down the starting current to a very low value without the danger of its assuming, so to speak, a negative sign. He found that if mounted in this way large meters could be adjusted to start at 0·5 per cent. of their maximum current, and yet not be jolted into motion by the passage of vehicles in the street when no current was passing to the lamps. Thus a meter for 25 amperes at 440 volts used on a five-wire system could be relied on to register as soon as a single 10-c.p. lamp was switched on, although it showed no reading for the time no current was flowing.

Electrical Ignition of Fire-Damp and Coal Dust.—The *Electrotechnischer Anzeiger* of last week publishes the following particulars extracted from recent articles contributed by T. Heise and Dr. Theim to "Glückauf" and the *Electrotechnische Zeitschrift*, containing a report of certain very exhaustive experiments made by them on the "Ignition of Fire-Damp and Coal Dust by Electricity." It is not claimed that these experiments permit of definitely conclusive deductions being drawn, yet they serve as a valuable basis for further researches. The results, briefly summarised, are as follows:—

That the quantity of electricity which, under certain circumstances, is capable of ingiting fire-damp is exceedingly small, but it is impossible to ascertain its exact amount, inasmuch as this depends not only on the quantity of electricity, but also upon the way in which it comes into effect (whether by means of sparks when the contact is broken, or by heated wire, incandescent carbon threads, &c.), and other circumstances. It is only possible to calculate the minimum for certain kinds of transformation of energy in a circuit the conditions of which are accurately and precisely known. In any case the appearance of naked sparks is to be most carefully avoided, as the question which forms of these are free from danger can only be decided by experiment. Independent explosions of coal dust caused by electricity alone appear to be impossible unless the dust contains particles of a specially dangerous nature, and experience leads to the conclusion that the detonation of the blasting powder is largely responsible for such occurrences. The coal dust would in this case come within the category of "explosive dust." It is desirable that the use of large bulbs for incandescent lamps should be adopted, in order that the surrounding glass, when broken, should be drawn forcibly inwards, causing a powerful cooling off. The lamp socket must be so arranged that its upper edge projects above the points of attachment of the filament, in order that a shock does not bring the wires into contact, thus causing a short circuit. High-pressure lamps with double filaments should be avoided, as the threads are liable to touch each other, producing a short circuit. The normal strength of current should be under 0·6 ampere, and pressures above 150 volts are not practicable.

Electric Cranes at Crewe Railway Works.—Electricity is very largely used for working the cranes at the Crewe shops of the London and North-Western Railway. The motors have field-magnets of the Manchester type, and Paccinotti armatures. In starting a motor, says *Engineering*, a variable resistance is switched in to diminish the starting current, being cut out when the motor is fairly running. All the motors used are designed to run at 1,500 revolutions per minute, the speed being afterwards reduced by worm-gearing. In the case of the 30-ton cranes used in the erecting shops for lifting locomotives, the load is lifted at a speed of 2ft. 6in. per minute at an expenditure of 70 amperes at 120 volts. The long travelling is performed at a speed of 100ft. per minute, with an expenditure of 60 amperes at 120 volts, and the cross traverse at a speed of 50ft. per minute, with an expenditure of 30 amperes at 120 volts. In the case of light weights the speed of lifting is 10ft. per minute. In the case of the 15-ton crane, which has been provided in connection with a boiler-riveting plant, the crane is 50ft. above the floor level, and all its movements are controlled by switches on the ground, a magnetic brake being provided on the armature shaft to arrest the motion as soon as a rivet-hole has been brought into place for the closing of the rivet. The cost of repairs has, Mr. Webb states, so far been very small; no renewal of commutators has been necessary, but they are lightly skimmed up in the lathe about once in twelve months. The carbon switches and brushes are renewed once in six months.

Submarine Cable Repairs.—An error was made in the headings of Mr. Andrew Gray's table, published on page 493 in our issue of Feb. 4. We now reprint the table with the necessary corrections, as it will probably be more useful to our readers to have it in the correct form, rather than to have to refer corrections for themselves to the previous copy. The corrections refer to the headings of the column and line of percentages:—

Table showing relation between depth of water, length of suspended bight, &c., &c., with various percentages of slack. Depth of water taken as unity.

Angle at surface.	Horizontal distance between apex of bight and place where cable touches the bottom.	Length of cable suspended between apex of bight and bottom.	Percentage S > x.	Chart distance (D) on either side of apex of bight to cable undisturbed by lifting of bight, with the various percentages of slack given below.							
α	x	S	%	1%	5%	8%	10%	12%	13%	15%	20%
° ′											
27 38	3·9	4·1	4·2	16	...	...	...	...	...	...	...
30 20	3·5	3·7	5·3	19	3·7	...	...	...	...	...	...
31 55	3·3	3·5	5·8	19	3·9	...	...	...	...	...	...
33 41	3·1	3·3	6·6	21	4·1	...	...	...	...	...	...
35 38	2·9	3·1	7·5	22	4·4	...	...	...	...	...	...
37 50	2·7	2·9	8·7	23	4·7	2·9	...	...	...	...	...
40 17	2·5	2·7	10·0	25	5·0	3·2	2·5	...	...	...	...
43 1	2·3	2·5	12·0	27	5·4	3·4	2·7	2·3	...	...	...
46 5	2·1	2·4	14·0	29	5·9	3·7	2·9	2·4	2·3	...	...
49 37	1·8	2·2	18·0	32	6·4	4·0	3·2	2·7	2·5	2·2	...
51 31	1·7	2·1	20·0	34	6·8	4·2	3·4	2·8	2·6	2·3	...
53 33	1·6	2·0	22·0	36	7·1	4·4	3·6	3·0	2·7	2·4	1·8
55 42	1·5	1·9	25·0	37	7·5	4·7	3·7	3·1	2·9	2·5	1·9
58 2	1·4	1·8	28·0	40	7·9	5·0	4·0	3·3	3·0	2·6	2·0
60 28	1·3	1·7	32·0	42	8·4	5·3	4·2	3·5	3·2	2·8	2·1
63 3	1·2	1·6	38·0	45	8·9	5·6	4·5	3·7	3·4	3·0	2·2
65 46	1·1	1·5	44·0	48	9·5	5·9	4·8	4·0	3·7	3·2	2·4
68 35	1·0	1·5	53·0	51	10·0	6·3	5·1	4·2	3·9	3·4	2·5
71 33	0·8	1·4	65·0	55	11·0	6·8	5·5	4·6	4·2	3·6	2·7
74 35	0·7	1·3	81·0	59	12·0	7·4	5·9	4·9	4·5	3·9	2·9
77 41	0·6	1·2	106·0	64	13·0	8·0	6·4	5·3	4·9	4·3	3·2
80 37	0·5	1·2	142·0	69	14·0	8·6	6·9	5·8	5·3	4·6	3·5

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6.30 p.m. Students' visit to the generating stations of the St. Pancras Vestry. Applications to join this party should be made at once to the Students' Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbott's Terrace, W.)

MONDAY, February 21st.

THE WORSHIPFUL COMPANY OF CARPENTERS.

8 p.m. Lecture by Prof. S. P. Thompson, F.R.S., on "Electric Motive-power," at the Carpenters' Hall, London Wall, E.C.

TUESDAY, February 22nd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be read: (1) "The Theory, Design and Practical Working of Alternate-Current Motors," by Llewelyn B. Atkinson. (2) "Dublin Electric Tramways," by H. F. Parshall.

THURSDAY, February 24th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "On the Manufacture of Lamps and other Apparatus for 200-volt Circuits," by G. Binswanger Byng.

FRIDAY, February 25th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6.30 p.m. Students' visit to the Shoreditch Electricity Supply Station, Coronet-street, Shoreditch.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "The Problem of Train Resistance," by C. E. Wolff.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Theory of Colour Vision Applied to Modern Colour Photography," by Captain Abney, F.R.S.

SATURDAY, February 26th.

PHYSICAL SOCIETY OF LONDON.

4 p.m. Meeting in the Chemistry Lecture Room, Keate's Lane, Eton College, when the Rev. T. C. Porter will describe (1) A New Theory of Geysers; (2) A New Method of Viewing Newton's Rings; (3) Experiments bearing on the Sensation of Light; (4) A Method of Viewing Lantern Projections in Stereoscopic Relief; (5) Winter Observations on the Shadow of El Teide, with a New Method for Measuring Approximately the Diameter of the Earth; (6) Temperature of the Water of Niagara.

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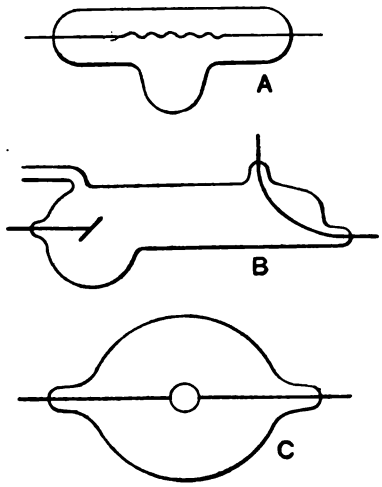
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

A New Departure in Vacuum Tubes.—This is announced by J. Trowbridge and J. E. Burbank as follows:—"The experiments described in this Paper were conducted with Crookes tubes containing no interval between the anode and the cathode, and no discharge, therefore, in the usual sense occurred in the tubes. A continuous conductor was led through the rarefied tube, and it was discovered that the X-rays were given off from every element of this conductor at right angles to its surface, when a disruptive discharge occurred in the circuit of which the tube formed a part. This remarkable result was obtained by means of the very high electromotive force obtained by a Planté rheostatic machine, which was charged by 10,000 storage cells." This new departure, coupled with the mass of detail enumerated in the same paper, cannot fail to be of extreme interest. It is practically an investigation of what takes place in the space surrounding any wire conveying an electric current, and it immediately recalls the fact that the electric energy reaches the wire not along the metallic path, but through the surrounding ether, and enters it at right angles to the wire surface. Some of the vacuum tubes used by Trowbridge and Burbank are shown in the figure. A is the simplest form of tube. At high exhaustions the whole tube is filled with brilliant fluorescence. A photographic plate exposed to it shows a general darkening, and a number of stars due to brush discharges between the plate and the tube, even when protected



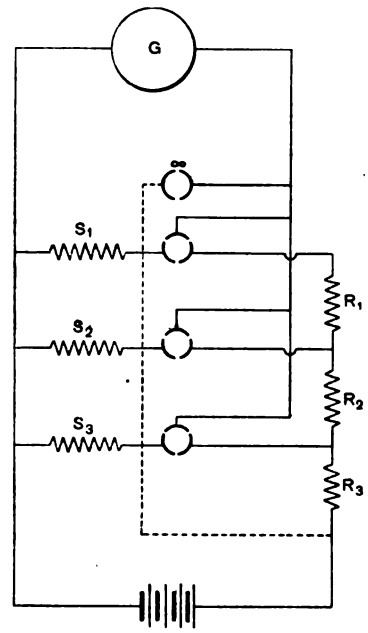
by glass ½in. thick. An appearance resembling an X-ray burn is produced on the hand, probably also due to brush discharge. When the conductor is bent (B) a bright caustic is produced on the wall adjoining the concave side, which throws a distorted shadow of the wire on the further walls. A platinum mirror gives out X-rays, and a piece of calcite glows red. When an aluminium mirror (C) forms part of the continuous conductor, a beam of rays proceeds from the mirror and is focussed on the wall of the tube. This beam is more brilliant if the tube is connected on the negative side of the spark-gap than when it is on the positive side; but at the highest exhaustions this difference disappears, and there is no longer any difference between anode and cathode rays. The direction of the beam is strongly influenced by a piece of tinfoil stuck on the outside of the tube. The authors also discovered a peculiar action of aluminium which closely resembles the condenser action in an Al – C electric cell. When a vacuum tube has point electrodes of platinum and aluminium, the discharge passes more easily from the former to the latter than *vice versâ*.

[Trowbridge and Burbank, *Amer. Jour. of Science*, February, 1898.]

Lunar Auroral Period.—Several years ago H. H. Clayton observed a tendency in auroral displays to recur at intervals of 27 days. In 1895 auroras were recorded at the Blue Hill Meteorological Observatory on Jan. 19th, Feb. 14th to 16th, March 14th, and April 10th, at intervals of exactly 27 days, with no intermediate displays. In other years, similar periods were observed, but with irregular displays in addition. The probability of a chance coincidence as above is 1 in 19,683. Such sequences have, however, been noticed before, but have usually been attributed to the rotation period of the sun. The author tabulates the auroras observed from 1870 to 1892. He finds that when numbering the days of the period from the day preceding the moon's greatest northern declination there is an excess of auroras amounting to 46 per cent. above the mean on the fifteenth day, when the moon reaches its greatest southern declination. Minima amounting to 20 per cent. below the average occur on the seventh and twenty-first days. This range of 66 per cent. in the totals of 300 successive periods is entirely too large to be considered accidental. There may be some connection between this period and the fact observed by Arrhenius and Ekholm that the difference of potential between earth and air is least when the moon is high in the heavens. The explanation is that the moon is charged negatively, like the earth. All these things are worth investigating, but it may be some time before the solar and lunar periods are unravelled.

[Clayton, *Amer. Jour. of Science*, February, 1898.]

Simple Compensated Shunt Box.—The usual method adopted to compensate for the shunting of a galvanometer so that the



resistance of the circuit may remain unaffected by the introduction of the shunt, is to insert in series with the galvanometer, in succession, certain auxiliary or compensating resistances. The equations for calculating the resistances are tedious to solve, and their final values are such as to throw doubt on the accuracy of adjustment of a box. W. M. Stine has devised another arrangement, in which the compensating resistances are not introduced into the circuit to be shunted, thus giving rise to a great simplification. The arrangement is shown in the diagram, which speaks for itself.

[Stine, *Amer. Jour. of Science*, February, 1898.]

A Standard of Inductance.—A standard of self-induction, which can be theoretically computed with extreme accuracy has been constructed by L. Fröhlich. He cut a ring of Carrara, marble into a rectangular section, and wound it with a single spiral layer of insulated copper wire of radius 0·11147mm. in 2,738 turns. The marble ring was 35cm. broad and 20cm. thick, and weighed over 100 kilogrammes. Its magnetic moment was, however, only 0·45. The advantage of using a single layer of fine wire was that no error was introduced by pressure of outer layers, and the correction for thickness of wire was only one-thousandth of the total coefficient, the latter being approximately 0·1 by 10^9cm.

[Fröhlich, *Wied. Ann.*, No. 13, 1897.]

Complex Cathodes.—E. Wiedemann describes some peculiar phenomena illustrating the mutual influence of the several

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parts of a cathode. They show that cathode rays proceeding from one surface and impinging upon the dark space due to another cathode are deflected by the latter. They seem indeed to be brushed aside. This may be exhibited in the simplest manner by employing a rectangular cathode with one-half bent at right angles to the other half, and inserting between the two surfaces, and at an acute angle to both, a sheet of paper spread with chalk. The boundary of the dark space is marked by the beginning of the red fluorescence. No phenomena resembling Jaumann's interference effects are discernible.

[WIEDEMANN, *Wied. Ann.*, No. 13, 1897.]

LACHINE RAPIDS POWER UTILISATION PLANT.

(BY OUR SPECIAL CORRESPONDENT.)

The Lachine Rapids electric power station and pole line were the first piece of engineering on the American continent that I had an opportunity to study thoroughly and systematically, but in the three days' journey up the St. Lawrence river

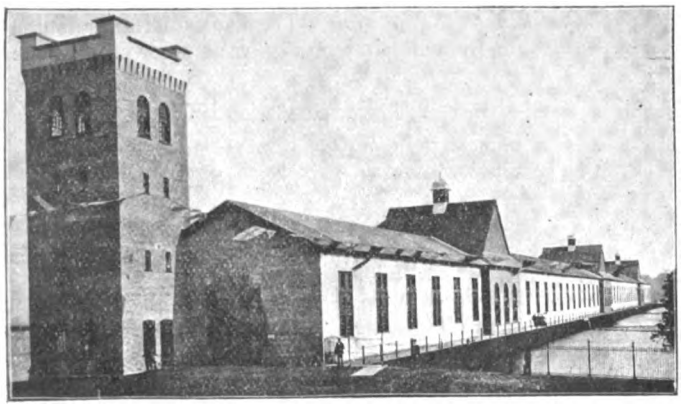

FIG. 1.—External View of Lachine Rapids Power House.

to Montreal I had a few opportunities for a preliminary training in Canadian and American methods of electrical engineering, as well as of forming a good idea of the immensity of the volume of water that is utilised for power purposes at numerous points along that extensive watershed. On nearing the historic fortress of Quebec a magnificent view is afforded of the famous Falls of Montmorency, power from which is transmitted to Quebec, where it is utilised for lighting the town and driving the short lengths of tramways in the town itself and its vicinity.

ungainly and heavy timber poles, planted with the most liberal disregard to the plumb-line, festooned with cross brackets and green glass insulators galore, and with here and there an unusually thick and heavy pole singled out as a support for a long horizontal iron arm, with an arc lamp gibbeted at one end and a counterweight slung at the other. The liberal proportions of this cross-arm enable the lamp to be swung out to the centre of the narrow street, where at night the arcs wink at one another down the road, or sleepily subside to dull red sparks, only occasionally bracing themselves up for a brief though somewhat noisy display of their better capabilities. Beneath this maze of wires, and between the irregular rows of thickly planted timber poles, are the trolley lines and their clanging, wheezing, clattering cars. Three gongs are a common allowance for an American trolley car, on one of which the motorman keeps up a perpetual clangor as the car rushes on; while the conductor rings the changes on the other two, using one as a signal to the motorman and mercilessly "ringing up" the other for each individual fare. As the car starts, a concert is played on the gongs, then commences the loud, "syren"-like wheeze of the motors, while at every joint in the badly-laid rails there is a loud thump that develops at each crossing or turn-out into a deafening clatter. Such is the worst side of American electrical engineering, and I know of no place where it is so obtrusive as in historic little Quebec.

Once arrived at Montreal and well on shore, one realises that there is better and more substantial electrical engineering to be seen in America than at Quebec. There are still timber poles ranged on either side of the roadways, but these are set more regularly and vertical; wires of all sizes and for all purposes still are, to a great extent, carried overhead, but the width of the streets and the care bestowed on the work render these less obtrusive; and the clangor, wheeze and jolt of the ubiquitous trolley car here, too, rob the place of quietude indoors and out from early morn till late at night, but the lines are better laid and the cars are more substantially built. The tramways of Montreal, with the interurban lines to which they are connected, form the largest street railway system in Canada, and comprises 82 miles of track.

With sunset comes an opportunity to judge of the merits of the electric lighting. The street lamps are placed closer together, and are better looked after than in Quebec; but here, as everywhere in Canada and the United States, I found the public arc lighting distinctly inferior to that of the average electrically-lighted town in England, both in regard to the brilliance and the steadiness of the light. To some extent the insufficiency of light is due to the abundance of shade trees, the thick foliage of which casts the side walks into deep gloom; and to the custom of planting these trees may be attributed the American fondness for slinging arc

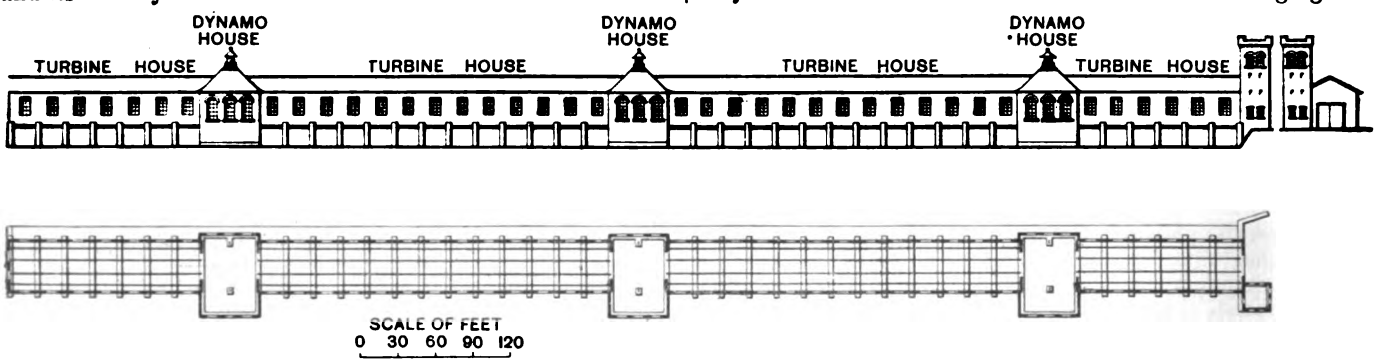

FIG. 2.—Plan and Elevation of the Power House at Lachine Rapids.

For the visitor unacquainted with the appearance of the average electrically-engineered American street, Quebec furnishes an instructive object lesson with which to commence his study thereof. Its streets are narrow, badly paved, old-fashioned, and for the most part steep and tortuous—conditions which furnish an extraordinarily effective setting for the display of the worst features of the American rough-and-ready method of running-up electrical work. The air overhead is thick with wires and cables, crossing and re-crossing in all directions. The view up the streets appears like a forest of

lamps in the middle of the streets. But even in the business thoroughfares, where the luxury of a shade tree is unknown, the arc lamps, whether slung in the centre of ugly span wires across the streets, or placed on side brackets, give scanty and uncertain illumination.

Electric current at Montreal is used principally for lighting and for running the trolley cars, though in summer there is a considerable demand for fan motors, and in winter an increasing trade in electric radiators. Hitherto the necessary power has been generated by steam, but two independent

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schemes for the utilisation of water power in the neighbourhood have recently been developed, and when both of these are completed an aggregate of about 40,000 H.P. will be placed at the disposal of Montreal. One of these is the power plant at Chambly, a description of which occurs in *The Electrician*, Vol. XXXIX., p. 863; the other is the plant inaugurated last September at Lachine Rapids.

The fictitiousness of the title "Our Lady of the Snows," as applied to Canada, impresses itself indelibly on one during a tramp on an August afternoon from Montreal to the famous Lachine Rapids. But even in such circumstances as these I felt well repaid for the fatigue of a hot, dusty march by the profusion of interesting and instructive material in and around the long, slender power house, that stretches far out into the turbulent river, and by the courtesy extended to me by Mr. W. McLea Walbank, the managing director and chief engineer of the Lachine Rapids Hydraulic and Land Company. At the time of my visit the erection of the generating plant was sufficiently far advanced for a portion of it to be run on load, power being transmitted experimentally over the substantial pole line to the city, and the opening ceremony was fixed to take place in a few days (though I believe it was ultimately postponed for a week or two).

The power house, external views of which are shown in Figs. 1 and 2, is built upon a weir, or dam, that stretches for a distance of 1,000ft. into the river, at a point situated just below the rapids. A general plan of the mill site and construction work, together with an elevation of the masonry, are afforded by Fig. 3. The declivity of the stream here is considerable—although the rapids are navigable—and the original bottom of that part of the stream occupied by the hydraulic works was irregular and rocky. A considerable amount of blasting and excavation was necessitated by these conditions, in order to obtain an even floor and a suitable depth and volume of water in the head race. In Fig. 4 are indicated the original bottom and stream-level, and the new excavated bottom and present water-line; the elevations are shown at the various points of importance. I may add that extreme care seems to have been bestowed on this preliminary excavation work, the artificial floor of the head race being rendered not merely roughly level but practically smooth. Equal attention has been paid to the laying-out and construction of the main and wing dams, the ice breakers and booms, and the arrangements for preserving a low tail-level when the river develops ground ice. It is anticipated that no trouble will be experienced through either floating or anchor ice, and, judging from the excellent arrangements for obviating such difficulties, I should suppose the risk of serious obstruction from them to be very small, unless, indeed, in an exceptionally severe winter. *Apropos* of these remarks, I may say that no provision has been made for running the station should water-power fail, in which respect it resembles the Niagara Falls but differs from the St. Anthony Falls systems. Ice is deflected from the entrance to the head race by a substantial timber boom, shown in Fig. 3, terminating in a masonry ice breaker at the end of the overflow dam. Small float ice that

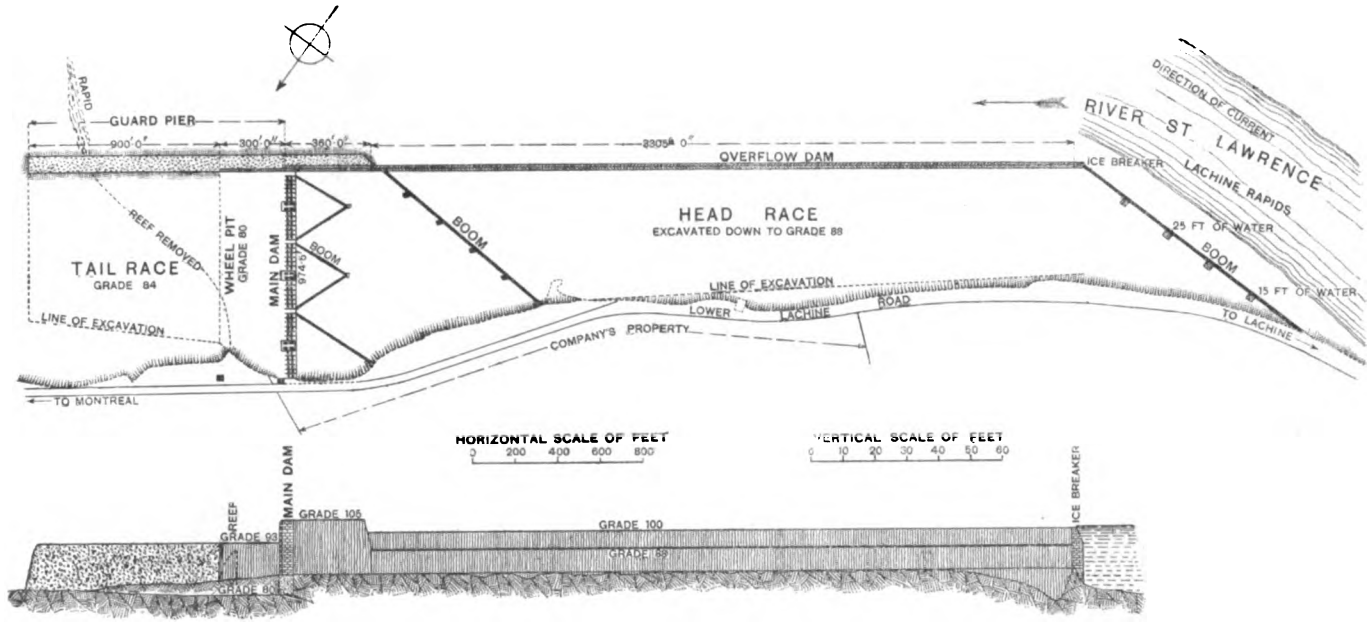

FIG. 3.—Plan of Mill Site and Sectional Elevation of Masonry Construction at Lachine Rapids.

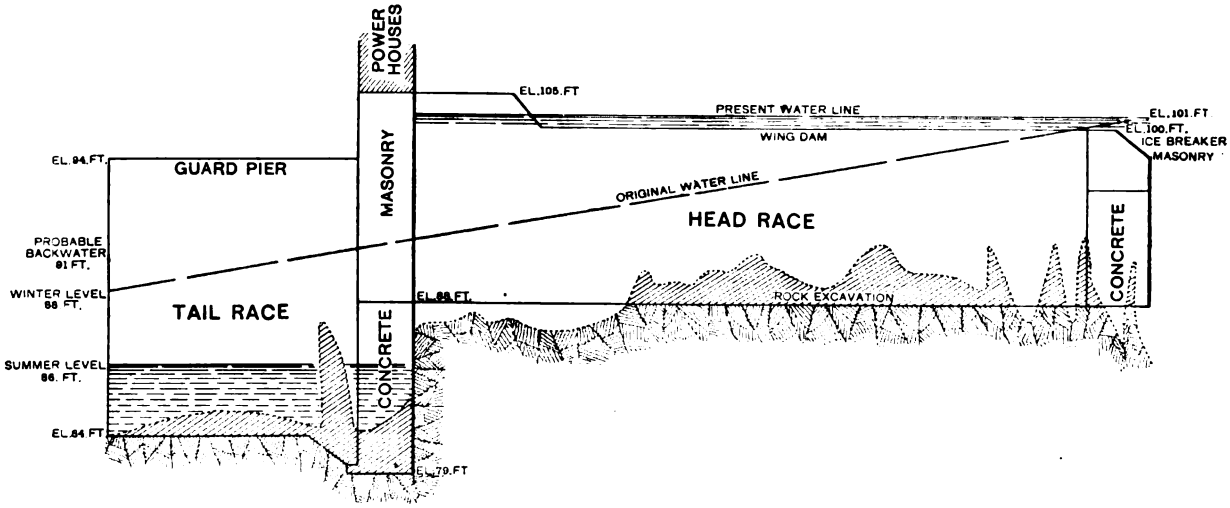

FIG. 4.—Section along the Mill Site, showing original and existing Floor and Water Levels.

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may get into the head race is deflected over this dam by another boom placed at the lower end of the head race.

Referring to Fig. 2, it will be seen that the power house, which is built on a weir of trimmed stone, consists of a number of alternate turbine and dynamo houses, there being four of the former and three of the latter. The entire structure measures 1,000ft. in length, and is 40ft. wide in the turbine houses and 61ft. wide in the dynamo houses. The framework is of steel beams, brickwork being used for the outside and partition walls of the dynamo houses, and corrugated iron for the turbine houses. Each turbine house is equipped with 24 vertical turbines, arranged in four equal sets, and in each dynamo house there are four generators, direct coupled to the countershafts that project from the adjacent turbine houses. There are six turbines geared to each countershaft. A view up one of the turbine houses, and a distant view of another turbine house beyond the brick dynamo house, are afforded in Fig. 5. The turbines are of the "Victor" mixed flow type, each engine measuring 57in. in diameter, and being capable of developing 300 H.P. under a normal head of 16ft. when running at 83 revolutions per minute. The turbines are drowned, and are, therefore, unprovided with suction tubes; they are regulated by cylinder gates, which are automatically controlled by a centrifugal relay governor, there being one such governor on each set of six turbine. The governor is operated at high speed by a belt from the main shaft, and controls a scale-beam lever, having at each end an electrical contact, steadied by a small alcohol dash pot. The electrical contacts control two powerful electromagnets adapted to move a pair of friction discs, keyed on the main shaft, to the right or left. These engage with other friction discs, to which are connected a powerful screw gearing which controls, through a system of levers, the cylinder gates of the six wheels. These gates are counter-weighted to decrease the effort necessary for their control. The governor will shut off all the water from full head in 9 seconds. The turbines were built

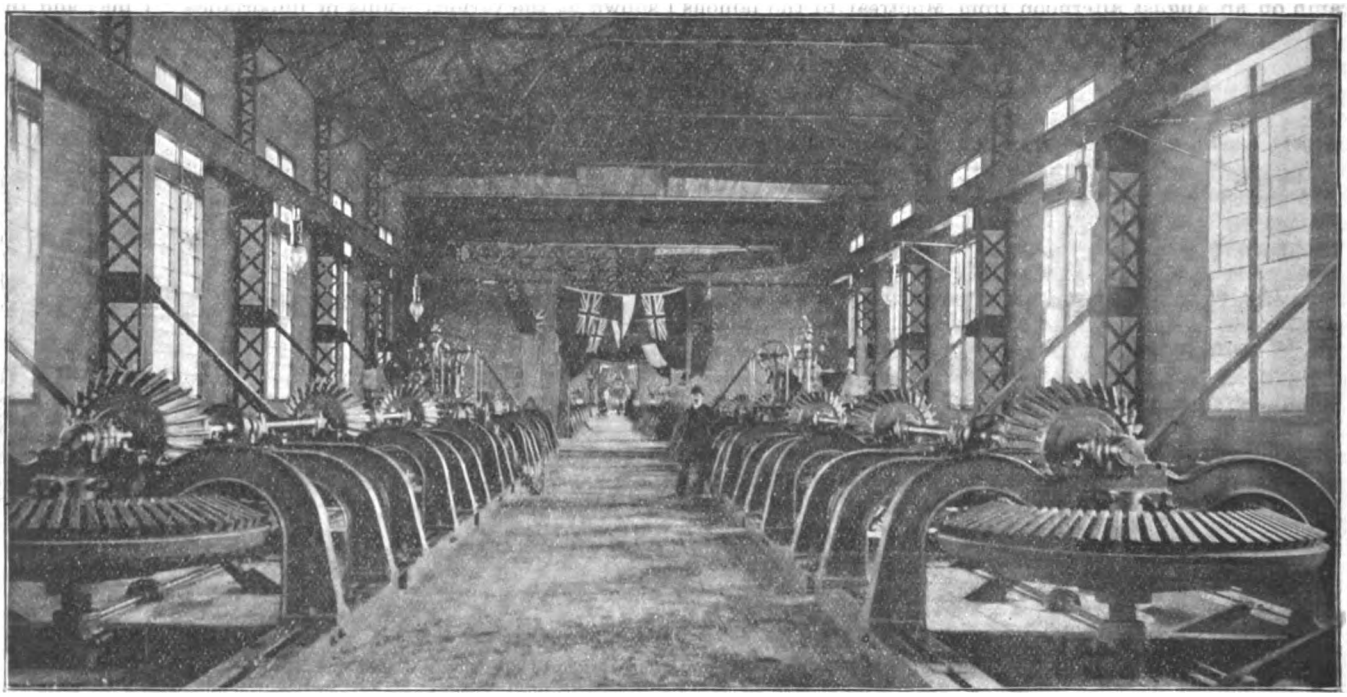

FIG. 5.—Interior View of Lachine Rapids Power House.

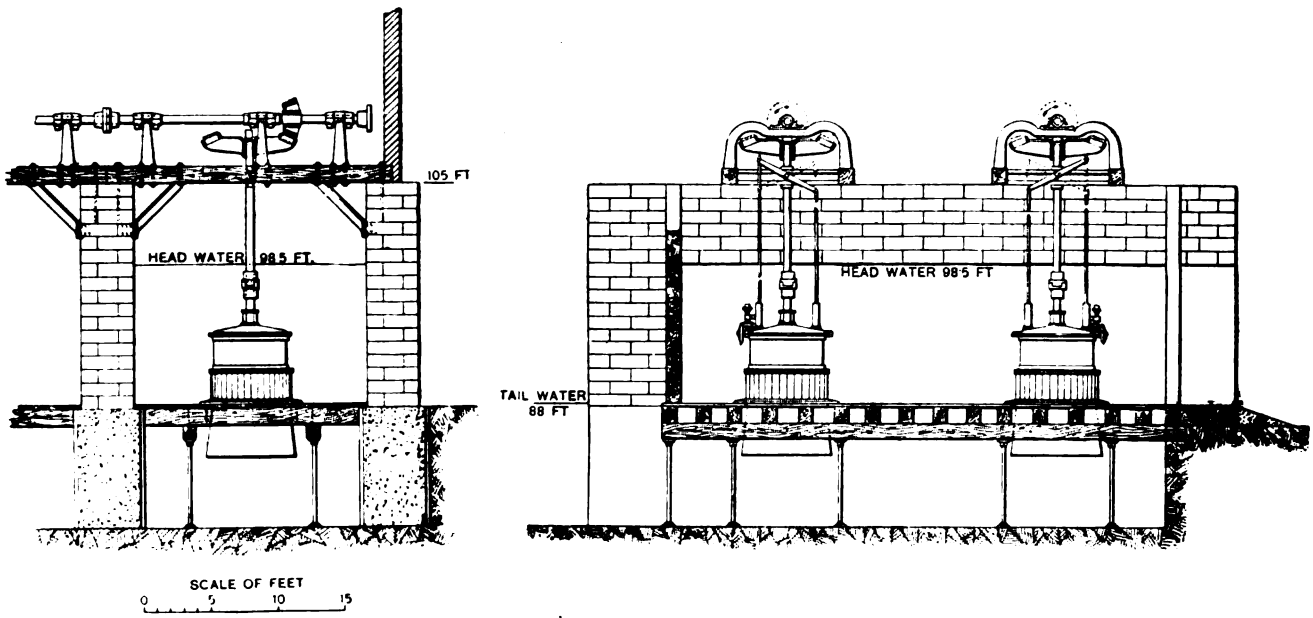

FIG. 6.—Longitudinal and Transverse Sections of the Wheel Pit, showing Turbine Setting and Gearing.

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by the Stilwell-Bierce Company, of America, and are similar in construction to those supplied by Mr. F. Nell for the Worcester water-power electric supply station. The arrangements of the turbine setting are indicated in Fig. 6.

Twelve three-phase generators will ultimately comprise the full equipment of generating plant, but at the time of my visit, or even now, somewhat later, while I am writing, the entire set has not yet been erected. These machines, one of which is shown in Fig. 7, are massive and well-designed pieces of engineering. Each generator is capable of developing 750 kilowatts at 4,400 volts, with a frequency of 60 cycles per second. An exciter is provided for each generator, and, as shown in the illustration, is driven from the countershaft by a belt run off a large pulley The exciter is a 4-pole 40-kilowatt machine, developing 150 volts when run at 875 revolutions per minute. All the exciters in each dynamo house are coupled in parallel at the switchboard. The generators and their exciters were built by the Canadian General Electric Company, to the designs of Mr. W. McLea Walbank, by whom the entire engineering work was designed, and under whose superintendence it has been erected.

One of the most interesting features of the Lachine Rapids utilisation plant is the substantial pole lines, by means of which the power is transmitted by aërial conductors to the

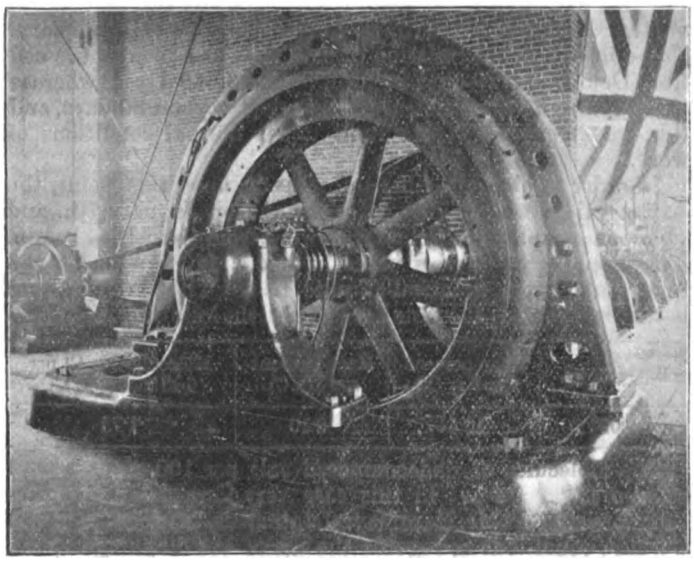

Fig. 7.—One of the twelve Electric Generators at Lachine Rapids Power House.

city limits. This pole-line is by far the most substantial and elegant to be met with on the American continent, Mr. Walbank having adopted steel lattice poles instead of timber. Of the total length of the pole-line is about 33,000ft., the greater part way owned by the Company constructed over a lane or private right-of-104ft. apart and are set in concrete. The poles are placed about of No. 0 copper wire supported on double-petticoat six conductors insulators. At the power house end the strain of the conductors is taken up by the street railway pattern of strain insulators, twelve of these being attached to the power house walls. At the city end of the pole-line, which adjoins the Lachine canal, there is a substantial dead-end strain column of steel. The overhead line is protected by Wurtz lightning arresters placed at four points along its length. From the terminal column onwards the power is conveyed through underground conductors, consisting of paper-insulated and lead-covered cables, laid in brickwork and cement conduits. By this means the power is conveyed to the transformer sub-stations, of which the present number is three, though a further number will shortly be built. At each of the former three static transformers reduce the pressure to 2,000 and 1,000 volts, the power on the secondary circuits being three-phase and two-phase. In one of the sub-stations a 200 kilowatt rotatory converter, built by the Walker Company, of Cleveland, will shortly be installed, and will supply continuous current at 250 volts for motor purposes.

When at Lachine Rapids I was informed that the basis of charge for supply for ordinary consumption would be at the rate of 1 cent (½d.) per ampere-hour at 104 volts; this is equivalent to a little under 5d. per Board of Trade unit, in British measure. For large and steady consumption a much lower rate will be charged. It may be of interest to state that the capital of the Lachine Rapids Hydraulic and Land Company is £280,000, but the proportion actually expended on the power-house and transmission plant was not ascertainable. The capital was nearly all locally subscribed.

Unlike the power development schemes at Niagara Falls that at Lachine Rapids has the immense advantage of a large, populous and industrial city almost close at hand, affording a ready-made market for its electrical supply. There exists already a large demand for electric power, for lighting, heating and motor purposes; and it is probable that before long steam power will have been abandoned in the electric power houses in the neighbourhood, and that if these themselves are not abandoned they will be transformed into sub-stations for one or other of the two great water-power utilisation systems, those of Lachine and Chambly. Thus competition, if it survives, will be reduced to a duel between these two schemes, but more probable it will be found that there is ample scope for both.

THE HARGREAVES-BIRD ELECTROLYTIC ALKALI PROCESS.

BY JOHN B. C. KERSHAW, F.I.C.

The writer was recently afforded an opportunity of inspecting the experimental plant at Farnworth, near Widnes, for the production of alkali and chlorine in the Hargreaves-Bird form of cell by the electrolysis of solutions of common salt. This plant (Fig. 1) has now been running at Farnworth almost continuously for over two years, and many improvements in details of form and working have resulted from the experience gained during this long period of trial. As no independent description of this plant has yet appeared in print, and since the process is now on the eve of being launched upon a much larger scale of operations in France and in this country, the following details of the plant and its working results may prove of considerable interest to readers of *The Electrician*.

The general principles of the process and the distinctive features of the cell were fully described by the present writer in the issue of *The Electrician* for February 12 of last year (Vol. XXXVIII., p. 501), and readers are referred to that issue for information upon the fundamentals of the process. The power at Farnworth is supplied by a gas engine of the well known Otto type, running at 175 revolutions per minute and generating 20 H.P. This engine drives a dynamo made by Holmes, of Newcastle, by belting, the mean speed of the dynamo being 350 revolutions per minute, and the output 2,200 amperes at 5 volts pressure. There is considerable loss of energy occurring in the dynamo at Farnworth on account of the low voltage required. When a large number of decomposing cells are coupled in series it will be possible to utilise currents generated at from 50 to 100 volts pressure, and an efficiency of 94 per cent. will no doubt be attainable. There is also some unnecessary loss of energy in the conductors, a drop of 0·35 volt being observed in the comparatively [illegible] lead between the dynamo and the electrolytic cell. Copper conductors of 2½ sq. in. sectional area are used. The electrolytic cell in which the whole of the electrical energy delivered by this conductor is being consumed is raised by a brick-work foundation about 2ft. from the ground, and is internally 5ft. deep, 10ft. in length and 14in. in breadth. It is divided into one inner anode chamber and two outer cathode chambers, in the manner described in the previous article on this process. Fig. 2 represents diagrammatically a vertical end section of the cell with one of the anodes in position in the anode chamber. This inner chamber of the cell is almost filled with the brine, which is maintained in continual circulation through it, and at a constant level. The outer cathode chambers are kept

constantly supplied with steam and carbonic acid gas (the exhaust from the gas engine supplies the latter at Farnworth); the solution of sodium carbonate formed on the wire gauze cathodes collects at the bottom of the chambers, and is continually running off by the pipes shown in the diagram. The diaphragms are 5ft. 4in. by 10ft. 4in., including overlap at the edges, leaving 5ft. by 10ft. of active surface inside the margin. Mr. Hargreaves considers these dimensions as large as are practicable at present, but they may, no doubt, be increased when more

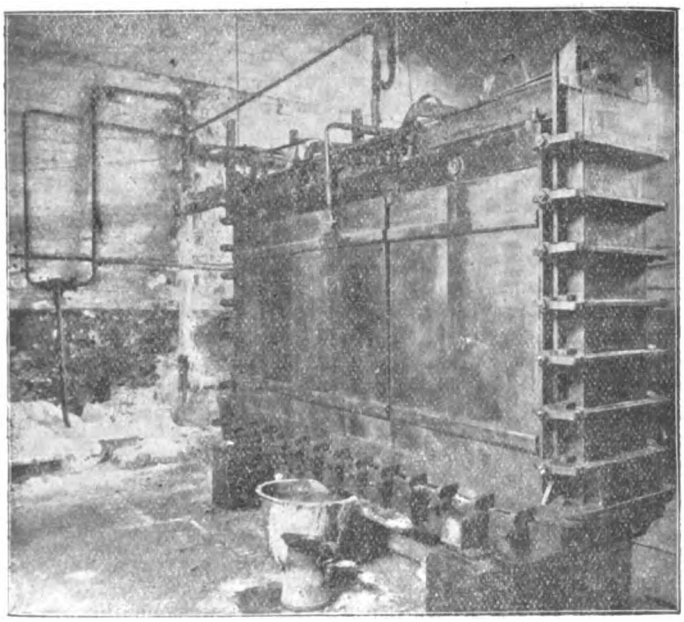

FIG. 1.—Hargreaves-Bird Electrolytic Alkali Cell at Farnworth. Dimensions, 10ft. by 5ft.

experience in handling them has been acquired. The cathode area in the cell at Farnworth with two of these large diaphragm-cathodes is, therefore, 100 sq. ft. The anodes at present in use are compound ones, formed by boring perfectly round 8in. holes in a number of roughly-shaped blocks of gas carbon, and by fitting these upon a round shaft of lead-copper alloy. A special cement is used to

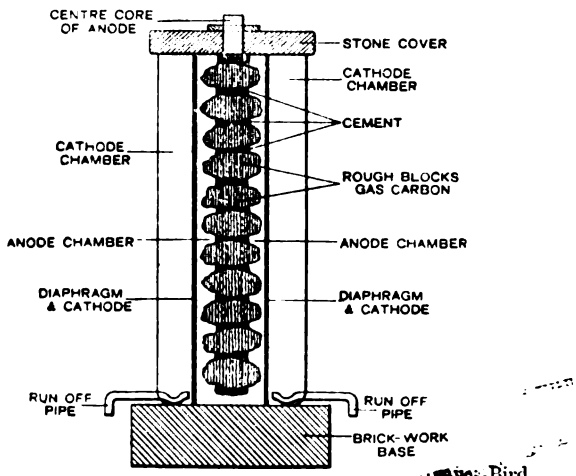

FIG. 2.—Diagrammatic Vertical Section of [illegible]-Bird Electrolytic [illegible]

protect this shaft from the action of the brine and chlorine, in parts that would otherwise be exposed. This novel form of anode, the general appearance of which is shown in Fig. 2, is the invention of Mr. Connor, of Belfast, and the patent is now owned by the General Electrolytic Parent Company, who likewise control the Hargreaves-Bird patents. A row of six of these compound anodes connected in parallel extends from side to side of the anode chamber, and they are said to be much superior in every respect to the flat plates of carbon which were formerly used. The chlorine gas produced at the anodes rises to the surface of the liquid, and is led away by the pipe which carries off the overflow of the brine. The brine and chlorine are conducted to a separating well, where the brine is re-saturated with salt, and is returned by a pump to the cell, while the chlorine gas is led to an absorbing chamber or tower, for the production of bleaching powder or chlorate of soda. At Farnworth it is possible to use the chlorine produced in the cell for either purpose, and on the occasion of the writer's visit bleaching powder was being produced. Both the bleaching powder and chlorate manufactured by the plant in operation at this place are stated to have been of excellent quality. The alkaline liquor flowing from each cathode compartment of the cell was sampled in the presence of the writer and found to possess a specific gravity, in one case of 1·125° and in the other of 1·112°, measured hot.

These samples were bottled and sealed, and have since been tested with the following results:—

Mean sp. gr.	Mean percentage Na_2CO_3.	Mean percentage Na Cl.	Molecules Na Cl per 100 mol. Na_2CO_3.
1·125	10·90	0·94	15·6

The amount of undecomposed salt in these samples was very much higher than that found under normal working conditions. The increase was attributed by Mr. Hargreaves to the use of the diaphragms ten days longer than was customary. Those in use on the occasion of this visit had been in the cell from October 12th—that is, for a period of 40 days; whereas the diaphragms were not usually worked beyond 30 days, and this was regarded as the limit under normal conditions of work.

In order to obtain further information upon this point, the writer paid a second visit to the works on January 7th, and obtained samples of the liquor flowing from the cell as before. The diaphragms on this occasion had only been in use 36 hours, and were practically quite new. The samples were bottled and sealed; the tests have yielded the following results:—

Mean sp. gr.	Mean percentage Na_2CO_3.	Mean percentage Na Cl.	Molecules Na Cl per 100 mol. Na_2CO_3.
1·094	10·44	0·10	1·73

The molecules of undecomposed salt per 100 molecules of sodium carbonate are in this case very low, and the figures therefore support Mr. Hargreaves' statement, that under normal working conditions as regards the age of the diaphragms, the proportion of undecomposed salt in the solution of alkali flowing from the cell can be kept within satisfactory limits.

The current passing through the cell on the occasion of the second visit was 1,800 amperes, and the E.M.F. at the cell terminals was 5·40 volts. It was stated that the E.M.F. necessary to overcome the resistance of the diaphragms would diminish as they became older, and that consequently the amperes of current passing through the cell would increase. Neither free chlorine nor hypochlorite were present in the compartments of the samples of liquor taken from the [illegible] of the cell.

At Farnworth the liquor is boiled down and is then crystallised. Sodium carbonate with 10 molecules of water (the deca-hydrate) is obtained. It is optional whether this form of alkali, soda ash, or caustic shall be produced by the process, and the decision in the case of the larger plants which are about to be built will depend upon the relative market-sale prices of these products.

The quantity of salt decomposed in the cell now working at Farnworth was stated to be about 220lbs. (dry) per 24 hours.

The following figures represent the details of the previous run and of the one in progress at the date of the writer's first visit. The cell is run continuously, seven days per week, until the diaphragms require renewal.

Period of run.	Mean current. Amperes.	Mean E.M.F. Volts.	Salt. Lbs. per 24 hours.	Efficiencies per cent. Current.	Energy.
Sept. 15—Oct. 11 ...	2031·5	4·2	217·3	92·7	50·05
Oct. 12—Nov. 22 ...	2089·8	4·24	218·06	90·4	48·99

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The current and energy efficiencies have been worked out by the writer on the same basis as those given in the article already alluded to. They are not quite so favourable as those based upon the results of earlier runs. This is no doubt partly due to the higher current-density now being used, and to the greater loss resulting from the conversion of electrical energy into heat in the cell. The brine in the inner compartment of the cell is maintained at a temperature of 70°C., partly by the current and partly by the transmission of heat from the steam through the diaphragms. The higher current-density now being employed (from 20 to 22 amperes per square foot) is purposely used in order to obtain a greater output of alkali and chlorine from one cell, and this is held to compensate for the slight increase of voltage that may be traced to this cause.

In conclusion, the writer must express his thanks to the management of the General Electrolytic Parent Company for their courtesy in granting him permission to inspect the plant at Farnworth, and also to Messrs. Hargreaves and Connor for their attention on the occasion of his visit. The writer was afforded every reasonable facility for judging of the working of the cell, and the figures given to him would seem to indicate that there is every prospect that financially successful results will follow the large industrial operations now being planned in this country and abroad.

NOTES ON THE ELECTRO-CHEMICAL TREATMENT OF ORES CONTAINING THE PRECIOUS METALS.*

BY MAJOR-GENERAL C. E. WEBBER, C.B., (RET.) R.E., M.INST.C.E.

(Concluded from page 519).

In the latter half of 1894, J. H. Haycraft, of Adelaide, in West Australia (whose invention jointly with Breakell has been already mentioned), described an improved process for the treatment of auriferous and argentiferous ores. He expressly disclaims originality for the apparatus, and for any separate part of his process, or for any two or more parts together, but considers that his invention consists in the entire and particular combination planned by him. In this process we again find the following conditions:—One circular vessel for the whole process of treatment, having a revolving stirrer with projecting arms connected with the positive pole of a dynamo. The charge under treatment is a mixture of pulverised ore and water, and the precipitation is obtained by the use of a solvent in conjunction with the electric current, the precious metal being absorbed (and afterwards recovered) by amalgamation in mercury. But, in addition, the process presents the following features:—First, the vessel is heated by a furnace or by a steam chamber underneath, and being therefore of metal, the whole of it forms the cathode. The stirrer, which is the anode, can doubtless be insulated from the vessel without much difficulty, and its arms are clad with carbon electrodes at their extremities, which in revolving are separated from the cathode by a space of about ¼in. To the charge of ore is added about 5 per cent. of its weight of mercury, with about 1 per cent. of chloride of sodium or any other salt capable of yielding chlorine by electrolysis; but these proportions the inventor varies according to the class of ore under treatment.†

Any one with very little practical experience in working an apparatus of the description given by Haycraft might be expected to fail in three out of many difficulties that the construction presents, namely: (1) in keeping the density of the solution uniform throughout; (2) in bringing it under the influence of the current within the ¼in. space between the anodes which lie nearest to the cathode, where the path of the greater part of the current would lie; and (3) the difficulty of maintaining surface parallelism between the electrodes.

In September, 1894, P. Danckwardt patented in the United States an improved apparatus for, and process of, extracting gold and silver from ores. In this we find again the treatment of finely pulverised ore in a solution containing potassium cyanide—in this case about 10lb. of cyanide to the ton of ore—and agitation. Besides, the inventor adds to the solution 2lb. to 3lb. of ammonium, "or another alkali," sulphide, the object of which is said to be to reduce the consumption of cyanide to a minimum, as a means of preventing "the formation of soluble combinations between any of the raw metal combinations and part of the cyanide of potassium."* In spite of the low tension of the current employed, the difficulty of insulation between the cylinders at their axial bearings must be considerable. I can find no record of this combination having ever been used on a practical scale, and I do not think that the description given is such as to enable an apparatus to be constructed that would produce practical results on a working scale. The actual subjection to electrolysis of the mixture described was, of course, not novel in 1894.

Edward W. Clark filed an application in the United States in November, 1894, describing a process and apparatus, which he calls an "electric chlorinator," for extracting ores by electrolysis.

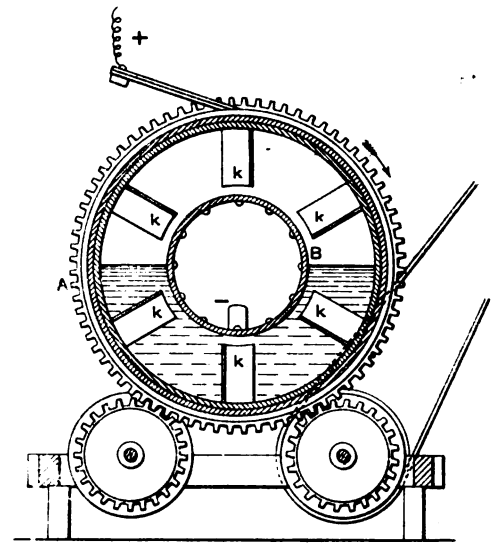

FIG. 6.

He passes an electric current through a solution containing the crushed ore to be treated and chloride of sodium. He uses an agitator of a particular form, and mercury as his cathode.† With the exception of that part of the combination which is affected by the special form of apparatus, and which is said to prevent the combination of the liberated hydrogen, oxygen and chlorine, there is no reason for claiming novelty for the invention.

* Paper read before the Institution of Electrical Engineers on Jan. 27.

† The charge having been introduced into the vessel, the current—about 200 amperes by 3 volts to each ton of ore under treatment—having been started, and the temperature raised to and maintained at a little under the boiling-point of water, the process is continued for about one hour, the stirrer revolving slowly all the time. The bullion is afterwards recovered from the amalgam in the usual way; but in the first instance the amalgam must be separated from the pulp with which it has been mixed during the treatment. The peculiarities of this process, which may occur to the electrical engineer, are that the bottom of the vessel slopes towards the centre, and that, using the words of a description by Prof. Wiedemann, of the University of Munich, "a large quantity of quicksilver placed in the centre of the pan gives the cathode or negative electrode; thus the pans remain the only suitable leading link between the cathode and dynamo; he (the Professor) attaches great importance to the free movement of the quicksilver cathode, as at boiling water temperature the quicksilver spreads through the whole pan, thus coming into contact with the coarser particles of gold, which settle down at the bottom of the pan by their own specific gravity." And then he adds—what is still less easy to understand, seeing that the space between the anode and the cathode is only about ¼ of an inch—"The spreading of the quicksilver brings into action the most distant carbon shoes, otherwise the electric current would pass to the iron pan electrode, and by its action would prove no value, as there would be a continuous deposition and reunion." Again he says: "The electric current by its passage through the liquor (salt water and the ore in suspension) decomposes," &c.

* The agitation is effected by the rotation of a cylindrical drum, A, on its axis, and two ways of doing this are described. In one case (Fig. 6) the rotating drum is external to the inner one, and the conditions are the other way in the second example (Fig. 7). In each case the cylinder in motion B constitutes the anode, the stationary vessel the cathode. In the first case the outer revolving drum carries internally blades *k*, *k*, by which the solution is stirred and guided on to the amalgamated surface of the inner fixed cylinder B, which is made of copper.

The second example (Fig. 7) of effecting agitation in this way is an auxiliary one, and only resorted to in case the extraction by means of the first form of apparatus is imperfect, when the solution taken from the first, having been filtered, is passed through one or more of the agitating vessels; and in this latter case the outer and stationary tanks A, A, besides being amalgamated on their inner side, contain a little mercury, M, M.

† The vessel in which the agitation takes place is a horizontally-fixed cylinder, A (Fig. 8), with a shaft, B, carrying spirally-fixed stirring arms, C, which revolve inside on its axis. The bearings are gas- and water-tight. The anode is a fixed carbon lying on the bottom of the cylinder. The mercury cathode lies at the bottom of small boxes, D, D, attached in pairs at intervals on each side of the cylinder. The communication between the cylinder and the boxes is by means of openings, E, E, at the lower sides of the former, which are covered with a canvas screen or filter. The current has to pass between the electrodes through these screens, in company with the solution on its way for the chloride of gold to deposit the gold in the above-named boxes or amalgamating chambers.

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At the end of 1896 Dr. Keith, who read a Paper on "The Electrolysis of Gold" in March, 1895, before this Institution, took out a patent in Canada, in which he makes, amongst others, a claim for a "process of extracting gold and silver from auriferous and argentiferous materials, rocks, or ores, which consists in submitting them to the solvent action of a solution of cyanide of potassium, containing a solution either of cyanide or bromide of mercury, or both, and then depositing the gold or the silver, or both, and the mercury from the solution so obtained, by means of electricity upon a cathode or an amalgam." I understand that this was reported on by Prof. Silvanus Thompson; but the only encouragement I can find in the published part of his report is that the "process hastens the solution of the gold, in comparison with the use of potassium cyanide only."*

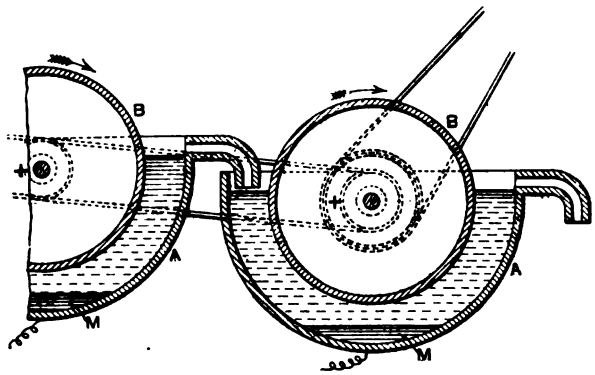


FIG. 7.

I now propose to go more carefully into the process I have described as that of Messrs. Pelatan-Clerici, which I have had under my observation for more than two years. It claims as its object the treatment of ores containing gold or silver, or both, so as to obtain the precious metal therefrom in a manner more complete, simple, satisfactory, and with greater economy of the agents, than hitherto. As an example, I shall refer to the simplest form—of which an illustration is given—namely, the circular vat, with the shaft of the anode in a vertical position (*see* Fig. 9). The improvements are—First, that the space (unlike some previous proposals) between the revolving anode and cathode is free from all obstructions, the disadvantages of which are that they tend to cause the ore

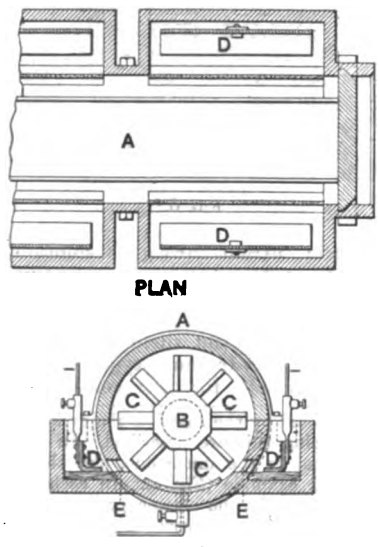
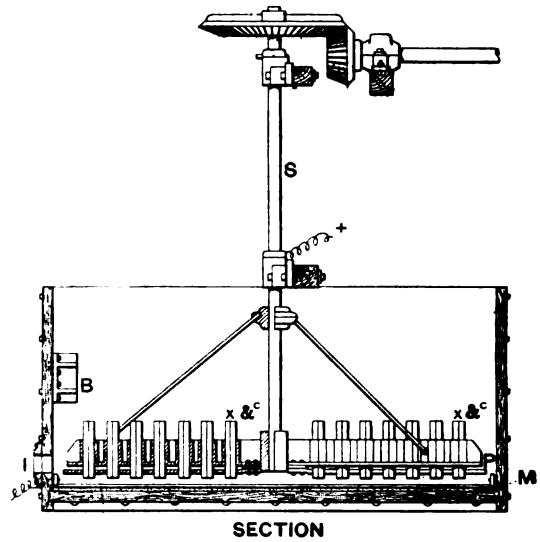


FIG. 8.

under treatment to accumulate upon the cathode, and prevent perfect parallelism between the surface of the mercury cathode and the effective under surface of the onode—a condition the necessity for which is obvious. Second, that the sludge is constantly and gently swept by the current from over the cathode so as to have no tendency to settle on it, and also so that that portion of the sludge which is above the anode should not acquire such a continuous rotary motion as to cause the heavier particles to be carried outwards by the centrifugal action, and thus to travel round in the same plane, instead of in their turn being subject to the combined action of the electric current and the chemical agents employed.

This leads me to draw attention to the necessity that efficient agitation should, in the first place, maintain the sludge perfectly homogeneous throughout its mass, and, in the second place, should not be such as to disturb or break up the mercury cathode. In the example before us this is secured by regulating the speed at which the anode is driven, according to the size of the vat and the number and length of arms that are attached to the shaft, either for the support of the anode plates, or to act only as stirrers. For instance, subject to the density of the sludge, it is found that, if the speed of the agitator has to be lowered 30 per cent., the number of arms should be doubled. As the diameter of a vat is increased, in order to maintain homogeneity in the mixture, the rate of motion at the periphery of the agitator would have to be increased, but to the detriment of the surface of the mercury cathode, namely, above a rate of about 8ft. to 10ft. a second. To avoid this the number of arms is increased. Provision is also made, to meet special circumstances, to add arms which



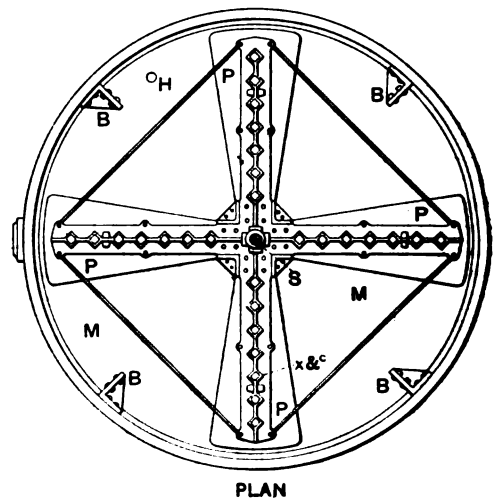


FIG. 9.

vary in length, which may form part of the anode or not. The proportion of water to ore in the sludge is a condition that also affects this department of the treatment, and it is found that between equal weights and proportions the best results are obtained when the water weighs three-fifths of the ore.*

* Similar means to some of those I have mentioned for doing the same work have been patented by De Neufville, September, 1895; Hinman, September, 1896; Becker, August, 1897; but, with the exception of the combination of very minor details, these present no feature of originality.

* The revolving anode is mounted so as to be suspended from above in the vat at the lower end of a vertical shaft, S, braced and supported in the manner shown in the drawings (Fig. 9). The lower surfaces of the iron plates, P, P, &c., attached to the under sides of the lowest tier of projecting arms are in the same horizontal plane, and are carried at a distance of between 4in. and 6in. from the mercury cathode, M, which is a matter of regulation according to conditions which are well understood. The positive connection from the dynamo is by way of the vertical shaft and a rubbing contact connected with the conductor. The connecting cable from the negative pole of the dynamo is led to the copper plate of the cathode, M, with which it may make connection at one or more points. In the space between the anode and the cathode the actions and reactions described further on take place, and the metal which is absorbed or taken up by the

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As regards the current, the potential should be capable of being governed between 5 and 14 volts, and this must be done by resistances fixed in the circuit of each vat or group of vats. For instance, when using vats of 9ft. interior diameter, each capable of treating 2½ tons of ore, in two shifts—total, five tons—in a day of 24 hours, should a plant to treat 200 tons of ore a day be worked 40 vats will be required, and these would probably be governed in eight groups of five vats in a group. The quantity is regulated by the resistance in that part of the external circuit which lies between the electrodes. Provision is made for a minimum quantity of 1½ amperes per square foot, being half the sum of the cathode and anode together in square feet: thus, if that area is equal to 52 sq. ft., the current should not be less, and not much more, than 39 amperes.

The inventors claim the use of several other forms of apparatus to effect the same objects, the details of which are more or less original, and are wholly original as forming parts of combinations; and they also describe conditions of variations of temperature during the progress of the treatment, as well as the addition of specific oxidising agents and compounds, and organic acids—all of which are matters appertaining to the discoveries they have made in experimentally treating samples on a working scale of ores from over 200 mines.*

In an investigation of the electro-chemistry of the process I shall confine myself to the simplest (or circular) form of apparatus. But before doing so it is well to remind any mining engineers who may be present that the degree of fineness of the pulverisation employed is obviously a varying factor in considering this part of my subject, both as regards the chemical and electrical, and their combined effects, especially when dealing with refractory ores.† To enable you to follow the course of what happens in the treatment tank, the process will be divided into more than one stage, although the actual order in which they follow one another, and the time occupied by each, may vary with the ore under treatment, and it is not always the case that it is worth while to separate them, even for a short time.

During the whole time of treatment, "agitation," as distinguished from "percolation" or "circulation," is going on. The stages may be with or without the accompaniment of an electric current during portions of the time, but in any case the current is used during more or less of the time. The liquid may contain sodium chloride (NaCl) or potassium cyanide (KCN) alone, or both; but, as the sodium chloride is directly and in the first instance used to "reduce the resistance" or "increase the conductivity" of the solution, there is no stage during which—except for the purpose of mixing—it is used alone, without being accompanied by the current. The expressions I have used—namely, "reduction of resistance" and "increase of conductivity"—are useful because they are easily understood; but, be it remembered, they are not correct as applied to the solvent, *i.e.*, water. Indeed, these descriptions of the effect of the mixture of sodium chloride in a solution, and then placing that solution between an anode and a cathode, is scientifically inaccurate. What happens to the sodium chloride in solution in the water is, that it is disintegrated and reformed, and thus it becomes the intermediary by which, at the instant that chlorine gas and sodium are set free, the current is enabled to "communicate" between the electrodes.

During the time of electrolysis, when the liquid contains only sodium chloride (NaCl), the primary decomposition will be sodium (Na) and Chlorine (Cl). In practice the quantity by weight of NaCl may be between 0·2 and 1 per cent. of the weight of the ore in the sludge, but this depends upon the nature of the gangue. In any case, the presence and addition as required of sodium chloride is a regulator of the electrical resistance of the solution which at any given moment is situated between the cathode and the anode, and, as the resistance in the conductors counts for very little, it practically affords means of governing the current in the external circuit of the electrical generator or dynamo. Of the several compounds which might be used for the same purpose, common salt is doubtless much the cheapest.

Now to consider the action of these products of electrolysis. As the sodium is liberated, in contact with the mercury cathode, a small proportion will no doubt be dissolved in the mercury as an amalgam. If the current ceases, this is converted into sodium hydrate (NaHO), with liberation of hydrogen. But the greater part of the sodium liberated will react at once with the water in the solution giving NaHO and H, the former to be used as described further on. Most of the chlorine liberated will at first be dissolved in the solution, but, as the liberation will take place at the surface of the anode, a small quantity may be used up in attacking the metal of which the anode is made. While this is going on the liquid immediately in contact with the cathode will become rich in sodium hydrate (NaHO), and the agitation will cause it to come in contact with the chlorine liberated at the anode, with some of it to reform sodium chloride (NaCl), and with another portion sodium hypochlorite (NaClO) and water (H_2O).*

This formation of hypochlorite in solution will, subject to the adverse conditions caused by agitation, be directly in proportion to the quantity of NaCl used to regulate the resistance, and with the relations of the areas of the anode and cathode respectively. But this formation of sodium hypochlorite will be limited by the extent to which the sodium hydrate above referred to, when it is liberated at the cathode, rises to lay hold of the chlorine which is rich around the anode. This we may regard as taking place in spite of the agitation of the stirrers, which probably tends to cause temporarily a rapid diffusion of the chlorine and sodium hydrate separately in the solution, although eventually they must come together. Although, when not in excess, it is a useful oxidiser, this formation of sodium hypochlorite has little advantage; and when potassium cyanide is added to the solution, it is, when in excess, even when alkaline, likely to oxidise some of it into potassium cyanate—a decided disadvantage, as it is a salt which is easily decomposed, and much less useful.

Let us now consider what may be effected by the chlorine liberated, but not engaged, as above described. In the first place, one might expect the nascent chlorine to attack some of the baser metallic ores present in a finely divided state. For instance, sulphides, selenides, arsenides, &c., often attached to particles of gold or silver, would be so attacked; the chlorine uniting with the metallic base iron (Fe) or copper (Cu), and the (S) sulphur, (Se) selenium, or (As) arsenic being oxidised by the combined action of the chlorine and sodium hypochlorite above alluded to, into sulphuric, selenic, or arsenic acids. These changes would be marked by the formation of sodium sulphate, sodium selenate, &c., and the consequent formation of free acids, including

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amalgam is there allowed to collect through the continuance of the treatment of successive charges until, when it is saturated, a "clean up" takes place. According to the richness of the ore, a "clean up" may be necessary at intervals of, say, two to fifteen days. In order that the agitation of the sludge may be such as to prevent the accumulation of heavy material on the surface of the mercury, the revolving arms are provided with pins, *x*, *x*, *x*, &c., say of wood or other non-conducting material, placed vertically, and projecting downwards to within a short distance, say an inch, of the cathode. These pins, as show on the drawing, also project upwards, so as to help to mainain agitation throughout the liquid mass. In order to correct the tendency to continued centrifugal movement of the liquid, projections, or bafflers, B, B, &c., are fixed at intervals to the inner side of the vat above the arms either vertically or at an angle to the vertical. By their influence the revolving current is broken up, and guided inwards and downwards so as to oblige every portion to pass in rapid succession through the space below the anode. The pipe opening at the side of the vat and a little above the bottom, I, is for drawing off a charge at the expiration of its treatment; and the hole, H, in the bottom is provided for the purpose of drawing off the mercury at the time of periodical "clean up."

* Results of some tests on a full-size scale, made at Denver with low-grade ores from various mines, pulverised to 40 mesh only:—

Name of mine.	Dwts. to the ton. Assay gold value.	Precipitated direct.	Precipitated from the solution.	Total gold saved per cent.
Rose	10·0	40	50	90
De la Mar	13·0	46	31	77
„	4·8	55	25	80
Oaxaca	8·0	45	30	75
Bassick tailings	6·3	23	53	76
Baby	13·2	64	21	85
Phœnix	2·4	75	17	92
Leroi	8·4	57	19	76
Alma	18·4	80	9	89
Miller	7·8	60	25	85

Some of the above samples were pulverised also to 60 mesh, and gave a result from 6 to 10 per cent. better.

† The advocates of treatment by simple leaching with chemical solutions dislike fine crushing, say, finer than will pass a mesh of 20 to 30 to the lineal inch, because it encourages the formation of "slimes," in the presence of which systems of treatment that act by means of percolation becomes less effective.

In those systems of treatment in which extreme fineness is not detrimental—rather otherwise—crushing so that the powdered ore will pass a mesh of 80 to 100 to the lineal inch is easily practicable, and makers of milling machinery have no hesitation in facing the problem.

Even then the way in which the work is done depends on the nature of the ore and the means employed. For instance, with some kinds of gangue, and of milling machinery, the particles in which the precious metal is intimately attached to a baser metal—say iron pyrites—instead of the result rendering them more pervious to chemicals, they may be found to be pressed out in solid, rounded, and smooth atoms, and in the worst form for separation and subsequent stages of the process.

These conditions would govern the net results, subject to the cost of fine crushing.

* $2\,NaHO + Cl_2 = NaCl + NaClO + H_2O$.

At a higher temperature, say 130° Fahr., the NaClO would become sodium chlorate, according to the following equation:—

$$3\,NaClO = NaClO_3 + 2\,NaCl.$$

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hydrochloric acid.* This probably represents what actually is the cause of disintegration of some of the metallic compounds which are present in refractory ores, as the chlorine attacks these first in preference to the gold. At the same time, it is no doubt the case that, as the process continues, some of the gold is brought into solution by the chlorine diffused through it, as chloride of gold ($AuCl_3$), the metal from which is readily deposited by electrolysis on the mercury. We all know that the solution of gold by chlorine is in common use, but I think that in the example given it is effected under novel conditions, the chlorine being added electrolytically instead of mechanically.

During the first two or three hours of treatment by agitation with the electric current, there is no doubt that the free gold which is not dissolved will be precipitated, the heavy particles at a very early stage of the process. In all such mixtures there is also more or less of what is called "float" gold, which in the processes using "percolation," and even "circulation," is lost in the "slimes." These particles, if they escape solution, will be so well mixed up in, and diffused through, the solution by agitation, that they should all in their turn be brought into close neighbourhood of the mercury surface of the cathode.

The advantage of mechanically adding small quantities of sodium to mercury employed in gold extraction to assist amalgamation has long been recognised, but in this case the sodium so used is provided electrolytically. There is little doubt that the heavier particles of gold and silver which reach the bottom by subsidence will, owing to the surface being strongly polarised both by the current and by the slight amount of sodium amalgam formed by the current, be more readily amalgamated, and the same conditions also will promote the seizure by the mercury of the minute particles of float gold and silver when they approach its surface. The reason for this is probably not merely that it is thereby "kept clean"—*i.e.*, free from oxide in the well-known sense—but that the difference of electrical potential set up between the mercury and the liquid alters the surface tension at the liquid junction, and helps the metallic particles to come in actual contact with the mercury. This is, I believe, a new way of defining what occurs when what is called "prevention of flouring," and the establishment of metallic contact with the mercury, takes place.

The presence of the excess of an acid such as hydrochloric acid has to be provided for by the adittion, say, of lime, to make the solution neutral; but this will not get rid of any excess of hypochlorite, previously mentioned, if present. Lime, to remove free chlorine, will not be added until any metals in the solution, such as copper sulphides, or arsenides, have been formed into electrolysed salts through conversion into chlorides. These, which cause waste of cyanide of potassium, would to a certain extent go into solution, and, by electrolytic action, become deposited in the mercury, and their values saved.

It will be understood, therefore, that all this preliminary work not only amalgamates a large proportion of the free gold and silver, but also prepares for the more effective action of potassium cyanide, both as a solvent and as an auxiliary in producing the condition of increased conductivity in the solution. Thus everything that chlorine can do to help the disintegration of the metallic ores which are found accompanying gold facilitates the action of potassium cyanide when it is added. This preliminary disintegration would be helped, not hindered, by temporary increased acidity of the liquid, when bodies like sulphides are oxidised at the expense of the chlorine; showing that the best time for neutralising the solution is at at the end of this preliminary stage, and just before the potassium cyanide is introduced.

In all this preliminary stage it will be seen that the eventual economy of potassium cyanide (or other solvent) should be aimed at, because, although with "percolation" processes the "leaching" can be effected with even ½lb. of it, as much as 2lb. of it to the ton of ore under treatment may be here required. Obviously the greater part of it is wasted, as, in treating a low-grade ore containing, say 15 grammes of gold and say 30 grammes of silver, 60 per cent. of the gold and 40 per cent. of the silver may be separated and amalgamated in the first two or three hours, and before the potassium cyanide is added. Clearly, it does not require 2lb. to treat 6 grammes of gold and 18 grammes of silver, even if all the values that remain in the sludge *could* be dissolved. The addition of potassium cyanide (KCN) to an ordinary agitating vat causes the solution of some of the finely divided gold; and a further solution will ensue when, by the passage of an electric current, a decomposition yielding free cyanogen at the anode and caustic potash and hydrogen at the cathode will ensue. So far the reactions are common to all arrangements which combine agitation with electro-cyanide processes.* The addition of potassium cyanide in excess in the Pelatan-Clerici process has been doubtless due to the necessity of allowing for the oxidisation of it by any excess of hypochlorite previously mentioned.† It is also desirable to have some cyanide to spare, because the cyanogen (C_2N_2) formed at the anode dissolved in the solution will readily unite with the minutest and lightest particles of gold, to form with some of the said excess of it the double cyanide of gold [Au K (C N)$_2$], which is a salt that is easily soluble and readily electrolysed.‡ These conditions point to the advantage of getting rid of any excess of hypochlorite and of acidity by neutralisation before the cyanide (K C N) is added; also avoiding excessive oxidation of it, when, if an insufficiency were to ensue and tests were neglected, it is possible that Au C N might be formed and remain insoluble, and hence escape electrolysis and pass away in the tailings.

There is an advantage also in the simultaneous electrolysis of both sodium chloride and potassium cyanide, though the duty of the former is principally to facilitate the conductivity of the electrolyte. Chlorine and cyanogen are both yielded at the anode, and would probably lead to the production of cyanogen chloride, which (in common with cyanogen bromide) would be in the presence of potassium cyanide as effective in attacking gold, if not more so, as cyanogen itself. The difference between this and what is known as the Sulman-Teed process is, that in it

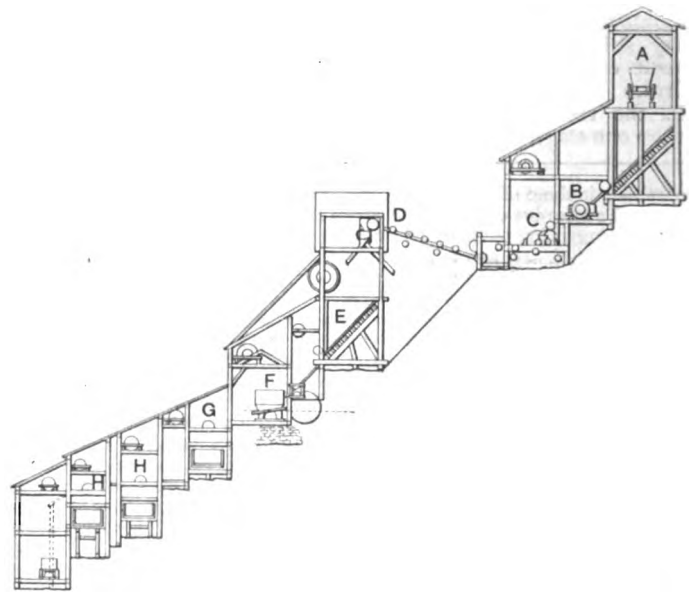

FIG. 10.—Rough Section of Mill at Rossland (B.C.) for the Treatment of Low Grade Ores by the Pelatin-Clerici Process.

cyanogen chloride (or bromide) is added mechanically to a solution containing potassium cyanide and gold or silver ore,§ whereas in this process the conditions to effect a corresponding reaction are produced electrolytically. To Mr. E. F. Herroun, of King's College, I owe every thanks for assisting me to prepare the above investigation of some of the features of the process.

When some members of the British Association visited Rossland, in British Columbia, last September, Prof. Armstrong is reported to have said: "One thing that has struck me most forcibly is that some better method than smelting should be applied to your low-

* The reaction in this process may be represented in two stages, as follows:—

$$FeS + Cl_2 = FeCl_2 + S,$$

or

$$FeS_2 + Cl_2 = FeCl_2 + S_2 \text{ (iron pyrites)};$$

and

$$S + NaClO + 4Cl + 3H_2O = NaHSO_4 + 5HCl.$$

* They are: With dissolved oxygen alone available—

$$4KCN + Au_2 + H_2O + O + 2KAu(CN)_2 + 2KHO;$$

with nascent cyanogen—

$$KCN + Au + CN = KAu(CN)_2.$$

$$+ Na\,Cl\,O \times K\,C\,N = Na\,Cl + K\,C\,N\,O.$$

‡ Observation to ascertain the continued presence of cyanide (K C N) is made from time to time with the nitrate of silver test—a drop in a test-tube of the solution. If too much chloride of sodium is present, the effect would be masked by the formation of chloride of silver, when it would be difficult to distinguish the cloudiness of the liquid caused by the one from that caused by the other. In such a case iodide of starch, which is bleached by potassium cyanide, and not by chloride, is useful as a substitue for nitrate of silver.

§ Thus: $CNBr + 3KCN + Au_2 = 2KAu(CN)_2 + KBr.$

This equation no doubt represents what happens so far as the cyanide which actually combines with the gold is concerned; but the whole of the cyanide is not converted into $KAu(CN)_2$; probably the largest proportion will be decomposed by the cyanogen bromide, giving potassium bromide, potassium cyanate, and hydrocyanic acid.

The following two equations represent actions that are taking place together in the solution, but which have no constant ratio to one another:—

(I.) $CNBr + 3KCN + Au_2 = 2KAu(CN)_2 + KBr.$

(II.) $CNBr + 2KCN + H_2O = KBr + KCNO + 2HCN.$

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grade ore. It seems to me that some of the recent discoveries in electrolytic treatment might be applied to such ores." Nearly a year before these remarks are said to have been made, I was instrumental in submitting samples of some of the Rossland ores, on a working scale, to the electrolytic treatmeant of the General Gold Extracting Company by the Pelatan-Clerici process at their testing works in Denver, Colorado ; and the following drawings will give some idea of the arrangement of a mill for treating ore by that process, which, in consequence of the results of those trials, and others of a more recent date, is now in course of erection between the Red Mountain Railway and the Little Sheep Creek, about three miles from the city of Rossland.

At A, in plan and section (Figs. 10 and 11) is shown a railway siding with a shed over and an ore bin under it. At B and C are placed the stone breakers and rollers. D is where an elevator discharges the crushed ore over a sampler into a second ore bin, E, whence it is drawn into the Chilian mills, F, F, F. Thence the sludge that passes the screens is taken to the mixing tanks, G, &c., and when mixed in due proportion the liquid is passed to the treatment tanks, or vats, 12 of which are shown (H, H, &c.). The motive power is situated to the left, and about the same level as D; and with about 75 B.H.P. actually in use at one time, about 50 tons of ore can be treated daily on 300 days of 24 hours in the year. By adding two Chilian mills, three mixing, and 10 treatment tanks, and 35 B.H.P., 100 tons a day can be treated. The sketches—which do not show the power house, the sampling, cupelling, testing, and other subordinate departments of such a mill—are intended as an example of how ore carried straight by rail from the "dump" can be pulverised and treated for extraction without any handling.

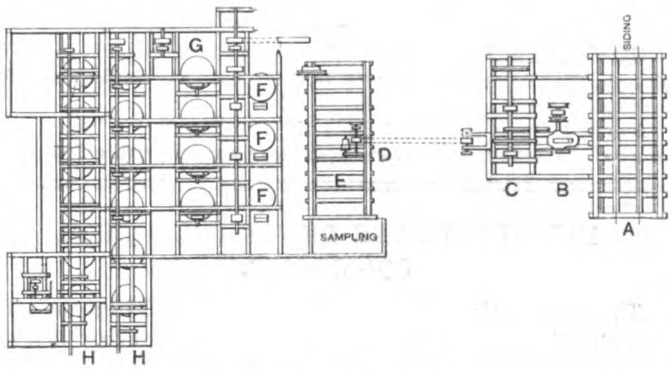

FIG. 11.—Plan of Rossland Mill

The designs were made and the work laid out, under my own supervision, by Mr. Fisher, of Helena, who has been engineer and millwright to many well-known smelting works and extracting mills in the Western States of America, but who had had no previous experience with this class of treatment plant.

Below is a simple means, given me by Mr. Peletan, of testing quantitively for the presence of gold and silver in the solutions with potassium cyanide as a solvent at each stage of treatment, which can be easily used by the assayer in charge.*

PHYSICAL SOCIETY.

At the annual general meeting of the Physical Society, on February 11th (Mr. Shelford Bidwell, President, in the chair), the report of the Council was read by Mr. Elder. Dr. Atkinson then presented the Treasurer's report, and informed the Society of the improved condition of its finances. The difficulties of the previous year had arisen from the expenses incurred by the publication of abstracts of current scientific literature: those difficulties had been surmounted without drawing upon the reserve fund. Very few Fellows had objected to the increase of subscriptions. In acknowledgment and appreciation of the abstracts, now presented to all Fellows, many of the original life-members had lately made additional voluntary donations to the funds of the Society, thus sharing with new Fellows the extra outlay involved by the abstracts. It was to be hoped that all life-members would adopt this course, more especially as the scope of scientific literature covered by the abstracts was now being extended to British as well as to foreign sources. Votes of thanks were passed to the Council, the Officers, and to the Council of the Chemical Society for the use of their rooms at Burlington House. Two Honorary Fellows were unanimously elected by ballot, *i.e.*, Riccardo Felici, Professor in the University of Pisa, and Emilio Villari, Professor in the University of Naples. Council and officers for the forthcoming year were elected as follows:—President: Shelford Bidwell. Vice-Presidents who have filled the office of President: Dr. J. H. Gladstone, Prof. G. C. Foster, Prof. W. G. Adams, Lord Kelvin, Prof. R. B. Clifton, Prof. A. W. Reinold, Prof. W. E. Ayrton, Prof. G. F. Fitzgerald, Prof. A. W. Rücker, Capt. W. de W. Abney. Vice-Presidents: Prof. C. Vernon Boys, Major-Gen. E. R. Festing, Mr. G. Griffith, Prof. J. Perry. Secretary: Mr. H. M. Elder, 50, City-road, E.C. Foreign Secretary: Prof. S. P. Thompson. Treasurer: Dr. E. Atkinson. Librarian: Mr. W. Watson. Other Members of Council: Prof. H. E. Armstrong, Mr. Walter Baily, Mr. L. Clark, Dr. A. A. Fison, Mr. R. T. Glazebrook, Prof. A. Gray, Prof. J. Viriamu Jones, Mr. S. Lupton, Prof. G. M. Minchin, Mr. J. Walker.

The PRESIDENT then read an address, in which the aims and history of the Physical Society were outlined. This address will be published in full in due course. Prof. RÜCKER said that among the new and useful departures lately made by the Physical Society the institution of a Presidential Address was particularly worthy of notice ; it was very desirable from time to time to hear a summary of what had been achieved during the year. It was also desirable that the objects of the Society should be, from time to time, definitely stated; this departure had been fully justified by the address of Mr. Shelford Bidwell.

A Paper by Mr. G. H. BRYAN, on

"Electromagnetic Induction in Plane, Cylindrical and Spherical Current Sheets, and its Representation by Moving Trails of Images,"

was read by Mr. ELFLER. The phenomena of induction in a cylindrical conducting sheet in a two-dimensional field, and of induction in a spherical sheet in any field due to the generation or motion of poles, magnets, or currents, in the presence of the sheet, can be represented by moving trails of images which are but slightly more complicated than the well-known trails of images in a plane sheet. The images, representing the potentials of the induced currents on the two sides, start from the source of disturbance and its inverse point, and more normally away from the surface of the sphere cylinder, with velocity varying directly as the disturbance. At the surface of the sheet this velocity becomes equal to the corresponding velocity for a plane sheet. The images are in most cases similar in nature to the inducing source of disturbance, and their intensities are found, in every case, to vary as a power of the distance from the centre. The images due to the sudden generation of a magnetic pole in the presence of a spherical sheet are, however, analogous to the hydrodynamical image of a source in a sphere.—Dr. S. P. THOMPSON said the method and the results obtained would find useful application in the solution of many allied problems.—The PRESIDENT proposed a vote of thanks to the author.

The meeting was then adjourned until Saturday, February 26th, on which occasion the Physical Society will visit Eton College. Fellows are informed that a train leaves Paddington for Windsor at 2:25 p.m. ; this arrives in time for the meeting, which is at 4 p.m.

Granite Telegraph Poles.—In a letter to the *Engineering News* of New York, Mr. C. H. Snow, of New York University, states that while travelling in Switzerland last summer he came across an engineering curiosity in the shape of a telegraph line with stone poles. This line passes along the fine military road which skirts the west side of Lake Maggiore, and connects Milan with Switzerland by way of the Simplon Pass. The telegraph poles are of grey granite. They average probably 10in. square, and 25ft. high. He was told by a telegraph official that these poles were in use for a distance of 30 to 40 miles, and that their cost in position was about 10 francs (or 8s.) each. The quarries from which the poles were cut are situated just above the town of Stresa. Mr. Snow's informant volunteered the further statement that renewals were now made in wood, the principal cause of dissatisfaction with the stone poles being that they did not stand well against any transverse strain due to the pull exerted when tightening the wires.

* Take 500 cubic cm. of solution. Heat nearly to boiling point. Add 2 grammes *sulphate of copper* (bluestone) and 2 grammes of *sodium sulphide*. Add hydrochloric acid so as to have a strong acidity. Heat to boiling point. Filter the black precipitate in which the all gold and silver are retained. Scorify the precipitate with 50 grains litharge. The precious metals are recovered from the lead by cupellation. The sodium sulphide used in this test is made in a very simple way, by fusing in a crucible one part of *carbonate of soda* and one part of *sulphur*. The crucible must be well covered.

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ELECTRIC POWER DISTRIBUTION FROM COLLIERIES.

The consumption of coal at the pit mouth and its conversion into electric energy for transmission to surrounding districts has long been a favourite scheme with engineers. Again and again it has been proposed in more or less serious detail, and recently the problem has been attacked in sober earnest. The Midland Electric Corporation for Power Distribution (Limited) is announced as prepared to enter into agreements to supply electrical energy for manufacturing purposes at 1d. per unit, and for lighting at 6d. per unit for the first hour and 3d. per unit afterwards. The same corporation is willing to lay an extensive system of power mains in South Staffordshire, and to supply motors on hire, so that the consumer's capital outlay will be limited to the wiring of his premises. No exact details are yet forthcoming, but given a well thought-out scheme, both as regards generation and distribution, and due economy in capital outlay, there is evidently money to be made. We would point out, however, that the scheme involved is not a mere question of the relative costs of carrying coal and transmitting electric power. Experience has shown that the cost of fuel is insignificant in comparison with the costs of generation and distribution unless the output be large, and be produced at a uniform rate. In fact, success will depend chiefly upon the load factor. It will be of little use to get cheap fuel unless the distribution losses are kept down and the demand is fairly steady. Mr. Albion T. Snell, in a lecture at Derby in 1893, pointed out how high the load factors of most collerieries were or could be made. He showed that by a little adjustment they could in many cases be made as high as from 50 to 75 per cent. Again, in 1894, in the introduction to his work on "Electric Motive Power," referring to the same subject, he wrote, "It is not at all improbable that the Midland towns may one day be lighted and their mills driven by electric

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power derived from coal burnt at the pit mouth." The idea, therefore, is by no means a new one; nor is it altogether untried, for on several coalfields in the United States central stations have been laid down to supply power to a group of coal pits, and have been found to lower the cost of power very materially.

The chief points of interest at the moment, in regard to the scheme of the Midland Electric Corporation, relate to the system of generation and distribution. It is evident that the transmission must be effected at high pressure, say at from 5,000 to 15,000 volts, for which there is ample precedent both on the Continent and in America. The next question to be settled is: Should continuous or alternate currents be used—and if the latter, should they be monophase or polyphase? English practice, as represented by some of the great Midland electrical manufacturing firms, is probably in favour of continuous currents. And there is much support given by the success obtained by the series plants at Genoa and also by several high-pressure parallel schemes in various parts of the world. But experience gained both in America and on the Continent clearly points towards alternate current as the better adapted for at least the transmission part of the scheme. There are scores of plants working now with alternate currents and giving unqualified success, and it is interesting to notice that most of the important Swiss and American schemes now in progress are of this class.

The real question does not appear to us to lie between continuous and polyphase, but rather between two-phase and three-phase working. Accepting this dictum for the moment, we are at once confronted by an array of experts on each side, each backed by the experience gained in many a well-thought-out and carefully-executed scheme. The arguments to be advanced on each side are borne out more or less by numerous cases, and are most difficult to combat. Yet it is an indisputable fact that the great Swiss engineering firms of Messrs. Brown, Boveri and Company and the Oerlikon Company have both practically accepted three-phase working as superior to two-phase, at any rate for the generating and transmitting part of the plant. And it is significant that three-phase currents are being largely used by the same firms for distribution in many of their new schemes. A remarkable illustration is found in the light and power plant at Milan now being extended by Messrs. Brown, Boveri and Co. It is the practice there at present, and will be in the extensions, to transmit power at high pressure to three separate transformers, having a common yoke with the connections in Y fashion. On the low-pressure side power is supplied from the three mains, while lighting is effected by monophase currents from one of the main conductors, and a fourth conductor connected to the middle of the winding. Lamps run excellently on these circuits at a frequency of about 42 ∾. Another instructive and still more important example is to be found in the Lachine Rapids power transmission and distribution plant, a description of which occurs in our issue this week (page 544). In this latter instance power is generated and transmitted by three-phase plant, but is distributed either by single-, two- or three-phase alternate currents, or by continuous current, according to requirements. It is one of the strongest points in favour of three-phase working, for large power utilisation schemes, that it so readily lends itself to this diversity of transformation and usage, without inconvenience or trouble arising, and with reasonably high efficiency. This system, indeed, seems to combine in the highest degree the advantages of high-pressure transmission and yet permits of an efficient service for power and light. In our judgment it offers the best available method for utilising the energy of coal at the pit mouth. Now that polyphase machines are being "made in England" we look to the speedy development of this useful class of plant.

ELECTROMAGNETIC THEORY.—CIII.*

BY OLIVER HEAVISIDE.

(*Continued from page 381*).

§ 418. We now come to the very last way I shall give of algebrising the operational solutions for initial states. It has some historical interest, and had especial value in being the first way in which I was able to obtain full mathematical confirmation of the results relating to the generation of positive and negative tails obtained by a consideration of the distortionless circuit.

For explicitness, say that $V = V_0$ initially, without any C. Then, by (6), (7), the resulting states of V and C are

$$V = \epsilon^{-\rho t}(p+\sigma)\frac{\sinh \nu t}{\nu}V_0, \tag{74}$$

$$C = -\epsilon^{-\rho t}\frac{\sinh \nu t}{L\nu}\Delta V_0. \tag{75}$$

Now in the distortionless case $\epsilon^{\nu t}$ reduces to $\epsilon^{vt\Delta}$, which is merely a translational operator, and enables the algebrisation to be immediately effected. But since when there is distortion the property of propagation of elementary disturbances at speed v remains true, if we express $\nu^{-1}\epsilon^{\nu t}$ in the form $\epsilon^{vt\Delta} f(v\Delta)$, then we separate the distortion from the translation. Whether this is useful will depend upon the form assumed by $f(v\Delta)$. If $f(v\Delta)V_0$ can be algebrised, then the work is done.

The required expansion may be effected by § 375, equation (166). Turn y to t, s^2 to σ^2, and p to $v\Delta$.

The result is

$$\frac{\epsilon^{\nu t}}{\nu} = \frac{\epsilon^{vt\Delta}}{v\Delta}\left\{1 + \frac{s\sigma t}{2}r_1 + \left(\frac{s\sigma t}{2}\right)^2\frac{r_2}{\lfloor 2} + \left(\frac{s\sigma t}{2}\right)^3\frac{r_3}{\lfloor 3} + \ldots\right\}, \tag{76}$$

where $s = \sigma/v\Delta$, and the r's are functions of $(v\Delta)^{-1}$, thus,

$$r_1 = 1 - \frac{1}{vt\Delta}, \quad r_2 = 1 - \frac{3}{vt\Delta} + \frac{3}{(vt\Delta)^2}, \quad \&c., \tag{77}$$

as described in § 375, only with yp there changed to $vt\Delta$ here.

Since changing the sign of t gives us $\epsilon^{-\nu t}/\nu$, it is clear that the solutions (74), (75) are expanded as required, and since $f(v\Delta)$ contains Δ inversely in s and in the r's, the expansion is suitable for the treatment of discontinuities.

In the practical execution it is perhaps as well, or better, to rearrange (76) in powers of $(v\Delta)^{-1}$. This is to be done by inspection of the r functions. The result is

$$\frac{\epsilon^{\nu t}}{\nu} = \frac{\epsilon^{vt\Delta}}{v\Delta}\{1 + sg_1 + s^2g_2 + s^3g_3 + \ldots\}, \tag{78}$$

where the g's are time functions, namely

$$g_1 = \frac{1}{2}\sigma t, \quad g_2 = -\frac{1}{2} + \frac{\sigma^2t^2}{2.4}, \quad g_3 = -\frac{3\sigma t}{8} + \frac{\sigma^3t^3}{2.4.6}, \tag{79}$$

being the same as in § 376, equation (179), where they turned up in another way. The next three are

$$g_4 = \frac{3}{8} - \frac{\sigma^2t^2}{8} + \frac{\sigma^4t^4}{2.4.6.8}, \quad g_5 = \frac{5\sigma t}{16} - \frac{5}{4}\frac{\sigma^3t^3}{2.4.6} + \frac{\sigma^5t^5}{2.4.6.8.10},$$

$$g_6 = -\frac{5}{16} + \frac{15}{16}\frac{\sigma^2t^2}{2.4} - \frac{3}{2}\frac{\sigma^4t^4}{2.4.6.8} + \frac{\sigma^6t^6}{2.4.6.8.10.12}. \tag{80}$$

Similarly we can develop $(p+\sigma)\epsilon^{\nu t}/\nu$, either by differentiating (78), or by using the A series in § 375. We get

$$(p+\sigma)\frac{\epsilon^{\nu t}}{\nu} = \epsilon^{vt\Delta}(1 + sf_1 + s^2f_2 + s^3f_3 + \ldots), \tag{81}$$

* This series of Articles is a portion of Vol. II. of Mr. Heaviside's work on "Electromagnetic Theory." All rights of reproduction are reserved.

where the f's are also time functions, of which the first six are

$$f_1=1+\frac{\sigma t}{2},\quad f_2=\frac{\sigma t}{2}\left(1+\frac{\sigma t}{4}\right),\quad f_3=-\frac{1}{2}\left(1+\frac{\sigma t}{4}\right)+\frac{\sigma^2t^2}{2.4}\left(1+\frac{\sigma t}{6}\right),$$

$$f_4=-\frac{3\sigma t}{8}\left(1+\frac{\sigma t}{6}\right)+\frac{\sigma^3t^3}{2.4.6}\left(1+\frac{\sigma t}{8}\right),$$

$$f_5=\frac{3}{8}\left(1+\frac{\sigma t}{6}\right)-\frac{\sigma^2t^2}{2.4}\left(1+\frac{\sigma t}{8}\right)+\frac{\sigma^4t^4}{2.4.6.8}\left(1+\frac{\sigma t}{10}\right),$$

$$f_6=\frac{5\sigma t}{16}\left(1+\frac{\sigma t}{8}\right)-\frac{5}{4}\frac{\sigma^3t^3}{2.4.6}\left(1+\frac{\sigma t}{10}\right)+\frac{\sigma^5t^5}{2.4.6.8.10}\left(1+\frac{\sigma t}{12}\right). \quad (82)$$

By changing the sign of σ, and also that of t, we get

$$(p-\sigma)\frac{\epsilon^{-\nu t}}{\nu}=\epsilon^{-vt\Delta}(1-sf_1+s^2f_2-s^3f_3+\ldots); \quad (83)$$

and so, by taking half the sum of (81) and (83), (74) becomes expanded.

Our original equations (74), (75) are therefore brought to the forms

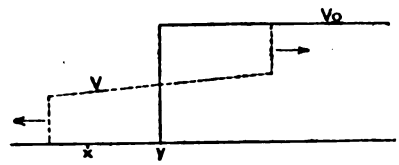
$$V=\tfrac{1}{2}\epsilon^{-pt}\epsilon^{vt\Delta}(1+sf_1+s^2f_2+s^3f_3+\ldots)V_0 + \tfrac{1}{2}\epsilon^{-pt}\epsilon^{-vt\Delta}(1-sf_1+s^2f_2-s^3f_3+\ldots)V_0, \quad (84)$$

$$Lv C=\tfrac{1}{2}\epsilon^{-pt}\epsilon^{vt\Delta}(1+sg_1+s^2g_2+s^3g_3+\ldots)V_0, + \tfrac{1}{2}\epsilon^{-pt}\epsilon^{-vt\Delta}(1-sg_1+s^2g_2-s^3g_3+\ldots)V_0. \quad (85)$$

The only operations to be performed now, except the translations to right and left respectively, are the integrations sV_0, s^2V_0, &c. Suppose, for example, V_0 is constant, but exists only from the point y to $+\infty$, and we want V outside the V_0 region. Then the second line in (84) is zero, because V_0 is zero; and in the first line, $\Delta^{-n}V_0$ is $V_0(x-y)^n/\underline{n}$, when $x>y$, and zero on the other side. That is, all these integrals exist from y to ∞. Then $\epsilon^{vt\Delta}$ turns x to $x+vt$, and makes (84) become

$$V=\tfrac{1}{2}\epsilon^{-pt}V_0\left\{1+\frac{\sigma y_1}{v}f_1+\left(\frac{\sigma y_1}{v}\right)^2\frac{f_2}{\underline{2}}+\left(\frac{\sigma y_1}{v}\right)^3\frac{f_3}{\underline{3}}+\ldots\right\}, \quad (86)$$

where $y_1=x+vt-y$. Here y_1 must be positive. If it be negative, V is zero. This diagram will illustrate :—



The dotted line shows the beginning of the V wave before it has attenuated much at its front, without any allowance for the attenuation of V_0, if there be any. The curve of V is not a straight line, as mistakeably represented. But later diagrams will show the approximate shape under different circumstances.

Similarly, the other formula (85) makes

$$Lv C=\tfrac{1}{2}\epsilon^{-pt}V_0\left\{1+\frac{\sigma y_1}{v}y_1+\left(\frac{\sigma y_1}{v}\right)^2\frac{g_2}{\underline{2}}+\left(\frac{\sigma y_1}{v}\right)^3\frac{g_3}{\underline{3}}+\ldots\right\}. \quad (87)$$

It gives the current between the limits $x=y+vt$ and $y-vt$. It is pretty easy to calculate these formulæ when t is not too big. In fact, to show how the wave begins, they are easier than the corresponding Bessel formulæ.

If the initial V_0 is on the left side of the origin, that is, from $-\infty$ to $x=0$, then the proper change in the meaning of y_1 makes

$$V=\tfrac{1}{2}V_0\epsilon^{-pt}\left[1+\sigma tf_1\left(1-\frac{x}{vt}\right)+\frac{\sigma^2t^2}{\underline{2}}f_2\left(1-\frac{x}{vt}\right)^2+\ldots\right], \quad (88)$$

express V at x on the positive side, from $x=0$ to vt; beyond which, V is zero. And the corresponding C is given by

$$Lv C=\tfrac{1}{2}V_0\epsilon^{-pt}\left[1+\sigma tg_1\left(1-\frac{x}{vt}\right)+\frac{\sigma^2t^2}{2}g_2\left(1-\frac{x}{vt}\right)^2+\ldots\right]. \quad (89)$$

To obtain the formula for the C due to C_0 change the sign of σ in (88), explicit and in the f's, of course also writing C and C_0 instead of V and V_0. To obtain the formula for the V due to C_0, change $Lv C$ to SrV, and V_0 to C_0, in (89), without other change, because reversing the sign of σ leaves σtg_1, &c., the same.

Comparing different ways of working, we may collect some of the results thus :—

$$\frac{\epsilon^{-t(v^2\Delta^2+\sigma^2)^{\frac{1}{2}}}}{(v^2\Delta^2+\sigma^2)^{\frac{1}{2}}}v\Delta 1=\frac{\epsilon-xv^{-1}(p^2-\sigma^2)^{\frac{1}{2}}}{(p^2-\sigma^2)^{\frac{1}{2}}}p1 \quad (90)$$

$$=\left(\frac{p-\sigma}{p+\sigma}\right)^{\frac{1}{2}}\epsilon^{-xv^{-1}(p^2-\sigma^2)^{\frac{1}{2}}}\epsilon^{\sigma t}=I_0\{\sigma(t^2-x^2/v^2)^{\frac{1}{2}}\} \quad (91)$$

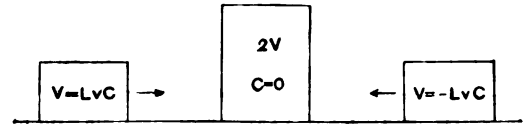
$$=\frac{2r}{\pi}\int_0^\infty\cos mx\frac{\sin t(m^2v^2-\sigma^2)^{\frac{1}{2}}}{(m^2v^2-\sigma^2)^{\frac{1}{2}}}dm \quad (92)$$

$$=1+\sigma tg_1\left(1-\frac{x}{vt}\right)+\frac{\sigma^2t^2}{\underline{2}}g_2\left(1-\frac{x}{vt}\right)^2+\ldots. \quad (93)$$

There are several other forms, but these are the principal. There are also combination formulæ, when there is initially existent both V_0 and C_0; for example, to show how an initial pure wave casts its tail behind. But they do not involve fresh investigation, and as space is running short, I now bring the development of these formulæ to a conclusion. I have gone over pretty well all the ground. Another way of attacking the mathematics of the subject will be found in Webster's lately published "Electricity and Magnetism," § 255, due to Boussinesq, and methods by Poincaré and Picard are also referred to there. In these the reader may revel if he wants more. I have had enough of it for the present. Naturally, I prefer my own ways, because I can understand them better. And best of all I like the distortionless circuit, because everything essential to a general understanding can be foreseen by its means without any of the complicated mathematics, which however is of course necessary to complete the matter, and permit particular people to admit the truth of the conclusions, and to allow of close calculations being made if desired ("El. Pa.," Vol. 2, pp. 119 to 155, and pp. 381, 427, 475, &c.).

§ 419. Having in Chap. IV., Vol. I., described pretty fully the meaning of the theory, in its application to conducting circuits as well as to plane waves in a uniform medium with two conductivities, it is unnecessary to repeat the information here. What follows is supplementary, particularly for the assistance of those readers who may desire to go into numerical detail, and draw the curves according to the preceding formulæ.

First take the case of no resistance and no leakage. Represent V by the ordinate erected on the base line which stands for the circuit. Then let there be two equal waves travelling towards one another. The one on the left is the positive wave. In it $V=Lv C$. On the left is the negative wave, in which $V=-Lv C$. This being the state at a certain moment, the subsequent history is got by moving the positive wave to the right and the negative to the left, at the same speed v. When they overlap the real V and C are got by superposition. It follows that when they coincide in position there is no C, whilst V is doubled. After that the negative wave emerges on the left, and the positive on the right.



This also shows how an initial state of transverse voltage only, without magnetic force, behaves. Say it is 2V, as in the middle. Then it splits immediately into the positive and negative waves, not as shown in the diagram, but as they would be after emerging from coincidence. Similarly as regards an initial state of current only. Say it is 2C. Then it splits into a positive wave in which $V=LvC$ going to the right, and a negative wave in which $-V=LvC$ going to the left.

After this rudimentary preliminary, pass to the distortionless circuit with resistance. Besides the undistorted transmission as above, there is now attenuation in transit. The time factor of attenuation is $\epsilon^{-Rx/Lv}$. The curve of attenuation along the circuit is therefore $y=\epsilon^{-Rx/Lv}$. Draw it, and then let an elementary plane wave slide along it at speed v, and it will correctly represent the transit of the wave as modified by the resistance and the leakage.

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SPARKING IN DYNAMOS.

BY EUSTACE THOMAS, B.SC.

An examination of the constants of a large number of the most modern continuous-current dynamos in June, 1897, impressed upon the writer the inadequacy of the commonly-accepted theories to explain the absence of sparking under the conditions of practice. In traction work especially it is one of the first essentials that the brushes shall remain fixed, and most specifications for both dynamos and motors require that it shall be possible to throw on or off at least the full load without sparking. In actual fact, machines are built to be practically sparkless, with fixed brushes, for all variations from 25 per cent. of full load to 25 per cent. of overload, and have often a greater range than this.

The cause of the difficulty is well known, but it may be worth while to briefly describe it again. The current carried by an armature coil is reversed each time the commutator segments, to which it is attached, come under a brush. During the period of such reversal the coil is short-circuited by the brushes. For sparkless running it is necessary that there should be some agency at work capable of providing an E.M.F. which shall reverse the current in the short-circuited coil, and shall have exactly built it up to the original value in the opposite direction at the moment the short-circuit ceases. If this "reversing E.M.F." is too large or too small the current in the short-circuited coil will not have reversed and risen to the right value when the short-circuit ceases, and sparking is certain to result. The "reversing E.M.F." is generally taken to be due to the short-circuited coil finding itself in the fringe from the pole-pieces in a field of such strength as will provide the necessary E.M.F. A little thought, however, will suffice to show that this is insufficient to explain sparkless commutation with *fixed* brushes.

Let us imagine that the brushes have been set so that at three-quarters of full-load the "reversing" field is of exactly the correct strength to provide the necessary reversing E.M.F. Then at *no* load the armature reactions will be so diminished that the coils will find themselves during reversal in a stronger field than that of three-quarter load. But as the current to be reversed is almost *nil*, we require a much *weaker* field, instead of a stronger one. Similarly at, say, 25 per cent. overload, increased armature reaction will have caused the reversing field to be *weaker* than at three-quarter load. But as the current to be reversed is much greater, it is really a stronger field that we require. Some other explanation is therefore necessary, and in view of the different behaviour of the different types of brushes, was to be looked for there.

Some experiments in 1893 showed that a certain machine would carry—

With copper brushes	200 amps.
With gauze ditto	300 ,,
With G.S. ditto	320 ,,

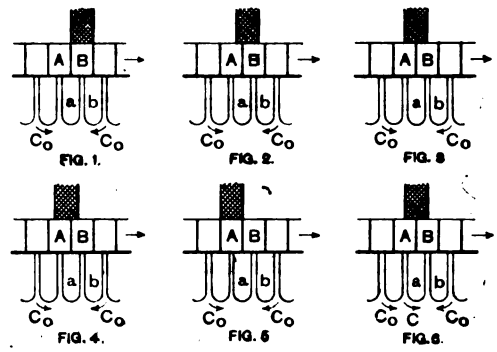
With carbon brushes properly put on to a commutator in good condition, the freedom from sparking is so much increased with fixed brushes that they are coming to be universal in traction machines, and even in many others where the conditions are not so trying. The explanation usually received is that the carbon or gauze brushes introduce a greater resistance in the path of the short-circuit currents when a coil is under reversal. This is obviously incomplete, since it certainly does not explain how the current in the short-circuited coil is reversed and brought to exactly the right strength at the instant the short circuit ceases, and this condition is essential for sparkless commutation.

The writer was led to give the following explanation, which he embodied in a report on the machines referred to in July, 1897. He has since found that a similar explanation has been suggested by Weymouth and others, but does not think sufficient attention has been given to the matter. Figs. 1 to 5 represent diagrammatically a commutator with coils attached to it, all travelling to the right under a brush. In Fig. 1 the coil A carries a current, C_o, flowing in a counter-clockwise direction. In Figs. 2 to 4 it is short-circuited, in Fig. 5 the short-circuit has just ceased. The current in *b* can find its way to the brush—taken here for simplicity's sake as equal in width to one commutator segment—either directly by the bar B, or through the coil *a*. Let us examine what would happen if the first path only were open. In Fig. 1 the whole width of the bar B is in contact with the brush, in Figs. 2 to 5, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$, and 0 respectively. If the contact resistance between brush and bar be 0·01 ohm in Fig. 1, it will be 0·0133, 0·02, 0·04, and ∞ respectively in the other figures, the resistance being assumed for the moment to be independent of the current density. Hence, if all the current in *b* has to pass through this contact resistance, bar B will rise in potential above the brush as the area of contact decreases. Bar A, on the other hand, is making better and better contact with the brush, and is nearly at the same potential. Thus the tendency is for bar B to rise in potential above bar A, and consequently for a current to flow through *a* from B to A. The varying contact resistance of brush and commutator segment is thus responsible for the provision of a reversing E.M.F. of the character we require. Further, it will be seen that this reversing E.M.F. is self-adjusting, for if the armature currents are large the P.D. between B and the brush will be large also, and *vice versâ*.

From experiments made, it was found in a particular case that if the short-circuit coil carried no current the P.D. between B and the brush will have the following successive values:—

B	completely covered by brush	...	0·89	(P.D. between B and brush).		
B	$\frac{1}{2}$	,,	,, ...	1·2	,,	,, ,,
B	$\frac{1}{4}$	,,	,, ...	2·4	,,	,, ,,
B	$\frac{1}{8}$	,,	,, ...	4·8	,,	,, ,,

A at the same time would be nearly at the same potential as the brush, and it will be clearly seen that under such conditions the current in coil *a* must necessarily be reversed, and that the whole reversing E.M.F. is self-adjusting for different loads. The above explanation would imply that there should



be found a difference of potential between that part of the commutator under the leading edge of the brush and the part under the trailing edge. The writer has before him numerous potential curves plotted from experiments, which all confirm this. Fig. 7 shows typical curves of this nature drawn from actual tests on a 500 kilowatt machine.

Numerous devices have been employed to minimise sparking, and all have been found at times to produce apparently good results, and at others negative or even harmful ones. No doubt a good many of the troubles have been allocated to wrong causes, for when difficulty is experienced, and a machine pulled to pieces for alterations, it is rare that one matter only is tried at a time. If good results follow, they are as likely as not to be considered as due to the wrong cause, and hence contradiction arises between different experimenters. In some cases, boring out the fields to increase the gap and at the same time increasing the field turns has been found good; in others, not. Chamfering the edges of the pole-pieces has been recommended by some for the same purpose, and found useless by others. A certain generator was provided with G.S. commutator leads, and so great an improvement followed that it was proposed to adopt the device in other cases. Further experience failed to justify this course. Different breadths of brushes have been tried, and it might naturally be expected that good results would follow from experiment in this direction. The results are, however, again apparently contradictory, as some machines will work best with relatively wide brushes, and some with relatively narrow ones. A wide brush gives a longer time for reversal,

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and should therefore render a smaller reversing E.M.F. possible. But, on the other hand, if the brushes are not in the best position, a wide brush may allow a short-circuit current to be set up and to grow to such a value that subsequent reversal will be more difficult than if a narrow brush had been used at the beginning.

It has been proposed several times to put deep slots into the field coils parallel to the armature in order to diminish the cross flux. The writer is unable to see that any useful result is to be obtained in this way, as in the neighbourhood of the two horns the cross-magnetising lines and the field lines are combined into a resultant flux, and at these places there is simply the algebraic sum of the field and cross-magnetising ampere-turns. The weakening at the leading horn will take place in spite of any such slots.

Sparking Criterion—

Let C_0 be the normal current carried by any armature coil,
" t " time elapsed since short circuit commenced,
" T " whole time of short circuit,
" C " current in the short-circuited coil at time t,
" R " resistance in the short circuit path,
" L " equivalent inductance of a coil,
" E " reversing E.M.F., supposed constant, and due to a reversing field.

Then, $C = \frac{-E - L\frac{dC}{dt}}{R}$. From this it follows that—

$$E = RC_0 \frac{1+\epsilon^{-\frac{R}{L}T}}{1-\epsilon^{-\frac{R}{L}T}},$$

(A similar formula to this was given by Swinburne, *Journal* of the Institution of Electrical Engineers, No. 85, 1890.)

As an example, a machine was found to have (calculated) resistance and inductance per coil of, respectively, 0·00522 ohm and 0·0000116 henry. The time of short circuit T was 0·00111 second. C_0 was 37·5 amperes. E works out to be 0·82 volt.

Where fixed brushes are used, and the reversing field is not of the correct strength to produce exact reversal, the equations require modification.

In Fig. 6 let
E_1 = P.D. between bar A and brush.
E_2 = P.D. between bar B and brush.
e = E.M.F. due to reversing field.
R_0 = contact resistance when one bar is completely covered by brush.
R = resistance of one coil.
w = width of one segment of commutator.
s = peripheral speed of commutator.
The other symbols have the same meaning as before.

Then
$$E_1 = (C_0 - C)R_0\frac{w}{st}.$$

$$E_2 = (C_0 + C)R_0\frac{w}{w - st}.$$

$$C = \frac{-e + E_1 - E_2 - L\frac{dc}{dt}}{R}.$$

The writer has been unable to obtain an intelligible solution to these equations, as they appear to lead to a divergent series. The reversing E.M.F. is truly a variable quantity. In the absence of a solution the first equation

$$E = RC_0\frac{1+\epsilon^{-\frac{R}{L}T}}{1-\epsilon^{-\frac{R}{L}T}}.$$

has been taken as affording some guide. Within the limits occurring in a given type of machine, it will be found that

$$\frac{1+\epsilon^{-\frac{R}{L}T-}}{1-\epsilon^{-\frac{R}{L}T-}} \propto \text{ nearly to } \frac{L}{R}T.$$

$$\therefore \quad E \text{ is approximately } \propto RC_0 \times \frac{L}{T} \propto \frac{C_0 L}{T}.$$

This expression is the essential part of the so-called "Inductance E.M.F.," which has been largely used by dynamo designers. It will be understood that in the method of derivation given above several assumptions and omissions have been made (*e.g.*, contact resistance at brushes), but it has shown itself in practice to be of some value as a guide. The writer hopes that the more correct equations may have some useful solution which he does not know of at present, and which may be used as a more correct criterion.

The calculation of the inductance of an armature coil is a matter of considerable uncertainty, but if the same system is used throughout (*see* Swinburne's Paper referred to above for smooth core armatures), the values are comparative, which is all that is required. The average volts per commutator segment are frequently used as a guide to the likelihood of sparking. Examination of a line of machines shows that the inductance E.M.F. and the volts per bar are more or less closely related. It will be understood throughout that the contact resistance at the brushes is only necessary to supply a reversing E.M.F. when a coil finds itself in a reversing field of the wrong strength, as will arise through the use of fixed brushes with varying loads, the brushes being always placed in such a position that the coil under commutation shall find itself in a reversing field of the right strength for average load.

It would at first sight seem reasonable that the output of a machine should be increased by decreasing the contact area

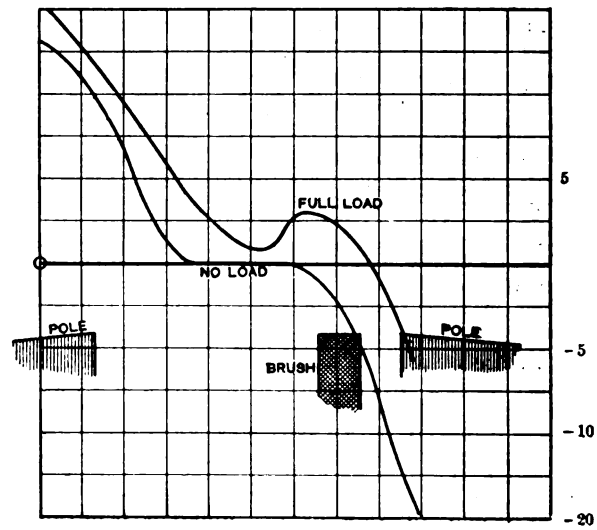

FIG. 7.

of the brushes, thus increasing the contact resistance. This is contrary to experience, which has shown that there is a certain maximum safe current-density for each type of brush. Attempts to economise in commutator copper are very liable to lead to disaster. There are several reasons for this. In the first place the commutator gets much too hot if the current-density is too high, and with its other disadvantages this in itself would help to promote sparking at the edges of the sections, which get much more hot than the body of the commutator. In the second place, the current-density being much increased, causes the potential difference between the brush and the commutator to rise to such a value that, being very close to one another, an arc is started, and once started this endures for an appreciable space of time after the bar has passed the brush.

There is, of course, hope for further development in the direction of new brushes, but for the present we can only increase the output of a machine by re-designing it to have lower inductance per coil (or, in the case of bar-wound armatures, shorter conductors parallel to the shaft), or a type of construction which makes the circuit of its self-induced magnetism magnetically worse.

Various windings have been adopted to decrease the difficulty with sparking, such as those of Sayers and Mordey. But in actual practice it is found easy to keep the inductance of the armature coils so low, even with slotted armatures, that the heating limit shall be reached before the sparking limit,

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and this with small air-gaps without the use of any but the common multiple circuit windings. But for this purpose the armature reaction is also kept low by making the machine multipolar. Multipolar construction has been repeatedly shown to be cheaper on large machines than bipolar construction, and has been adopted everywhere but in this country. When English manufacturers come up to date in this respect they will find they can build cheaper machines, and at the same time will not not need to burden them with more or less complicated winding to avoid sparking troubles. The subject of brushes and contact resistance at the brushes will be found to repay a much larger amount of general attention than has at present been devoted to it.

PRACTICAL HINTS ON STARTING A MUNICIPAL ELECTRICAL DEPARTMENT.

As announced in a recent issue of *The Electrician*, Mr. J. J. Steinitz, borough electrical engineer at West Ham, read a Paper on the above subject before the Falcon Works Engineering Society. The subject is important, and Mr. Steinitz's treatment of it was so practical and well informed that the following copious extracts will probably interest a large circle of readers. After a few preliminary remarks, in which the author observed that in the pioneer days of municipal electrical engineering he would "have been glad of someone's advice as to the correct way of going to work," he proceeds to supply this want for others. First, he discusses the difference between a municipal and a company undertaking:—

The great initial difference is that in the latter form the engineer and manager has only to deal with a board of directors, generally composed of not more than eight to ten moneyed or influential men, while in the former he has to deal with—first, his Committee, with probably not less than twelve members; secondly, with the Council, a body popularly elected, who, while being no doubt, in many cases, men of first-rate business ability, are certainly not elected for their knowledge of electrical monopolies; and thirdly, he is more or less hampered by the provisions under the various necessary Acts for controlling the spending of public moneys. When a man has been appointed electrical engineer to a corporation he generally finds that the Provisional Order has been obtained. Sometimes it has not; but there is very little for the engineer to do. Practically, the whole of this work belongs to the Town Clerk's Department, and ought to be done by it. Should however it be left to the engineer, he can obtain all information from the rules drafted by the Board of Trade, under the 5th section of the 1882 Electric Lighting Acts. He can then, if he wishes it—and this is certainly an advantage—get a few special clauses inserted, otherwise some model order may be followed.

Mr. Steinitz next reviews the preliminary work of a municipal electrical engineer, which is stated to consist in (1) inspecting the limited area, (2) preparation of a general scheme and report, the following being the chief heads of the report:—

Introduction.—(1) A description of the limited area, with probable number of lights you propose to allow for that district; (2) a notice of any further area that it may be advisable to include, with reasons; (3) the system to be adopted.

Site.—The best position for building a central station, showing how it is situated for obtaining water for feeding and condensing purposes, for the delivery of goods by train or water, or both; freedom from annoyance to neighbours, and ample room for extension for many years to come.

Arrangements for Private Lighting.—The system to be adopted, with reasons; the names of the streets in which distributing mains are to be laid, and whether on both sides or not; the pressure to be supplied at, and the price to be charged; and if some differential mode is suggested, a full explanation.

Public Lighting.—The names of streets and the number of lamps, together with a map showing their approximate position*; how the light will be supplied, from special machinery or from the private lighting plant; whether special mains are to be used, and how the light is to be controlled; whether all the arc lamps will run all night or some be turned off at midnight, and, if so, the arrangements to effect this; the proposed charge per lamp per annum, and whether this is to include trimming, cleaning, &c.; the number of gas lamps that will be replaced by the arc lamps, and the cost of such lamps per annum.

Plant.—The capacity of plant to be laid down in the equivalent of 8-c.p. lamps; the percentage of lamps you estimate will be alight at one time, and on this basis the amount of reserve you allow for; next a covering estimate for the whole of the work, which shows how the money proposed to be borrowed is to be spent.

* The actual position it will be well to leave to the Committee. They like to be consulted, and as the selection is certain to give offence to a certain number of the burgesses, it is well to make the Committee responsible.

If your figures permit, it will look well to compare the cost per kilowatt with comparative figures in other towns. Of course, I am well aware to an engineering community such figures would hardly carry much weight. Here, if one likes, one may give an estimate of the probable revenue and expenditure. As before the works are started this figure is purely hypothetical, it seems to me preferable to say that "When the plant is fully loaded one may guarantee a handsome profit." In conclusion, one may refer to the advantages of electric traction, and whether the tramways are a municipal property or not it will be well, even in the first report, to begin a systematic campaign to secure the supply of electricity for such works for your own department.

This report must be piloted through the Committee and the Council, after which, the engineer must set about the preparation of estimates and plans to be sent to the Local Government Board, along with the formal application for power to raise a loan.

It is most essential to make the estimates sufficiently large, as there is a very great deal of trouble in obtaining permission to borrow amounts expended over the original estimate. Should you exceed your estimates, another Local Government Board inquiry is required. Too many details should not be sent, either in the description of the system or in the accompanying drawings; they are quite unnecessary. One case I may mention, in which elaborate drawings were submitted to the Local Government Board, the permission to borrow money was actually delayed some months as the water closets (with which the Local Government Board have nothing whatever to do) were not, in their opinion, in the proper place.

After some time, which, even at the soonest, will be at least eight weeks, the Local Government Board will send down an inspector to hold a public inquiry. During this interval the engineer may prepare his plans and specification. These require very considerable care and forethought if the undertaking is to be established on a sound basis from the commencement, and if extras, over which there is always considerable trouble and annoyance, and which are the bane of the municipal engineer's life, are to be avoided.

The specification must be drawn up in a liberal spirit, and fair both to contractors and the Corporation. Mr. Steinitz recommends the following headings:—

1. Extent of work.
2. *Bonâ fide* omissions.
3. Inspection.
4. Alterations, additions and deductions.
5. Commencement of work.
6. Extras, extent and under what conditions allowed.
7. Schedule of prices.
8. The dismissal of incompetent persons.
9. Arbitration pursuant to the provisions of the Common Law Procedure Act, 1854.
10. Delay in execution of the work.
11. Time for completion & penalties.
12. Maintenance.
13. Loss and damage.
14. Patent rights.
15. Day work.
16. Payment.
17. Labour clauses.

These headings practically explain themselves. Contractors sometimes take exception to No. 2, "omissions"; but the engineer is not infallible, and must protect himself. At the same time the contractor must be considered, and by putting in an arbitration clause, which I consider most essential, and not making the engineer sole arbitrator, all difficulties should be easily adjusted. I firmly believe that an arbitration clause is a godsend to the contractor, and safeguards the interests of both parties.

Time for Completion and Penalties.—Care should be taken to give the manufacturer a fair time to complete the work; then if the contractor, having agreed to this time, is late, the penalties ought certainly to be insisted upon; but remember, this can only be done and money recovered if damage to the undertaking can be proved, by no means an easy matter at times. Again, do not make penalties unnecessarily stiff. A very fair way has been suggested to me by Mr. Rider, of Plymouth, who makes the penalties so much per cent. per week on the amount of the contract. Due notice ought to be taken in this clause of strikes, lock-outs, excessive inclement weather, &c.

Maintenance.—I have known engineers proud of clauses in their specification, in which they get their plant and mains guaranteed for a very large number of years, while they hold back a percentage of the purchase money. This may be all very well in its way, but it must be recognised that electrical contractors are not, as I have indicated before, all philanthropists, and make allowance in their prices for the capital they have lying idle, and that quite possibly it would be better to pay up at the end of a reasonable time and do repairs out of revenue. The former way simply adds to your capital outlay, on which you have both interest and sinking fund, to pay for many years.

While the guarantee is obviously a sensible way of securing good workmanship and materials, equally evident is it that it can be pushed too far. We would not wish to see the sinking fund or the depreciation fund take the place of guarantees entirely; but it is clear that they take their place in the long run. These funds are, in a sense, the equivalent of an eternal guaranty.

The next portion of the Paper deals with the engineering specifications of the various items of plant. These the author deals with in detail; but, as the nature of the specification must so largely depend on the system adopted, it would be of little service to reprint *in extenso* this part of the Paper. We

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now come back to the business and financial side of the scheme :—

To return now to the matters for the Local Government Board. The papers sent to the Local Government Board contain very much the facts given in the initial report ; only such items as engines and dynamos would be amplified, and the number and size of engine and dynamos would be given in detail. The drawings submitted will be satisfactory if they include a block plan and elevation of engine and boiler-house, showing boilers, engines, dynamos, and various pumps in position. The Local Government Board inquiry having been duly advertised is held, and after the scheme has been introduced by the town clerk's department, the engineer gives his technical evidence, which is once more a *résumé* of his report, only in detail. Any of the burgesses are at liberty under the direction of the inspector to ask questions, and, as a rule, they are the only trouble. However, even they are little trouble in inquiries we are concerned in, as the feeling that electricity is a necessity is very general all over the country. A hypothetical statement of revenue and expenditure will certainly be asked for, and this is easily given if based on a certain number of lights connected, taking the average consumption over the country.

When the assent of the Local Government Board arrives, or in some cases before, the advertisement which is necessary under the Public Health Acts is put in the leading engineering papers asking for tenders to the specification. On an appointed date the tenders come in and are opened at the first Council meeting, or may be referred, if they are a very large number, to the Electric Lighting Committee and the engineer. The Committee will open them, and probably hand them over to the engineer to report on. This is work that requires the very greatest care and consideration. If you can conscientiously recommend the lowest tender in each case, so much the better, at least as far as present trouble goes—but if you cannot, you may prepare for a certain amount of controversy. A certain section of the Council are sure to want the cheapest ; another section will want the work to go to a local firm (independently of the capabilities of the firm); while another, I am thankful to say, will uphold the advice of their technical officer. To me it seems that the only way to approach the question is to very carefully consider all the tenders, and take plenty of time to make up one's mind as to which will be the most advantageous to the borough. Having once done so, stick to your opinion, and accept the responsibility. If, however, the Committee override you, remind them that, while you will do your best, they, and not you, have become responsible for the working of the plant under consideration ; and not only remind them, but see that your advice is duly printed in the reports, so that at a future date if anything goes wrong, and you have a strange council (for councils change from year to year) you have documentary evidence of your advice. I may add, when put before them in this way, a committee considers matters very carefully before accepting the responsibility.

Mr. Steinitz advises that the buildings for the station should be designed by the borough engineer, as tending to produce less friction than if they are designed by an architect outside the Corporation staff. The electrical engineer must, of course, make his requirements known to the borough engineer or architect.

A rough plan and elevation showing the room you require for engine, boiler, and pump house, offices, testing and store rooms, and shaft, should be made and sent to the borough engineer. He will then do the necessary architectural work. The buildings ought to be arranged so that all parts of the machinery can easily be taken in and out. There is no good, as you will readily allow, in having, as is too often the case, a large travelling crane, and then finding all goods have to be unloaded outside the building. Make provision for the backing of large trollies under the crane. The offices, stores, and, in fact, the whole building, should be designed for large extensions in the near future. A little forethought exercised at this time will be found invaluable later on. Such details as means for running intercommunicating telephones, testing wires, &c., should be provided for during the erection of the buildings, the cost then being inappreciable. A little arrangement will enable you to run all testing wires from the transformer cable and meter stores to the testing room, where the testing instruments are permanently fixed, and with telephones to each store, the convenience to the testing room staff is enormous, the outlay being amply repaid by the saving of time and trouble. The various holes in the walls for the pipes and all wires ought to be clearly marked out in the drawings. It is most annoying to start cutting new brickwork to pieces just after erection ; and not only that, it is very expensive.

The laying-out of the engine and boiler foundations will be done by the builders, but require checking, and it is a great safeguard to have them again checked by the contractor for the machinery. Templates will have been furnished, and these should be used frequently by a responsible person as the foundation goes in. Care should be taken to keep the whole of the buildings fire-proof so that the amount of the insurance policy, now so heavy, can be saved.

While the buildings are in process of erection the cable work should be commenced.

The following notices will have to be served: (1) The Postmaster-General—one month's notice of the whole of the works, and three days before commencing actual work ; (2) for the tramway, railway, gas, and water companies three days' notice is all that is necessary, but it is very convenient to serve the whole of these notices together one month beforehand. In the notice to the Postmaster-General see that the notice covers both sides of the road, *whether the cables are going to be laid there or not*—it saves time and trouble at some future date. To the borough engineer, however, serve a notice only of what is actually to be done, and so to the various companies concerned. It is well to let the cable contractor do the excavating ; and it will be, in my opinion, necessary to have an assistant continually watching. The cables must be handled carefully ; a great deal more damage is done through careless laying than at any other time. Owing to obstructions in the streets the exact route as specified will have to be altered from time to time, and it is a great convenience to the contractor to have someone always on the spot to appeal to. However, it is not altogether for the contractor's sake I suggest having an assistant on the spot. I consider it very necessary that a plan of the mains *in situ* should be made. Very few gas or water companies know where their mains are, and it is high time someone should know what is underground. To my knowledge a gas company mislaid, or at least were 30ft. out of their reckoning as to the position of a 48in. gas main. If the position of the mains is systematically kept from the first (and it can be with very little trouble) it will be of great benefit, if not to yourself, at least to the undertaking, in years to come.

In the matter of arranging for and engaging a staff, Mr. Steinitz had some useful remarks to make. He is hopeful of better things in the future in regard to salaries of municipal electrical engineers and their assistants.

The staff ought to be gradually gathered together. I am quite sure it is a false policy to wait until all is ready to start work before engaging assistants. If the borough is of a tolerable size one may make up one's mind that the following are absolutely necessary : a chief assistant, a mains superintendent, and three engineers on watch. The salaries, as a rule, are small, but there seems every reason to hope that from what is going on in the country that they will rise as the works increase. I can quite understand committees during the first year not giving what one might call a fair salary, but after that period there is no excuse. The workmen are well taken care of, as the standard trades union rate will have to be paid.

As is well-known, municipal electrical enterprise has been largely mixed up with a number of schemes and devices for enticing customers to come on to the mains or to consume more units. Mr. Steinitz expresses his own opinion of these devices—"fads," he calls them :—

Amongst other questions which may arise is whether it is advisable to run a Corporation fitting department for the wiring of buildings. I have had some experience in this work, and I must certainly say I can see nothing to recommend it. Besides, a borough electrical engineer has quite enough to do without dabbling in other people's work. The various little fads for pampering consumers may be hinted to the Committee and gradually knocked into shape. I refer to free lamps, hired motors, free wiring, &c. Personally I should like to refrain from touching any such fads, but a great deal depends upon the district. At West Ham some means of getting houses wired must be adopted. There are a very large number of good houses in the borough without gas fittings, and I find either gas or its cheaper rival, electricity, would be used willingly if only the comparatively large initial outlay could be avoided. We intend to get over this difficult somehow, and if not by the help of the Free Wiring Company by some such similar means. I purposely refrained from touching on the system to be used. There have been so many Papers read lately on the subject, and so much discussion in the technical press that I should probably be unable to break fresh ground. For a long time to come it seems to me the controversy will rage. One thing is certain, however—more attention must be paid to a motor load than has been done in the past, and the most satisfactory system seems to me to be a three-phase one.

With a final word or two of advice to municipal engineers on general conduct and bearing towards their employers, Mr. Steinitz concludes a most interesting and useful Paper.

In conclusion, I should like to remind you that the peculiarities of the construction of the governing bodies of a municipal engineer make it absolutely imperative that he should, above all things, cultivate tact. The electrical engineer is comparatively a new-comer, and is not always looked on with favour by the other order of officials. I am glad to say I am not speaking from experience just now. He is probably new to municipal life, and it will require all his tact to work smoothly with them. His Committee and Council are probably not electrical experts, and if he wants to carry his work on successfully he must again exercise his tact. In fact, while not going quite so far as one of the electrical papers, which thought borough electrical engineers ought to be trained diplomats, I am perfectly certain that it is equally as necessary to cultivate tact as it is to go on progressing as one has to do day by day in the knowledge of one's profession. I would misquote Samuel Budgett and another, and say to all budding municipal engineers : "The conditions of success are Tact, Push, and Principle, and the greatest of these is Tact."

Monument to Philipp Reis.—The Physical Society of Frankfort intends to erect a monument to Philipp Reis, the inventor of the first telephone. It is proposed to erect it near to the one recently dedicated to Sömmering in that town. A committee has been formed, with Herr Gans as president, Herr E. Hartmann, vice-president, and Herr A. Savary, secretary. The estimated cost is £1,500.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *February 4, 1898.*

A Railway Motor Decision. — On January 24th, Judge Wheeler, in the United States Circuit Court in this city, rendered a decision in the case of the Sprague Electric Railway and Motor Company against the Union Railway Company and Others, which involves patent No. 324,892, granted to Frank J. Sprague on August 25, 1885. The patent is for an electric railway motor, consisting of a field magnet journalled on the axle of the driving wheels at one end and hung upon a spring from the truck or the car body at the other, and carrying the armature shaft upon its pole pieces parallel with the shaft of the driving wheels, and connected to them by gearing. The decision was in favour of the plaintiff company, which was merged into the General Electric Company several years ago. On the Union Railway ten motors, said to infringe these patents, and supplied by the Walker Company, are in use. In giving his verdict, Judge Wheeler stated that this patent was before the Circuit Court of Appeals in "Adams Electric Railway Company *v.* Lindell Railway Company," an action for infringement of patent No. 300,827 of June 24, 1884, granted to A. Wellington Adams for improvements in electric motors. The position of Sprague's invention with reference to prior structures, inventions and patents was then well and comprehensively set forth by Judge Sanborn, and the decree dismissing the bill appeared to have been affirmed because, briefly, Sprague's invention was independent of Adams's. And if Sprague's patent was for merely hanging and centring one end of the motor of a carriage upon the axle of the driving wheels, and suspending the other by a spring from the body of the vehicle or the truck, it would be shown from that case to be wholly lacking in novelty, and would, in consequence, be void. He was not a pioneer here, and could have a valid patent only for what was new in his method of making the power of the electrical current turn the driving wheels. No one had before, however, hung a field magnet at one end upon the axle of the driving wheels and at the other upon a spring from the body of the car or the truck, and combined with it an armature axle upon the pole pieces of the magnet parallel with, and geared to, the axle of the driving wheels, for driving a car by a current of electricity. The combination simplified greatly the required structures, improved their results, and came into immediate use. The invention of it seemed well to support these claims of the patent. The defendant's structures differed in some respects from those of the patent, but had all these parts, working together in the same relation to each other, for the same purpose, and producing the same result. The defendant's structures were not made independent of and clear from Sprague's, but upon the same lines as his, and his patent appeared to be infringed by this taking of his invention to improve upon. The Walker Company asserts that this decision has no practical effect on its railway motor business, as its motors, as made at the present time, avoid the Sprague patents entirely. The Walker Company has appealed, however. The effect of the decision applies only to the ten motors in use on the Union Railway. The belief obtains in the minds of some that this decision at this time will have an important effect in the contest to secure the contracts for the electrical equipment of the elevated railways in this city. The Walker Company and the General Electric Company will probably be competitive bidders for the work, and it is impossible to state what effect the decision will have in this direction. The Walker Company, however, says that it has nothing to fear, and that it will go on doing business as heretofore. It proposes to bid for the electric railway contracts with the assurance that the General Electric Company or any other concern cannot place any obstacle in the way of its carrying out any obligations that it may assume.

Tests of a Storage Battery Railway.—The most prominent storage battery traction experiment of late years has been on the line of the Englewood and Chicago Electric Railway. This line had been in operation since June 20, 1897, running from 9 to 20 cars on about 12 miles of track. Complete tests of the operation, particularly of the efficiency of the various parts, have recently been made. The cars are supplied with wooden battery boxes or trays, and brass contacts, the whole being hung from the truck frame between the axles. This carries 72 cells in hard rubber jars, each fitted with five chloride negative plates and four Tudor positive plates, the boxes being connected up in four groups of 18 cells each, the terminals of which are connected to the controllers. The weight of the batteries and tray is 7,800lb., and the capacity 400 amperes at 145 volts. The trays are removed to the charging table by a motor-driven derrick on the truck running in the car-house pit. Each car truck is equipped with one 50 H.P. four-pole Walker series motor overhung on the end of the truck. The motor cars weigh complete about 12 tons, and pull trail cars weighing 3 tons each. In the first power-house test the plant was run with two boilers, two engines and three generators, the fuel costing $1·90 per ton, and gave 10·145 B.T.U. per lb. The average steam pressure by gauge was 168·3lb. The trial lasted nine hours, 7,000lb. of coal being burned, and 43,823lb. of water being actually evaporated. The water evaporated per pound of combustible from and at 212degs. was 8 22lb., the percentage of the total calorific power of the fuel utilised being 62·86. The indicated engine power varied from a maximum of 246 to a minimum of 202. The ratio of electrical horse-power output of the dynamo to the indicated horse-power of the engines was 79·3 per cent., the watt-hours per pound of coal being 155·2, making the total cost of coal per net kilowatt-hour at the switchboard 0·611 cent. The total station efficiency from coal pile to switchboard was 5·58 per cent. The tests of the batteries showed a charge of 36,757 kilowatt-hours, followed by a discharge of 19,715 kilowatt-hours, and a second charge, or 31,631, giving an apparent efficiency of a little under 60 per cent. The tests showed that the car used 1·41 kilowatt-hours per car-mile at the charging table, and 0·87 kilowatt-hour per car-mile at the motor, giving about 10lb. of coal per car-mile. Acceleration tests were also made, showing a speed of four miles per hour 5sec. after starting, eight miles per hour 10sec. after starting, and 15 miles per hour 1min. after starting. The batteries have operated from 8,000 to 14,000 miles, and are standing the service remarkably well.

Third-Rail Systems.—A great many people believe that a surface third-rail railway system, with the rail divided into sections and rendered "alive" by electro-mechanical devices, is the only solution of the electric railway problem for city streets. There are now on exhibition in this city two systems of this character which possess considerable merit, and would seem to offer a solution of the problem; but both also possess the weak points of all systems of this kind—namely, a multiplicity of electro-mechanical devices which in the nature of things cannot be depended upon to act promptly at all times. In one of these systems the third rail is divided into sections, each section being a box-like structure, the surface rail of which is movable longitudinally to a slight extent. The friction of the shoe of the passing car moves the rail forward against the tension of a helical spring placed inside of the box, and actuates a switching device which effects a connection between the electrical conductor and the surface rail. When the car passes off the rail the spring restores the surface rail to its normal position, thus breaking the electrical contact and removing the current from the rail. In the other system the third rail is divided into sections, each section being rendered alive by bringing it into contact with the main feeder through the operation of a solenoid which controls a switching apparatus. The car carries a small motor-generator with a 10-volt winding on one commutator and a 500-volt winding on the other. An auxiliary source of current is a storage battery of a few cells, and this machine generates a 500-volt current with but a fraction of an ampere for the purpose of energising the series coil of the solenoid in order to restore contact with the power circuit when the car loses connection with the main supply. The two systems are just being brought to public attention, and the inventors are now seeking to engage capital and to organise companies to put them to practical use.

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CORRESPONDENCE.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been very much interested in Dr. Lodge's new form of transmitter and receiver, recently illustrated in the electrical papers. Independently I arrived at the same result as a direct outcome of an article on Alternate-Current Resonance, published in your journal on August 31, 1894. In Fig. 1 of this paper (see *The Electrician*, Vol. XXXIII., p. 516), if one imagines the plates of the condenser C separated but still connected to the coil B, one arrives at the same result.—Yours, &c., ERNEST WILSON.

Siemen's Laboratory, King's College, London, W.C.
February 15, 1898.

SYNCHRONISING ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From the letter in *The Electrician* of February 11th, over the initials H. H. N., I am led to the conclusion that that seeker after information has only a theoretical knowledge of alternating-current work, and that he is therefore unaware of what actually happens when alternators are run in parallel. In reply to the question, "How does the engine obtain the extra steam necessary," I beg to say that in spite of his theoretical objections on the score of rigid coupling and angular velocity, the governor does respond to the increased demand upon the engine, under the circumstances stated and with a well-built and governed engine, in a perfectly satisfactory manner.

If H. H. N. would care to betray his identity, I can put him in the way of seeing alternators in parallel, coupled to engines full open and on their governors, and taking their load from very small to full load, with no adjustment whatever beyond that of the excitation; and I have no doubt there are many others who can show him the same thing. Furthermore, if he is still dissatisfied, an inquiry from any good firm of electric lighting engine builders will convince him that they would be prepared to build him an engine to answer these requirements, and to guarantee its performance.

I regret to hear that H. H. N. knows of no mechanical governor that will answer these requirements; but this does not imply that his knowledge of the performance of mechanical governors is very extensive.—Yours, &c.,

February 14, 1898. H. E. M. KENSIT.

LEGAL INTELLIGENCE.

Lyell v. Davis.

This case was reported in *The Electrician* of the 4th inst., p. 495. Messrs. J. C. Lyell and Co., in the Westminster (London) County Court, sued the defendants, a firm of carriers, to recover damages for the loss of sale of a quantity of electrical goods entrusted to them for transit from London to Stockholm in connection with the jubilee of King Oscar of Sweden. The goods not being forwarded by a certain ship, they arrived too late, and were rejected by the consignee. Judge Lumley Smith now said he was quite satisfied that the defendants did contract to deliver the goods in Stockholm in time for the jubilee celebrations, and he was also satisfied that they failed to do so, and that the plaintiffs had them thrown on their hands in consequence. Judgment, therefore, would be for the plaintiff for £18 and costs, but as the question was one of some importance to carriers the defendants would have leave to appeal.

Trustees of F. H. Blake v. Central London Railway Company.

At the Sheriff's Court, Holborn (London), on Wednesday, Mr. Burchell and a special jury heard a claim by the trustees of the late F. J. Blake against the Central London Railway Company for £539 for repairing the residence No. 2, Marlborough-gate, Hyde Park, which was alleged to have suffered damage by subsidence due to the works of the railway company. It was alleged that the house in question had been structurally injured by the works of the Company either primarily or by reason of the bursting of a water main owing to the tunnelling operations for the Company's new line from the City to Shepherd's Bush. On behalf of the defendants, evidence was given in which it was contended that the system of tunnelling with the Greathead shield prevented any possibility of injury to adjacent buildings, and that the subsidence must have been caused by the bursting of the water main owing to internal pressure. The jury returned a verdict for the defendants on the ground that the damage was caused by the bursting of the water main, for which the Company had not been shown to be in any way responsible. It was agreed that other claims pending in regard to adjoining houses should be governed, as to liability, by the finding of the jury in the present action.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J WADE. *In the Press.*

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

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"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. nett 2s. 9d. post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is *now ready.* Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898, and contains about 150 additional pages over last year's book.

Tenders Invited.—The Wallasey Urban District Council invite tenders for the supply of (*a*) engine, alternator and exciter; (*b*) two Lancashire boilers and one water tube boiler; and (*c*) condensing apparatus. Some further particulars appear in an advertisement elsewhere, and copies of the specifications may be obtained from the engineer (Mr. J. H. Crowther), Gas and Water Works, Great Float, near Birkenhead. Tenders, addressed to the Chairman of the Gas, Water and Electricity Committee, must be delivered at the office of the clerk to the Council (Mr. H. W. Cook), Public Office, Church-street, Egremont, Cheshire, by 4 p.m. on Thursday, March 17.

——— The Watford Urban District Council require tenders for the supply and erection of (*a*) generating plant, boilers and fittings, economiser, feed pumps, &c., alternators and exciters, &c.; (*b*) switchboard and connections; (*c*) overhead travelling crane; (*d*) conduits and mains; (*e*) public lighting, including adaptation of existing public lamps; (*f*) transformer sub-stations, switch gear, &c.; (*g*) electric lamps and posts. Plans, &c., can be obtained at the offices of Mr. W. C. C. Hawtayne, consulting engineer to the Council, Mansion House-chambers, 20, Bucklersbury, London, E.C., and tenders must be sent to Mr. H. Morton Turner, Council Offices, Watford, by noon of the 16th March. Some further information will be found in an advertisement on another page.

——— As will be seen from our advertisement columns the Electric Lighting Committee of the Coventry Corporation invite tenders for the supply of (*a*) 300-kilowatt steam alternator and exciter; (*b*) 25-kilowatt steam dynamo and accumulators; (*c*) condenser, air pump, circulating pump, and footplates, &c.; (*d*) steam, exhaust, suction and discharge pipes, valves, oil separator, &c.; (*e*) main H.T. switchboard, exciter and accumulator switchboards, &c. Specifications may be obtained after the 19th inst. from the consulting engineer, Mr. Robert Hammond, Ormond House, Great Trinity-lane, London, E.C., and tenders, addressed to the town clerk (Mr. Lewis Beard), must be delivered at 10, Hay-lane, Coventry, by 4 p.m. of Tuesday, March 8.

——— The Shoreditch (London) Vestry require tenders for the supply of (*a*) electric cables and sundries; (*b*) engineer's stores, and (*c*) ironmongery, tools, &c., for the Electricity Works Department for the 12 months ending March 25, 1899. Particulars of the Vestry's requirements are given in an advertisement elsewhere, and samples may be seen at the Electric Lighting Station, Coronet-street, Hoxton, N. Tenders must be sent in to Dr. H. Mansfield Robinson, Solicitor and Clerk, Shoreditch Town Hall, Old-street, E.C., by 4 p.m. of Tuesday, March 8.

——— The West Derby Guardians invite tenders for the following work in connection with the electric lighting of the Mill Road Infirmary:—(1) Two dry back return tube boilers; (2) Three 50 B.H.P. coupled engines and dynamos, 1 booster, 2 feed pumps, 1 feed-water heater, 1 switchboard, steam, &c., piping, tanks, &c.; (3) a battery of accumulators of 900 ampere-hour capacity; (4) wiring of infirmary, administrative buildings, and Nurses' home, &c. Copies of specifications can be obtained from the Clerk of the Union (Mr. Harris P. Cleaver), and specifications and drawings can be seen at the office of the Consulting Engineer (Mr. Thomas L. Miller, M.Inst.E.E.) 7, Tower-buildings, Water-street, Liverpool. Further particulars are given in an advertisement in another column, and tenders (addressed to the Chairman of the West Derby Board of Guardians) must be delivered at Mr. Cleaver's office, Brougham-terrace, West Derby-road, Liverpool, by noon on Tuesday, March 8.

Tenders Invited.—The Carlisle Corporation invite tenders for the erection of an electricity supply station building. Tenders to City Engineer and Surveyor by 10 a.m. 25th inst.

——— The Council of the County Borough of West Ham invite tenders for wiring and fittings for the electric light of various public buildings in the Borough. Further particulars are given in an advertisement elsewhere, and plans, specifications, &c., can be obtained at the office of the Borough Electrical Engineer (Mr. John J. Steinitz), Pumping Station, Canning Town, E. Tenders must be sent to the Town Clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, E., by 4 p.m. of Tuesday, March 8.

——— The Corporation of Glasgow, as will be seen in an advertisement elsewhere, invite tenders for the supply of (1) lead-covered cables and accessories (for twelve months), (2) accumulators, equalisers or balancing motors and transformers, motor-driven boosters and relative switching apparatus. Specifications, &c., can be obtained at the offices of Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow, and tenders must be sent in to Sir J. D. Marwick, town clerk, City-chambers, Glasgow, not later than Monday, the 28th inst.

———The Corporation of Glasgow also require tenders from makers of dynamos and engines for the hire of such plant as is described in an advertisement elsewhere. All further particulars can be obtained of Mr. W. A. Chamen, engineer to the Corporation, 75, Waterloo-street, Glasgow, and tenders must be sent in to Sir J. D. Marwick, town clerk, City-chambers, Glasgow, not later than Monday, the 28th inst.

——— The Corporation of Sunderland require tenders for the supply of (1) indiarubber-covered cables, (2) armoured and unarmoured concentric cables (3) cast and wrought iron pipes an surface boxes and (4) stoneware casings. Specifications can be obtained from Mr. J. F. C. Snell, borough electrical engineer, at his office, Dunning-street, Sunderland, and tenders must be sent in to the office of Mr. Fras. H. M. Bowey, town clerk, Town Hall, Sunderland, by noon of the 25th inst. Some further particulars will be found in our advertisement columns.

——— The Lighting Committee of the Pembroke Township Commissioners invite tenders for the supply and erection of (*a*) Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor; (*b*) high-speed steam dynamos and accessories, oil filter, steam exhaust, feed, blow-off and sundry pipes, valves, feed water and storage tanks, &c.; (*c*) overhead travelling crane; (*d*) switchboards and instruments; (*e*) accumulators; (*f*) trenching, cables, &c.; (*g*) arc and incandescent street lamps and lamp posts; (*h*) meters. Tenders to Mr. J. C. Manly, Town Hall, Ball's Bridge, Co. Dublin, by March 5.

——— Portsmouth Corporation invite tenders for the supply and erection of additional Lancashire boilers, feed pumps, mechanical stokers, coal conveyor and elevator, economiser, steam, feed, condensing, water and other pipes, chequer plating, and sundry ironwork. Tenders to the Town Clerk (Mr. Alexander Hellard), Town Hall, Portsmouth, by 4 p.m., 22nd inst.

——— The Vestry of St. Pancras (London) invite tenders for the supply and erection of dry-back marine boilers (11ft. diameter, 13ft. 6in. long) with superheaters and brickwork seatings. Tenders to the Vestry Clerk (Mr. C. H. F. Barrett), Vestry Hall, St. Pancras, by noon, 22nd inst.

——— The Canterbury Corporation invite tenders for the erection of electricity supply station buildings and refuse destructor works. Tenders to the Town Clerk (Mr. H. Fielding) by Saturday, the 26th inst.

——— The Corporation of Belfast require tenders for the wiring of the new police cells, Chichester-street. Tenders to the town clerk (Sir Samuel Black), City Hall, Belfast, by 10 a.m., March 9.

——— The Harrogate Corporation require tenders for the supply of electric plant, &c. Particulars of and tenders to Town Clerk, Municipal Offices, Harrogate, by 24th inst.

——— The Corporation of St. Helens invite tenders for plant, &c., in connection with the supply of electricity for traction purposes. Tenders to Mr. W. J. Jeeves, town clerk, Town Hall, St. Helens, by Feb. 21.

——— The Vestry of St. Mary, Islington, require tenders for electrical and engineers' stores, &c. Tenders to the Clerk, Vestry Hall, Upper-street, Islington, N., by the 24th inst.

——— The Weaver Navigation Trustees invite tenders for the construction and erection of electric power plant for lighting and working the new swing bridges at Northwich, current being supplied by the Northwich Electric Supply Company. Tenders to the Clerk, Weaver Navigation Office, Northwich, by March 5.

——— Tenders are required for the electric lighting of the new Congregational Church, Richmond-road, Cardiff. Particulars from the architects (Messrs. Habershon and Fawckner), Pearl-street, Cardiff.

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Tenders Invited.—The municipal authorities of Piacenza invite tenders until March 2, for the establishment of an electricity supply station. Tenders to be sent to El Municipio di Piacenza, Italy, from whence particulars may be obtained.

——— Tenders are invited by the Municipal Authorities of Segorbe (Castellon), Spain, for the concession for the electric lighting of the streets for 5 years. Particulars from and tenders to El Secretario del Ayuntamiento de Segorbe (Castellon), by 25th inst.

——— The Prussian State Railway authorities at Cologne require tenders until the 26th inst. for the supply of 218 tons of galvanised telegraph wire, 7 tons of bronze wire, 3¾ tons of insulated wire, 9,250 porcelain insulators, and 8,100 iron insulator supports. Particulars from and tenders to Die Königliche Eisenbahn Direction, Cologne, Germany.

Tenders Accepted.—In our last issue we announced that the tender of Thomas Parker, Limited, of Wolverhampton, had been accepted for the supply of generating plant in connection with the Bootle Town Council's electric lighting scheme. The amount of the contract is £11,141. The tender of the British Insulated Wire Company, of Prescot, has been accepted for the supply of feeders, distributing mains, &c. (together with the maintenance of same for 10 years), at £10,095. 5s. 9d. The tender of Thomas Parker, Limited, has also been accepted for working the station, and for supplying electric current for public and private lighting, on the following terms: For each 10-ampere arc lamp, run for one hour after sunset to one hour before sunrise (3,620 hours per annum), £24 per annum; for each 10-ampere arc lamp, run for one hour after sunset to midnight (1,810 hours per annum) £12 per annum; for each lamp hour added or deducted from above, 1·55d.; for each incandescent light used for public lighting, 3d. per unit; for remainder of current up to guarantee of 100,000 units per annum for public and private purposes, 3·75d. per unit; for first 25,000 units above guarantee, 1·75d. per unit; for second 25,000 units above guarantee, 1·25d. per unit; for every unit in excess of 150,000 units, 1d. per unit. Twenty-four tenders in all were submitted, and the lowest was accepted. The highest tender for public lighting was £42. 10s. per lamp per annum.

——— The Newport Town Council have accepted the tender of Messrs. W. T. Glover and Co., for the supply of cables for electric lighting extensions at £4,288. 12s. 4d. The contract for the supply of transformers has been given to the Electric Construction Company (the lowest tender but one) at £661, and that for the supply of arc lamp posts to Messrs. Geo. Smith and Co., Glasgow.

——— The tender of Messrs. Mather and Platt has been accepted by the Aberdeen Town Council for the supply of a 650-H.P. steam engine and dynamo at £4,207.

——— The Electric Lighting Committee of the Walsall Corporation have accepted the tender of Messrs. Bumsted and Chandler for the supply of an additional engine at the electricity generating station for £910, and that of Messrs. Thomas Parker (Limited) for supplying a continuous-current dynamo and a spare armature at £1,160. Callender's Cable and Construction Company have obtained the contract for supplying and laying on the solid system, three new concentric cables.

Correction.—The figures supplied to us as the amount of the tender of Messrs. Spagnoletti and Crookes for the electric light wiring at the new warehouse of Messrs. Welch, Margetson and Co. (referred to in our last issue) should have been £702. 12s., not £72. 12s.

Plant for Sale.—Particulars are given in an advertisement elsewhere of two Edison-Hopkinson dynamos, two 16-H.P. nominal (Crossley) Otto gas engines, &c., for disposal.

Patent Amendment.—Notice is given in an advertisement elsewhere that Messrs. Alwyn Walter Staveley, Isaac Hardy Parsons, and Thomas John Murday, Faraday Works, Braunstone Gate, Leicester, have applied for leave to amend the specification of Letters Patent No. 12,390 (1896), for an "Improved form of Intergrating Watt or Ampere Hour Meter for Continuous or Alternating Current." Particulars of the proposed amendment are set forth in the *Illustrated Official Journal (Patents)*, of the 9th inst., and notice of opposition to the amendment must be made to the Patent Office within one calendar month from the 9th inst.

Appointment.—Mr. James K. Book, assistant at Leicester, has been appointed chief assistant in the Borough Electrical Engineer's Department at West Ham.

Dissolution of Partnership.—Messrs. John McLellan and Geo. Jas. Wells, electrical engineers, 19, Station-road, Blackburn (trading as John McLelland & Co.), have dissolved partnership. Debts by Mr. McLellan, who continues under the old style.

Business Notices.—Mr. Claude Vautin has removed his offices from 28, Basinghall-street, E.C., to 66, Old Broad-street, E.C.

——— Messrs. Johnson and Phillips have now established depôts at 91, Pitt-street, Sydney, and Brookman's-buildings, Adelaide, Australia.

Business Notice.—Messrs. Ball, Wylde and Co., of 9, Fenchurch-street, London, informs us that they have been appointed agents for Mr. Eugen Seeligman. The firm further notify that they hold several agencies for pumping machinery, turbines, steam and electrical machinery, &c.

Bankruptcies.—A first and final dividend of 3¾d. is payable (any day except Saturday) at Bankruptcy-buildings, London, W.C., in the failure of G. F. Lee, electrical engineer, lately trading as Lee and Hancock at 11, Sydney-street, Chelsea.

——— The discharge in bankruptcy of William A. Fraser, electrical engineer, late 28, Burleigh-mansions, Charing Cross-road, and 18, Cecil-court, Charing Cross-road, London, W.C., has been suspended for two years.

——— Claims against Edward James Paterson and Charles Friend Cooper, electrical engineers and contractors, European Works, Pownall-road, Dalston, and 3, Princes-mansions, Victoria-street, London, and 137, West Regent-street, Glasgow, must be sent in by 25th inst. Mr. E. C. Moore, 3, Crosby-square, London, E.C., is trustee.

——— The application for the discharge in bankruptcy of John Orme, electrical and scientific apparatus manufacturer, lately trading as John Orme and Co. at 6, Cross-street, Finsbury, London, will be heard on Mar. 11 at Bankruptcy-buildings, London.

Liquidations.—Mr. P. W. Northey, liquidator, receiver and manager of the Epstein Electric Accumulator Co., Ltd., 28, Victoria-street, Westminster, London, S.W., has issued a circular in which he announces that an offer has been made for the purchase of the Company's assets by a new Company, which proposes to take over the business as a going concern. The terms of purchase, while not immediately satisfying the entire claim of the First Debenture holders (£6,000), give them such interest in the new Company, coupled with a guarantee of minimum working capital, that the offer is likely to receive favourable consideration on their part. The owners of the Second Epstein Debentures will have the option of applying for fully-paid Ordinary shares in the new Company not exceeding in face value the amount of their present holding in Second Debentures at a discount of 50 per cent. Any such options not exercised by owners will be held at the disposal of other Second Debenture holders who wish to participate in the new scheme beyond their present holding. The actual assets of the Epstein Company, after collection of outstanding accounts, will be approximately £2,000 in cash, besides plant, £3,164. 17s. 5d.; stock, £3,296. 17s. 11d.; patents, £76,050., as nominally valued in books on January 1st last. While this offer is under consideration, Mr. Northey desires to invite competitive proposals which may be productive of better results. The offer referred to is open till February 26th.

——— Claims against the National Company for the Distribution of Electricity by Secondary Generators must be sent in by March 15th to the Liquidator (Mr. J. H. Thornton), 2, Warwick-street, Regent-street, London.

——— The creditors of the Electrical Traffic Syndicate, Limited, are required to send in particulars of their claims to the Liquidator (Mr. M. Jenks), 6, Old Jewry, London, by March 26th.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 9 to Feb. 15, with the ports of destination:—

Aden—£22 (telegraph material). *Argentina*—Buenos Ayres, £478 (telegraph material). *Australasia*—Auckland, £27; Melbourne, £777; Napier, £10; Sydney, £335; Wellington, £888 (including £679 telegraph material). *Belgium*—Antwerp, £333 (including £89 fuses); Ghent, £24; Ostend, £40. *Ceylon*—Colombo, £160. *China*—Shanghai, £360 (including £115 telegraph material). *France*—Boulogne, £20. *Gibraltar*, £538. *Holland*—Amsterdam, £80; Flushing, £60; Rotterdam, £70 (telegraph material). *Hong Kong*—£150. *India*—Calcutta, £851; Madras, £5. *Italy*—Genoa, £266; Leghorn, £122. *Japan*—Yokohama, £1,367 (including £432 telegraph apparatus). *Portugal*—Lisbon, £48. *Russia*—Vladiwostock, £87. *Siam*—Bangkok, £229. *South Africa*—Cape Town, £38; Chinde, £156; Delagoa Bay, £1,832 (telegraph material); Durban, £3,011. *Spain*—Barcelona, £308 (including £98 telegraph wire); Malaga, £20. *Straits Settlements*—Singapore, £239 (including £61 telegraph material). *Sweden*—Gothenburg, £123; Stockholm, £99 (telegraph material). *West Indies*—Trinidad, £22. Total, £13,095, against £13,217 in the corresponding week last year (Feb. 10 to Feb. 16).

The "Engineering Magazine."—The contents of the February issue of this magazine include articles on "The Possibilities and Limitations of Electric Traction," by F. J. Sprague, "Objections to Municipal Ownership of Electric Lighting Plants," by T. Carpenter Smith, "Equipment and Organisation of a City Fire Department," by Hugh Bonner; "The Economy and Efficiency of the Large Gas Engine," by Dugald Clark; "Future Supremacy in the Iron Markets of the World," by J. Stephen Jeans. Other articles deal with "The Gold Mines of the Witwatersand, South Africa;" "The Relations of Forestation to Water Supply;"

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"Shipbuilding as a Productive Industry in Great Britain;" "The Hot Water System for the Heating of Buildings," and "Peculiar Features of Irrigation and Engineering in Colorado." The usual review of the World's Technical Press is also given. Copies of this issue may be had, price 1s., post free 1s. 3d., at the office of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London.

Cassier's Magazine.—The articles included in the February issue of this magazine include:—"Recent Improvements in Electro-Galvanising"; "Technical Education in Great Britain and Foreign Competition"; "Mechanical Stokers"; "Floating Docks"; "Natural Gas in the United States"; "The Japanese battleship 'Yashima'"; and "Recovering Tar from Blast Furnace Gases."

"The Auto-Motor and Horseless Vehicle Journal."—No. 5 (Vol. 2) of this journal is now ready, and contains articles on "The Diesel Motor," and "Sir Charles Forbes' Liquid Fuel Regulator," and a good deal of other matter appertaining to auto-motors. The price of the journal is 6d., post free 7d., the annual subscription being 7s.

"British Almanac."—Amongst the many annuals, copies of which reach us, we have not hitherto recorded the "British Almanac and Year-Book" owned by Messrs. Letts and Co., of London, and the *Newcastle Daily Chronicle* edition of which is to hand. The whole of the early portion of the book is taken up with local matter dealing with Newcastle-upon-Tyne, and the counties of Northumberland, Durham, Cumberland and Westmoreland. The general matter runs to about 400 pages, and deals with almost every variety of subject likely to be sought for in a popular annual. Our old friend "Whitaker" and other well-established annuals have a sturdy competitor in the book under review.

"Scientific American Supplement."—We have received from Messrs. Munn and Co., of 361, Broadway, New York, a useful complete catalogue to the contents of the "Scientific American Supplement." This is an extremely serviceable compilation, and serves as an index to information on a multitude and wide range of subjects. Back numbers of the supplements can always be obtained.

Catalogue.—A very complete catalogue of electric light and power plant and machinery is issued by Messrs. Handley and Shanks, of Patrick-street, Cork, and Dublin, who are agents for the supply and erection of many of the best-known types of generating machinery, lamps, apparatus, &c. The list includes a number of testimonials from clients for whom installations have been put down.

Submarine Telegraphy.—Messrs. Crosby Lockwood and Son ask us to state that the forthcoming work on "Submarine Telegraphs, their History, Construction and Working," by Mr. C. Bright, will be published shortly, and subscription orders should be sent in by February 28th.

Aberdeen.—A conference took place on Saturday between the Gas and Electric Lighting Committee and Prof. A. B. W. Kennedy, who has been called in to prepare a report on the proposed extension of the electric lighting system to the west end of the town. Prof. Kennedy stated that he had visited the station, and he was of opinion that the proposal to erect a sub-station should not be entertained, as the lighting could be more economically managed from one centre. The proposed extension was likely to be remunerative, and he would prepare a full report on the matter, and submit it at an early date. The questions of the introduction of electric traction on the local tramways and the provision of a dust-destructor in connection with the electricity supply station are also to be reported upon.

Alloa.—The Burgh Commissioners have before them a scheme for the erection of electricity supply works. The capital expenditure is put at £3,000. The street lighting scheme only embraces the principal thoroughfares.

Barnsley.—The Town Council have appointed Mr. T. L. Miller, M.I.E.E., consulting engineer, to prepare a report on the electric lighting question, and also to design and superintend the erection of the plant and the construction of the works (exclusive of buildings) upon the following terms:—The report as to the system of supply and design and specification of the works to be prepared in consultation with, and subject to the approval of Mr. A. Bromley Holmes; a commission to be paid to these two gentlemen of 5 per cent. upon the value of the works, to be divided as they think fit; the Town Council to pay a competent clerk of the works; Mr. Miller to visit and inspect the works once a week; Mr. Bromley Holmes to visit and inspect at least once a year; Mr. Miller to give all help possible to the Council. The buildings to be designed by the borough surveyor. The Barnsley Provisional Order was obtained in 1890, and Councillor Jackson, in moving the report recommending the above-mentioned appointment, said that they must now go on with the work or stand aside and allow others to come in and supply electric current. He should have preferred a larger lighting area, but they intended to put down the plant in such a way that extensions could be easily and economically made.

Barrow.—At the last meeting of the Town Council it was announced that the Local Government Board had given their sanction to the borrowing of a sum of £29,000 for electric lighting purposes. The Board, however, intimated that they were not prepared to sanction the borrowing under the Electric Lighting Act and the Public Health Act (1875) of the sum of £1,000 included in the estimate for the provision of the site of the central station, but would give their approval under Article 7 of the Barrow-in-Furness Order (1894) to the appropriation of the land intended to be used for the purpose of the electric light undertaking on being furnished with plans and particulars of the land.

Bolton.—A report has been issued by the deputation which was recently appointed to visit Havre, Rouen and Dover for the purpose of inspecting the electric tramways in those towns. The document is a lengthy one, and deals very exhaustively with the system of traction in the three towns referred to.

Bermondsey (London).—The Vestry are negotiating for the purchase of a suitable site for the erection of an electricity supply station, and the Electric Lighting Committee have been authorised to engage the services of a professional valuer to proceed with the negotiations. Mr. Manville, the consulting electrical engineer, is to be asked to submit a supplementary report upon the advisability of combining a dust destructor with the electric lighting scheme.

Blackpool.—For some time past there has been considerable discussion as to the Corporation's proposal to lay an electric tramway along the new promenade at North Shore. A poll having been demanded by the ratepayers, it is now announced that the result of the voting has been adverse to the proposal. The Corporation's gas extension scheme has also been rejected.

Blockley (Worcestershire).—The streets of this village were lighted electrically for the first time on the 8th inst. Blockley still claims to be the first village electrically lighted, as nine years back the village adopted the offer of the Blockley Electric Light and Manufacturing Company to light the public streets, and this continued until the dissolution of the company three years back.

Brighton—The Lighting Committee recommend the Town Council to waive the condition attached to the appointment of Mr. Arthur Wright as engineer and manager of the Corporation's electricity works, which requires him to give his whole time to the work, and that he be permitted to take private practice as a consulting electrical engineer to other corporations or companies outside the borough.

The Lighting Committee have decided to make a change in the lighting of Montpelier-road. Hitherto this thoroughfare has been illuminated by means of incandescent electric lamps, and the Committee recommend that in place thereof ten 7-ampere arcs be substituted, at a total estimated capital expenditure of £820. A similar change is to be made in the lighting of Preston-road, where ten 7-ampere arcs are to displace the incandescent lamps, at an estimated capital cost of £1,005.

Broughty Ferry.—The Police Commissioners have appointed a committee to consider and report upon the advisability of establishing electricity supply works.

Cardiff.—A deputation, consisting of Ald. Carey, Mr. J. H. Hallett, the borough engineer (Mr. Harpur), and the borough electrical engineer (Mr. N. Appelbee), has been appointed to make inquiries into the most suitable system of electric traction for the local tramways, with authority to visit such places as may be necessary to obtain the required information.

Chili.—The total value of the imports of all classes of wire in 1896 into Valparaiso was £56,857, against £70,951 in 1895. Germany provided £27,719 out of this amount and Great Britain £23,991. The United States manufacturers are gradually securing a share of this trade.

Country House Lighting.—Lord Wantage has given an order to the National Electric Free Wiring Company to supply a complete electric lighting installation at Downs House, near Wantage, the wiring to be on the Company's "Patent Twin System."

Edinburgh.—The Electric Lighting Committee recommend the Town Council to lay down a new feeder main from Dewar-place, along Grove-street, and on to Merchiston, at an estimated cost of £1,400.

Electric Power Distribution in the Midlands.—The Newark Town Council have decided not to oppose the Bill of the General Power Distributing Company, who seek to supply electricity for lighting and motive power purposes within a radius of 26 miles of Warsop. The Matlock District Council are also unlikely to oppose the Bill.

Exhibitions.—The organisers of the Electrical and General Trades Exhibition, to be held at Bingley Hall, Birmingham, from March 19th to April 30th next, and which will be opened by the Right Hon. the Lord Mayor of Birmingham, have secured a large number of exhibitors amongst the electrical and allied

trades. This list can be obtained on application to Mr. George Stanley, 80, Coleman-street, London, E.C.

An international exhibition of motor cars, organised by the Automobile Club of France, will be opened in Paris on June 13th next, and remain open until July 3rd. The site of the exhibition is the Terasse de l'Orangerie, in the Tuileries Gardens. Further particulars may be obtained from the Automobile Club de France, 4, Place de l'Opéra, Paris.

The date of the opening of the Lima Exhibition has been postponed from the 27th inst. to March 20th.

Gas Undertakings.—Parliamentary returns just issued show that the authorised gas undertakings of the United Kingdom numbered (on Dec. 31, 1896) 438 worked by companies, and 208 by local authorities; paid-up and borrowed capital amount to £78,180,724; receipts for the year £19,659,571; expenditure £14,528,478. Over 12,000,000 tons of coal were carbonised during the year, to produce 127,041,000,000 cubic ft. of gas; there were 24,457,000 miles of gas mains, and 540,645 public gas lamps. There were 2,845,728 consumers of gas, all but 457,845 being in England and Wales, 400,000 in Scotland and 57,845 in Ireland. Electric lighting experts have now before them the figures which it is their duty, as doubtless it will be their gratification, to reduce as promptly as possible.

Grants-in-Aid in Germany.—A recent Foreign Office return shows that, among the numerous grants provided in the annual estimates 1898-9 of the German Ministry of the Interior, is a vote of £16,068 for the Physico-Technical Institute at Berlin, including £3,000 for experiments and instruments.

Great Yarmouth.—The receipts of the Electricity Department for the month of January amounted to £531. 5s. (£426 from private lighting and £105. 5s. from street lighting). The expenses amounted to £316. 12s.

Greenock.—Mr. Francis Teague, Burgh Electrical Engineer of Paisley, had a conference with the Electric Lighting Sub-committee on Thursday afternoon on the electric lighting question, and promised to present a report in ten days on the approximate cost of carrying out an extended electric lighting installation in Greenock.

Hackney (London).—At a special meeting of the Vestry on Wednesday, the report of the Joint Committee of the Public Health and Electric Lighting Committees on the electric lighting and refuse-destructor scheme was presented. The Vestry were recommended to adopt the terms submitted by the Electric Extension Company (Limited), offering to collect, destroy and dispose of the dust at 4s. per ton, to supply current for public and private lighting at 3½d. and 5d. per unit respectively, and, for power purposes, at 2½d. per unit. The Company also undertook to deposit £5,000 with the Vestry as a guarantee for the carrying out of the work, and to pay the Vestry £500 towards their expenses in obtaining and transferring the Order. After discussion the report was adopted, and the resolutions passed in January, 1896, pledging the Vestry to undertake the work, were rescinded.

Huddersfield.—The Electric Lighting Committee reported at Wednesday's meeting of the Town Council that there were at the end of January 618 customers of the electricity department, and the equivalent number of 8-c.p. lamps connected was 42,566, an increase of 864 for the month. An application has been received from the Elland District Council, asking upon what terms electric current could be supplied in Elland by the Huddersfield Council.

Ingleton (Yorks.).—A proposal has been put forward for the construction of an electric tramway from Ingleton to the summit of Ingleborough. The total length of the line would be a little over four miles. The steepest gradient would be 1 in 13, and the sharpest curves (towards the summit of the hill) of 8 chains radius. Plans and estimates of the cost of the line have been prepared by Mr. J. Hewitson. The probable outlay is estimated at from £20,000 to £25,000. The ratepayers, at a recent meeting, unanimously passed a resolution in favour of the project.

Interior Wiring.—A paper on this subject was read in December last, by Mr. R. C. Graham Clarke, A.I.E.E., before the South African Society of Electrical Engineers, Johannesburg. We gather from a communication to hand that interior wiring contracts are taken at very low figures in the neighbourhood of Johannesburg, the price for a great deal of the work being 17s. 6d. per light, everything included. A correspondent informs us that a recent contract was entered into for 500 lights for £400.

Ipswich.—The Town Council have re-appointed the Electric Lighting Committee in order to take into consideration the question of putting their Provisional Order into force. The Committee have also been instructed to take into consideration any offers which may be submitted for the transfer of the Order.

Kingston-on-Thames.—The 4th annual report of the Borough electrical engineer (Mr. J. E. Edgcome) is issued, and states that satisfactory progress has been made by the electricity department during the past 12 months. The number of consumers at the end of the year was 163, against 129 in the previous year. An equivalent of 2,375 8 c.p. lamps were connected to the mains in 1897, bringing the total number connected to 9,200. The total receipts from private consumers (£3,148. 17s. 1d.) and the public arc lamps (£720) was £4,868. 17s. 1d. After payment of all expenses there was a balance of £867. 19s. 9d. (against £301. 3s. 1d. in 1896), to meet interest, sinking fund instalment, &c. Various extensions of the plant and mains were carried out during the year, and other extensions are contemplated.

Lewisham (London).—The District Board of Works have received an offer from the Great Western Electric Light and Power Company to erect a dust destructor and to undertake the destruction of refuse in the district at a cost not exceeding 1s. 6d. per ton, provided the Board sanction the Company's application for a Provisional Electric Lighting Order. Current for both public and private lighting would be supplied and would be charged for on the maximum demand system, viz., 7d. per unit for the first hour, and 3d. afterwards for private lighting, and 2d. for public lighting. The Board would also have the option of taking over the Order on payment of the costs incurred. The matter is under consideration.

Light Railway Inquiries.—An inquiry was held yesterday (Thursday) into the application for sanction to the construction of a light electric railway between Bradford and Leeds. The inquiry into the Ventnor application has been fixed for Wednesday next, the 23rd inst., and for Bournemouth and Poole and Christchurch and Bournemouth light railways for Thursday the 24th inst.

London County Council.—At Tuesday's meetings the scheme of the Highways Committee to light the Thames Embankment and Westminster Bridge by electricity was again discussed. The details of the scheme and the Committee's recommendations have been already given in *The Electrician*. Earl Russell said he trusted the Council would dispose of the matter now. The scheme had been carefully considered, and it was no good continually sending it back to the committee. Major Probyn thought the subject should be brought before the new Council, which would shortly be elected. He thought the Embankment should not be desecrated by the erection of a generating station. He also thought that the electricity might be supplied to them cheaper than they could generate it themselves. Sir John Lubbock seconded an amendment to refer the matter back, for he thought that a small installation would be more expensive than getting the current from a company. The Committee's recommendation was ultimately carried, and tenders will now be invited for the erection of the generating station, plant, &c., &c.

The Parliamentary Committee reported having considered the Finchley, Hendon and District Light Railways (Electric) Order, and recommended "that applications under the Light Railways Act, 1896, for power to construct lines under the name of light railways which do not differ in their essential features from tramways, should be opposed by the Council, and that the Parliamentary Committee be authorised to oppose the proposed Finchley, Hendon and District Light Railways (Electric) Order."—Carried.

Londonderry.—The Town Council have offered to supply electric current for lighting the quays and docks at 2½d. per unit, provided current is taken for a minimum of 4,000 hours per annum. The matter is being considered by the Harbour Board and Bridge Commissioners.

Lynn.—Professor H. Robinson has been authorised to prepare a report on the electric lighting question for a fee of 40 guineas.

Macroom (Cork).—The Town Commissioners are making investigations into the cost of providing a system of electricity supply, and a deputation has been appointed to visit other towns where works are in operation.

Maidenhead.—At the last meeting of the Town Council a report from the Electric Lighting Committee was submitted by Mr. Pearce. The report gave statistics relating to electricity supply undertakings in other towns, and pointed out the advantages to be derived by local authorities from the adoption of the Electric Lighting Act.

Manchester.—Col. W. Langton Coke held a Local Government Board inquiry on Tuesday into the application of the Town Council to borrow £16,000 for electric lighting extension purposes. The Assistant Town Clerk (Mr. T. Hudson) stated that the loan was required for the purchase of land for the purpose of erecting a new electricity generating station. It was absolutely necessary that the new works should be established. The Chairman of the Committee (Ald. Lloyd Higginbottom) gave evidence in support of the application, and stated that the demand for electricity had outgrown their power of supply. The site selected for the new station was a suitable one. It was also proposed to use electricity as the motive power for the tramways. The inspector at this point stated that he was glad to hear this statement made, as he had been a convert to electric traction since a visit to Canada. Mr. Higginbottom mentioned that the net profits last year from the electricity undertaking were £16,000. For some years they had had in Man-

chester the record for the lowest total works-cost in the country for private lighting. They had had no public lighting of the streets till recently. The proposed new works would provide for 70,000 H.P., which, including the supply for the tramways, would probably be sufficient for their requirements for some years when there had been taken into account the 11,000 H.P. which would be available from the present works.

Peterborough.—A Local Government Board inquiry was held here last week into the application of the Town Council to borrow £15,000 for electric lighting purposes. The Council's application for permission to borrow £20,000 for a similar purpose was refused by the Board in 1896. Mr. G. M. Cohen said the Council obtained a Provisional Order in 1894, and a site for an electricity station had been secured for £1,700. The conditions of affairs had been greatly modified since the Board's original refusal to sanction a loan. Offers for the transfer of the Order had been received, and this was some proof that a well-devised electric lighting scheme would eventually pay its way. The borrowing powers of the Council were about £26,000. Mr. J. C. Gill, waterworks and electrical engineer to the Corporation, said that, in conjunction with Dr. J. A. Fleming, he prepared an electric lighting scheme, and he produced an estimate of the cost which this would entail. Prof. J. A. Fleming gave technical details of the scheme. He thought Mr. Gill's estimate of £15,000 a reasonable one. A low tension continuous current system was the most suitable one for a compact district like Peterborough. He considered a town of the size and importance of Peterborough should have electricity supply works, and that the scheme before the Council would prove a satisfactory one. Mr. Wragge, for the Peterborough Electric Light and Power Company (Limited), contended that although the Corporation might instal the electric light for £15,000, it would be necessary to extend the area farther to make the scheme a paying one. He argued that the Council's margin of borrowing powers did not permit of their embarking upon an electric lighting scheme, and he thought that no evidence had been adduced to justify the Board in reversing their previous decision. Mr. Cohen replied for the Council, after which the inquiry terminated, having lasted over three hours.

Poplar (London).—The District Board of Works have decided to establish electricity supply works at an estimated cost of £50,000.

Private Bill Legislation.—In the Bill lodged by the Thanet Gas Light and Coke Company powers are sought to arrange with the Corporation of Margate a transfer of their Provisional Electric Lighting Order.

Rome.—The Anglo-Roman Lighting Company have obtained a renewal of their concession for another 25 years, making the total period 38 years. In return for this the Company have made a reduction of 25 per cent. in the price of electric current, and 18 per cent. in the price of gas.

Russia.—A Foreign Office report dealing generally with matters of interest to manufacturers of agricultural and horticultural machinery has just been published, and contains a review of the agricultural and industrial exhibition held at Kief in July—October last. Reference is made to the excellent exhibits of many of the principal British firms, but special notice is taken of the spirited attempt made by German makers to capture the Russian trade. The electric generating plant for lighting the exhibition was provided by Messrs. Grether, Krivane and Co., a local firm; and with regard to the electrical and general exhibits, Germany was an easy first. The report states that in this branch of industry British manufacturers do not appear desirous of testing their strength against the German manufacturing firms, notwithstanding the great field Russia offers in street lighting, transmission of power, and ordinary installations of the electric light. In the neighbourhood of Kief there are an immense number of factories and mills, and the supply of electric lighting and distribution of power plant, plant for electric tramways, &c., are, it is pointed out, well worthy the attention of the British manufacturer. So far the Germans have secured the bulk of this trade, notwithstanding that English-made goods are, on the whole, considered in Russia to be superior to those made on the Continent.

Salford.—An important report on the municipalisation of the local tramways and on the introduction of electric traction was considered at the meeting of the Town Council on Wednesday. A special sub-committee had visited Birmingham, Walsall, Bristol, Leeds, Huddersfield and Glasgow, and, as the result of their investigations, the Council were strongly recommended to adopt the overhead trolley system on the existing lines. Conferences had taken place between the Tramway Committees of Salford and Manchester with a view to making arrangements as to similarity of structure and design of the tramways in the district, and for running powers over the respective lines. The current for working the lines would be taken from the electricity department of the Corporation. After discussion, the whole of the recommendations were adopted by 33 votes to 1.

Sheffield.—An unexpected hitch has occurred in the negotiations for the purchase of the undertaking of the Sheffield Electric Light and Power Company. Owing to certain reflections made on the good faith of the directors of the Company by members of the Council at their meeting last week, the Company's solicitors (Messrs. Broomhead, Wightman and Moore) have intimated the suspension of the negotiations for the sale. A special meeting of the Parliamentary Committee was held on Tuesday for the purpose of reviewing the situation, and a resolution was passed expressing regret at the attitude assumed by the Company and acquitting the directors of any improper secrecy or conduct in connection with the negotiations. A copy of this resolution has been forwarded to the directors, and in view of the conciliatory attitude assumed by the Committee, it is anticipated that the negotiations will be resumed.

Shrewsbury.—The Town Council's application for a Provisional Order has passed the Standing Orders of the Board of Trade, but a memorial signed by six persons, all interested in the local gas company, has been presented against the application, the objection being against the terms of the purchase of the undertaking of the Shropshire Electric Light and Power Company by the Corporation. At the last meeting of the Council the agreement for the purchase was submitted and approved. The Lighting Committee announce that in a short time an extension of the works will be necessary in order to meet the demand for current for private lighting, and the purchase of additional land at a cost of £800 for the extension of the station was recommended and agreed to.

Southampton.—The Town Council have instructed the Electric Lighting Committee to consider the subject of the electric lighting of the parks in conjunction with the question of the improved lighting of the chief thoroughfares in the town. At the last meeting Alderman Lemon explained that the committee were not in a position to supply further current until the new machinery, now on order, was in position, which he expected would be about the end of May

South Australia.—Last Session the Parliament of South Australia passed an Act in favour of the South Australian Electric Light and Motive Power Company, which gives that Company practically a monopoly in the supply of electricity for light and motive power purposes throughout the Colony. One of the promoters of the Bill was Mr. W. W. Crawford, M.I.M.E., C.H.E., A.I.E.E., the representative in Australia of Messrs. Johnson and Phillips, to whom orders for the Port Adelaide plant have already been transmitted. Mr. Crawford is a large stock holder, as well as a director of and consulting engineer to the Company.

Southgate.—The District Council have decided to oppose the Bill of the Tottenham and Edmonton Gas Company for power to supply electric current in this district.

Stourbridge-Kinver Light (Electric) Railway.—The Earl of Jersey and Col. Boughey held a light railway inquiry on Tuesday, at Stourbridge, into the application to construct a light electric railway between Stourbridge and Kinver. Mr. Sydney Morse, who appeared for the promoters (the British Electric Traction Company), said that the scheme was to take a line branching from the Dudley and Stourbridge Tramways, through Wollaston, and *via* the Stewponey, to a terminus at Kinver. Mr. Morse explained the strong financial position of the Company, and said when last week it offered £100,000 Preference stock it was subscribed for six times over, at a premium of 25 per cent. The proposed line to Kinver would make a connection with a number of existing lines, and would have a length of over four miles. The present scheme would provide for the conveyance of passengers and goods. The Company were willing to make their line so that it would give direct communication between Stourbridge and Kinver on the one hand, and also between the Dudley and Brierley Hill district and Kinver on the other. After taking evidence in support of the scheme, the engineer (Mr. S. Sellon) submitted technical details. Lord Jersey said it was obvious there was a concensus of opinion as to the order going forward, and the Commissioners would be happy to recommend that it should go forward, subject to certain conditions.

Swansea.—At the meeting of the Town Council, on Wednesday, the Mayor (Mr. A. Thomas) made a lengthy statement as to the position of the proposed electric lighting and tramway schemes of the Council. He gave a summary of the negotiations for the purchase of the undertaking of the Swansea Tramways Company, and said that the Council had lost seriously by the sale of the tramways to the British Electric Traction Company. The terms of the agreement for the sale were that the Company were to be paid £53,550 in respect to the Ordinary shares, £10,400 in respect to the Debentures and all the other liabilities of the Company; also £600 to the solicitors, £700 to the engineers, and £3,500 to the Directors; in all £68,750. For the Improvement Company the Traction Company were to pay £13,903. Continuing, he said that, notwithstanding this sale, he was still hopeful of having the Tramway Company as customers of their proposed electricity department. The question of the erection of refuse destructor works has been deferred for the present, but it is proposed to put the electric lighting powers into force at once, and Mr. E. Manville

has been asked to proceed with the preparation of an electric lighting scheme.

Taunton.—A report of the Borough electrical engineer (Mr. E. B. Thornhill) states that the National Free Wiring Company have started work in the district, and have already secured several customers. The lamp connections during the past quarter had increased to the equivalent of 364 8-c.p. lamps, while 220 more (exclusive of those of the Free Wiring Company, who have booked orders for the equivalent of 260 8-c.p. lamps) were awaiting connection.

The Engineering Settlement.—Last week the officials of the Amalgamated Society of Engineers issued an important statement regarding the recent dispute with the employers. In this document the officials of the Society review the position of affairs brought about by the collapse of the strike, and justify the action taken by the leaders in that dispute in order to bring about a settlement. The Voluntary Conciliation Act is described as "a wretched Parliamentary abortion." The officials responsible for this document admit that the Society "has undoubtedly received a check, but nothing from which we cannot recover if all do their duty. The financial position is not so serious as commonly reported." The men are urged to remain steadfast to their organisation and loyal to the principles of trades unionism. The tone of the document is certainly not that of the vanquished, but rather of men temporarily baulked in their efforts to dictate terms to the employers, who, with Parliament and the Government, are not over generously dealt with. In fact, it is stated that the employers "dominate and control Parliament almost as completely as they do their own workshops."

Much indignation has been expressed by the non-unionist workmen who so loyally supported the strikers in their struggle at the decision of the officials of the A.S.E. to withhold any further out-of-work pay to non-members of the Society.

Mr. Robert Knight, general secretary of the United Society of Boilermakers and Iron Shipbuilders, has contributed to the discussion now proceeding as to the losses occasioned by the recent dispute, and estimates that the strike has cost the men in loss of wages and their common fund a sum approaching three millions sterling.

The Shannon Electric Power Scheme.—A meeting of riparian landowners and others interested in the Shannon fisheries was held at Limerick on Saturday, to consider the scheme for the utilisation of the water of the river in the generation of electric current. Mr. H. C. Fuller, engineer to the Shannon Electric Power Syndicate, said that between Lough Derg and Limerick there was an available fall of 87ft. 6in. Of that total there was approximately a fall of 20ft. from Killaloe to Castleconnell. It was proposed to cut a canal slightly north-east of Erinagh, and to carry it for a distance of two miles along the northern bank, through Waterpark, and entering the river again at Landscape. The quantity of water required would be 60,000 cubic feet per minute. As to the effects of the scheme on the summer flow of the river, and its injurious effects on the fisheries, he had no hesitation in saying that the summer flow would not be affected to the slightest degree by the works proposed to be carried out. They would store the water during the summer months. The Shannon river admirably presented the opportunity of doing so. The area of Lough Allen was 9,000 statute acres, and utilising 60,000 cubic feet meant, in working ten hours a day, about 36,000,000 cubic feet. If one foot of water was stored at Lough Allen it would be equal to 392,000,000 cubic feet of water, and that would be sufficient to work the scheme for ten days at ten hours a day at full power.

The Telegraph and Telephone in Germany.—For the financial year 1896-7 the receipts from the German Government telephones nearly equal the receipts from the telegraphs, the respective figures being: telephone £1,023,419, telegraphs £1.275,643. The average yearly increase in the receipts has been 5·41 per cent. for the last three years. The telegraphs and telephones of the kingdoms of Bavaria and Wurtemburg are not included in the German Empire figures. At Munich (Bavaria) the telephone is in very general use, the annual charge being £7 10s., and petitions are now before the Government to reduce this amount to £5. Considerable reductions have recently been made in the charges for inter-town telephonic communication, from which a large increase in trunk line traffic is anticipated.

Tramway Extension in West London.—The London United Tramways Company have come to an understanding with the Acton District Council with regard to their scheme for the improvement of the tramway system of the district, and for introduction of electric traction. The District Council of Brentford have the matter still under consideration, while the Ealing Council have announced their decision to oppose the scheme. The Hammersmith Vestry has already assented to the Bill, and it is more than probable that the extension from Kew Bridge to Hounslow will be sanctioned.

Wandsworth (London).—The Vestry have passed a resolution in favour of inviting the City and South London Railway Company to extend their line under Clapham Common and Wandsworth Common as far as East Hill.

Willesden.—At the last meeting of the District Council the Chairman of the Works Committee (Mr. Charles Pinkham) reported that he, along with Mr. Adams and Mr. O. C. Robson, the Council's engineer, had visited several electric lighting stations and had collected valuable information for their future guidance. Judging from the results in other towns, an electrical undertaking would eventually prove to be a financial success. If other towns could make a profit in their third year there was no reason why they should not be equally successful in Willesden. If they wished to make their district attractive and keep it up to date they must embark upon an electric lighting scheme. The opposition to the electric lighting was solely to the Council undertaking the work. They had had petitions in favour of private companies, but if it would pay private companies it would doubtless also pay the Council. After discussion the Council, with one dissentient, voted in favour of an electric lighting project.

Withington.—The District Council have appointed a committee to enter into negotiations with the Manchester Corporation for the supply of electricity in the district for both public and private lighting.

Wolverhampton.—The Local Government Board have sanctioned the borrowing of a further sum of £9,000 by the Town Council for electric lighting purposes.

Electro-Harmonic Society.—A ladies' night entertainment will be given at the St. James's Hall Restaurant, Regent-street, London, W., on Friday evening, the 25th inst., at eight o'clock.

Smoking Concert.—The employés of Messrs. Drake and Gorham held a smoking concert at the Grosvenor Hall, Buckingham Palace-road, London, S.W., on Friday last. This concert was inaugurated 11 years ago, and has grown from year to year. Mr. Bernard Drake occupied the chair, and, in the course of a few introductory remarks, dwelt upon the advantages which such gatherings offered for their town and country members to meet one another and talk over affairs. We were also pleased to learn that the system of profit-sharing inaugurated by Messrs. Drake and Gorham was very successful last year, no less than £1,000 being distributed amongst the employés.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

December 16, 1897.

29,778. L. B. MILLER. London. Improvements in telegraphy.

29,821. F. W. SCHINDLER-JENFY. London. Improvements in electric heaters.

29,826. J. MILLIS. London. Improvements in conductors for electrical machinery, and in dynamo-electric machines, motors and other electrical apparatus.*

29,834. A. C. HEAP. London. Improvements in the construction of single-phase alternate-current motors and generators.

29,835. E. F. PORTER. London. Improvements in and relating to electric heaters.*

29,852. H. T. HILLISCHER. London. A new or improved underground duct for electric railway leads, and a contact slide to work therein.

December 18, 1897.

29,977. C. B. CRAWSHAW and C. W. HILL. Bradford. Improvements in electric motors and dynamos.

29,981. W. H. ALLEN, SON AND CO. and J. W. KEMPSTER. Bedford. Improvements in electric drilling machines, electric boring machines, and electric milling machines.

29,985. F. NICHOLSON. Manchester. The patent detachable collar electric incandescent lamp.

29,994. W. E. HEYS. Manchester. Improvements in and connected with electric locomotives. (J. J. Heilmann, France.)*

30,001. C. LUYERS. Brussels. Improvements in railway aero-electric brakes.*

30,020. A. SOAMES and C. W. S. CRAWLEY. London. Improvements in prepaid electric meters.

30,037. D. LACKO. London. Improvements in electric arc lamps. (Date applied for under Patents, &c., Act, 1883, Section 103, July 21, 1897, being date of application in France.)

December 20, 1897.

30,065. J. M. HUISMAN and H. C. GOVER. Glasgow. Improvements in key-switch holders for incandescent electric lamps.

30,085. B. DOYLE and H. V. THIRKELL. London. Improvements in electrical contact devices.

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30,089. E. Kosel. London. An improved process for preparation of an electric paste accumulator.
30,135. A. L. Fyfe. London. An improvement in vehicles driven by oil engines in connection with electric motors actuated by accumulators.

December 21, 1897.

30,157. A. Musker and F. J. P. Cheesebrough. Liverpool. Improvements in and connected with the manufacture of electrical cable or conductor conduits.
30,205. W. F. Browne. London. Improvements in coin-controlled mechanism for electric and other meters.*
30,211. W. P. Thompson. London. Improvements in and relating to insulating blocks for electric conductors. (J. Jungbluth, Germany.)*
30,221. N. Schmitt. London. An improved electric fuse and machine for the manufacture thereof.*
30,253. H. H. Lake. London. An improved electro-chemical explosive device. (G. Cornara, Italy.)
30,256. A. J. Marquand and F. G. Treharne. London. Improvements in electrical resistances.
30,259. E. Wilson and C. J. Evans. London. A method or methods for controlling a mechanism or mechanisms by means of electric or electromagnetic waves of high frequency.

December 22, 1897.

30,264. The British Thomson-Houston Company (Limited) and H. M. Hobart. London. Improvements in and relating to windings for polyphase machines.*
30,275. T. E. Weaver. Wolverhampton. Improvements in dynamo-electric machines.
30,295. C. E. B. Holt. Bradford. The automatic locking lever and lifting-lever combination for electrical lifts, cranes, or other machinery.
30,299. J. E. Duckworth. Manchester. Improved means for making electrical connections upon railway trains.
30,321. E. Egger. London. An improved switching apparatus for preventing self-induction sparks from being formed during the operations of disconnecting and reversing electromotors.
30,341. W. Antrobus. Cheshire. Improvements in and relating to electric smelting furnaces.
30,347. E. P. L. Mors and L. C. A. Pottier. London. Improvements in electrical arc lamps. (Date applied for under Patents, &c., Acts, 1883, Sec. 103, November 3, 1897, being date of application in France.)
30,364. E. B. Wedmore. London. Improvements in phase transformers for electric currents and the application of the same to monophase electric motors

December 23, 1897.

30,393. J. G. Knight. Dublin. An electro-mechanical dancing marionette figure in combination with rubber rotating sphere for advertising purposes and such like.
30,427. J. C. Howell. London. Improvements in and connected with metallic ribbon particularly adapted for battery plates, but useful also for other purposes.
30,441. C. L. R. E. Menges. London. Improvements in primary and secondary galvanic batteries.
30,445. Siemens Bros. and Co. (Limited) and E. Holmes. London. Apparatus for simultaneously connecting a number of pairs of electric conductors.*
30,447. Siemens Bros. and Co. (Limited). London. Improvements in supplying electrical energy to railways worked by alternating currents. (Siemens and Halske, Actien-Gesellschaft, Germany.)

December 24, 1897.

30,470. F. W. E. Jones. Leamington. An improved electricity meter shelf-fixing or box and main connection board or box combined.
30,476. H. W. Handcock and A. H. Dykes. London. Improvements in and connected with electric traction.
30,494. W. L. Wise. London. Improvements in the armatures of induction-motors. (The Maschinenfabrik Oerlikon, Switzerland.)
30,544. O. Parpart. London. Improvements relating to the electric welding of tubes and to apparatus therefor.

December 28, 1897.

30,572. C. C. Fowler and The Mutual Electric Trust (Limited). Brighton. Improvements in joints for electricity conductors.
30,619. J. W. Bullock. Wigan. Improvements in primary galvanic batteries or cells.
30,622. R. L. Hailey. Manchester. A combined manual and automatic switch for electric circuits.
30,625. The British Thomson-Houston Company (Limited). London. Improvements in the method of and means for regulating the phase relation between current and electromotive force in alternating-current systems of electricity distribution. (C. P. Steinmetz and E. W. Rice, jun., U.S.A.)*
30,627. The British Thomson-Houston Company (Limited). London. Improvements in and relating to electric railways. (W. B. Potter, U.S.A.)*
30,628. The British Thomson-Houston Company (Limited). London. Improvements in induction wattmeters. (E. Thomson and W. H. Pratt, U.S.A.)*
30,678. J. Rymer-Jones. London. A new or improved method of retransmitting telegraphic messages, and apparatus for use in connection with the said method and for other purposes.
30,686. C. J. Hubbell, H. G. Hubbell, W. D. Boyer and E. P. Mucklow. London. Improvements in and relating to primary batteries.*

December 29, 1897.

30,719. K. Breitenbach and the firm Gebl. Breitenbach. Brussels. A machine for smoothing cylinders worked by an electric motor.*

December 30, 1897.

30,832. J. Brockie. London. Improved arc lamp carrier.
30,838. C. Marschner. London. Improvements in apparatus for use in the manufacture of accumulator plates.*
30,841. G. C. Marks. London. Improvements in electrolytic apparatus (H. de Solages, France).
30,846. E. Wilson and C. J. Evans. London. A method or methods for controlling a mechanism or mechanisms by means of electric or electro-magnetic waves of high frequency.

December 31, 1897.

30,848. J. A. Timmis. London. Operating railway points by electromotors.
30,881. S. J. Motton. Penzance. A new and improved method of electrical signalling.
30,912. H. E. Mavor and Mavor and Coulson (Limited). London. Improvements in electrical resistance apparatus.
30,917. R. Burk. Liverpool. Improvements in electrically-operated clocks.*
30,923. H. H. Leigh. London. Improvements in electric elevators (F. J. Sprague, U.S.A.).

January 1, 1898.

16. J. W. Towers. Liverpool. Improvements in the manufacture of diaphragms for electrolysis.
26. T. F. J. Truss. Liverpool. An improved construction of and method and means of laying underground electrical cables or conductors.
45. W. T. Brain. Russia. Electric switch apparatus for railways to enable train to receive currents from signal stations when in contact with its electric current conductor (especially useful during fog).
58. M. Barschall. London. Improvements in rail joints for electric railways.
67. H. C. Gover, C. F. Proctor, and W. G. Pipkin. London. An improvement in holders for electric glow lamps.*
80. G. A. Lesieur. London. Improvements in electrical advertising devices.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

28,367. Hungerbühler. Electric arc lamps.
28,400. Thompson (Dulait). Electrically-propelled motor road vehicles.
28,704. Rawlings and Rawlings. Switches for electric currents.
25,631. Parker. Means employed in the electrolytic production of the chlorates of sodium and potassium.
27,558. Andrews. Electrical signalling apparatus for railways.
28,392. Boardman. Method of and apparatus employed in controlling gas valves by electrical energy.
28,678. Hateley. Pendants for gas, electric, oil and other lights.
28,955. Brown and Neilson. Means of telegraphing or telephoning without wires.
29,379. Beaumont. Electric arc lamp.
29,498. Blackburn and Moore. Distribution of electricity from a common generating plant for supplying simultaneously current both for traction and for lighting and for lighting or power.
29,702. Soames and Crawley. Prepaid electric meters.
29,804. Pickup, Pickup, Ashworth and McClellan. Apparatus for propelling fans or other machines or appliances by means of electricity.
29,923. Laing. Electric clock alarm and time indicator for billiard-rooms, hotels, and other places.
30,088. Whitehead. Electric clocks.

1897.

73. Wylie. Apparatus for the manufacture of metallic pipes and rods, and for covering electric telegraph and telephone cables and wires.
171. Bathurst. Electric light and power fittings especially adapted to boxes used in connection with armoured conduit systems of wiring.
203. Roderbourg. Accumulators or secondary batteries in electrically-propelled vehicles.
490. Wright. Electric deposition of metal on pipes, tubes, and other articles.
615. Böhm. Means for electrically obtaining ozone and employing the same for curative and other purposes.
645. Obelt. Phonographs.
851. Jackson and Co. (Limited) and Lewis. Brush holders for dynamo electric machines.
991. Dowsing. Automatic apparatus for producing X-rays and showing their effect on a prepared plate or screen
1,150. Koppel. Portable electric railways with overhead conductors.
1,203. Handcock and Dykes. Secondary battery plate.
1,204. Handcock and Dykes. Method of preparing positive plates for secondary batteries.
1,753. Lambert. Rheostats with a liquid medium.
1,771. Baines and Norris. Electrically-driven sheep-shearing or hair-clipping machines.
1,849. Balfour and Smith. Electric railways on the conduit system.
2,039. Pattersson. Electrically-operated gas burners.

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2,275. Tomkins. Electric meters.
2,445. Zeal. Thermometric electrical circuit closer.
2,559. Siemens Bros. and Co. (Limited) (Siemens and Halske). Method and apparatus for dividing an alternating current into two currents whose phases are shifted relatively to each other, more particularly applicable for working or starting single-phase alternate-current motors.
2,578. Parker. Arrangement of field coils of shunt motors for use with storage or other batteries, and method of connecting such coils with the batteries.
2,643. Burnand. Electric arc lamps.
2,709. Heys (Dumoulin). Electro deposition of copper and other metals.
2,710. Heys (Dumoulin). Method of and apparatus for the electro-deposition of copper and other metals on rotary mandrels.
3,722. Thompson (Kayser and Co.) Grooved frame carriers or supports for holding or suspending accumulator plates, photographic plates, and other plate-like articles.
4,035. Bathurst. Insulation of electrical conductors.
4,242. Clarke. Means for connecting or continuing electric circuits through electroliers, brackets for electric lamps and the like.
4,391. Heys (Chedville). Electric heating devices.
4,824. Daniels. Rail bonds for electric railways.
6,246. Dobson. Electric arc lamps.
7,005. Petzenburger. System of current supply for electric railways.
7,187. Ott and Silbermann. Means for supplying current to electrical cars.
8,346. Payen. Secondary batteries.
11,383. Gibbs. Electric heel plates and like articles.
11,714. Gover and Proctor. Holders for electric glow lamps.
13,976. The British Thomson-Houston Company (Limited). (Steinmetz.) Induction motors.
17,113. Wise (Krotz, Allen and Kelly). Underground systems of electrical distribution for electric railways and the like.
17,596. Wise (Krotz, Allen, and Kelly.) Trolleys or sliding contacts for electric cars.
19,179. Woltereck. Process of manufacturing white lead by electrolysis.
19,479. Stanley and Darlington. Magnetic means for resisting end thrust in shafts or spindles in electric meters, and other apparatus.
19,638. Kennedy. Electrical storage batteries and plates therefor.
19,846. Guelzow. Manufacture of plates for electric accumulators.
23,310. Klinger. Electrical igniting devices for distant gas lamps or burners.
23,369. Gover and Proctor. Electric safety fuses.
23,415. Liddle. (Farnham.) Dynamos.
23,418. Murray and Johnson. Electro-motors and dynamos.
23,792. Schneider. Electric propulsion of vehicles.
24,129. The British Thomson-Houston Company, Limited (Moody). Electrical transformers.
24,130. The British Thomson-Houston Company (Limited) (Potter). Mounting for the contact shoes of surface-contact railways.
25,369. Heys (Spruance and Waddell). Electro-magnetic circuit breakers.
25,386. Hess. Chemical-electric generators.
25,400. Motz and Welch. Electrolytic process and apparatus for the separation of metals from their ores and solutions.
25,528. Akester. Valve apparatus for electric batteries.
25,723. Scheefer. Alternating electric current meters.
25,745. The British Thomson-Houston Company (Limited) and Hobart. Reactance coils.
25,811. Russell. Sockets or holders for electric lamps.
25,998. Fairweather. (The Crocker Wheeler Electric Company.) Automatic circuit breakers.
26,010. The British Thomson-Houston Company (Limited) and Hobart. Construction of electrical transformers for use in three-wire systems.
26,210. Röhser. Method of and means for transmitting electric currents in tramways.
26,441. Bennert. Preparation of accumulator plates.
26,640. Hughes. Electrical resistance apparatus.
26,752. Greenfield. Flexible conduits for electrical conductors.

BOOKS RECEIVED.

"Elementarer praktischer Leitfaden der Elektrotechnik." By Oskar Hoppe. Essen: G. D. Baedeker. Price 4 marks.)

"Fortschritte der Elektrotechnik." Part III. of 1897. (Berlin: Julius Springer.)

"Journal of the Institution of Electrical Engineers." No. 131, Vol. XXVI. Edited by F. H. Webb. (London: E. and F. N. Spon. Price 3s. 6d.)

"Magnets and Electric Currents." By Prof. J. A. Fleming, F.R.S. (London: E. and F. N. Spon.)

"The Official Gazette of the United States Patent Office." No. 4, Vol. LXXXII. Published by Authority of Congress. (Washington: Government Printing Office.)

"The Official Gazette of the United States Patent Office." No. 5. Vol. LXXXII. Published by Authority of Congress. (Washington: Government Printing Office.)

"Angewandte Elektrochemie." By Dr. Franz Peters. Vol. II. Parts 1 and 2. (Leipzig: A. Hartleben). Price 3 marks each.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

An extraordinary general meeting of this Company was held on Tuesday, February 15th, at Winchester House, Old Broad-street, E.C., the Marquis of Tweeddale (Chairman) presiding.

The SECRETARY (Mr. George Draper) having read the notice calling the meeting,

The CHAIRMAN said: This meeting has been called to consider and, if thought fit, pass the following resolution:—

"*That the Regulations of the Company be varied by adding the following Article of Association, viz., 85a: "'Continuing Directors may act, notwithstanding any vacancy in their body.'*"

The object of this resolution is to provide against the inconvenience arising through the number of Directors falling below the minimum allowed by the Articles of Association, and to enable the Directors to carry on the business of the Company, including, of course, the filling up of vacancies. The desirability, or rather the necessity of such a proposal as that contained in the resolution was exemplified in a very painful manner only recently, when two of our directors, I am sorry to say, died within a few hours of each other. If this resolution meets with your approval your Directors will be able to carry on the duties of the Company in a legal and proper manner, while arranging for the filling up of any vacancies which may have occurred in a way that is suitable in the interests of the Company. You will easily understand that it is not always possible to at once find a director whom we could recommend to the shareholders. Arrangements are being made now for filling up the vacancies which occurred in the manner I have just referred to. One shareholder has written to say he considers the resolution somewhat vague, and suggests the insertion of words to the effect that the minimum should never be under four. He is evidently not aware that the minimum is seven, and that it is the duty of the Directors in the case of vacancies reducing the minimum to fill up such vacancies as soon as they can conveniently do so, and bring the number up to, at least, the minimum, if not more. It has been the practice in this Company to have one, and sometimes two, in excess of the minimum; and it is obviously the duty of the Directors, so long as the Articles of Association require a minimum of seven, to fill up vacancies that may occur in an adequate manner. With these observations, gentlemen, I beg to move the resolution which I have just read.

Mr. JOHN DENISON PENDER seconded the resolution, and it was unanimously agreed to without discussion.

The CHAIRMAN announced that the confirmatory meeting will take place on March 3, and the proceedings terminated.

Cuba Submarine Telegraph Company (Limited).

The fifty-third ordinary general meeting of this Company was held on Wednesday, at the offices of the Company, 58, Old Broad-street, E.C., Charles W. Parish, Esq., in the chair.

The SECRETARY (Mr. James Scott) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, you have had the report and accounts in your hands for some time, and I assume therefore that you will take them as read. The expenses charged to revenue account for the half-year now under review amount to £6,602, while in 1896 they were £8,352, but for the sake of accurate comparison three special items, amounting to £1,172, must be deducted from this sum, leaving an actual amount of £7,180, or £578 above this year. This is so far satisfactory, the chief difference being under "expenses at stations," which in 1896 were £4,821, against £4,316 in 1897. Our report calls your attention to the serious falling-off which has taken place in the receipts, which for the half-year in 1896 were £27,249, against £17,586 in the last half-year, or an actual reduction of £9,663, due principally to the loss of the French traffic. At the same time you will have been fully prepared for this result, as we were able to clearly warn you that the French traffic would naturally go by that Company's new cable from Hayti to New York. But a still more serious competitor has come upon us in the cable just laid by the Direct West India Cable Company—under a subsidy from the British Government—between Bermuda and Jamaica, and so completing the Bermuda-Halifax route. As far back as 1889 our Government granted a subsidy of £8,100 for the cable from Halifax to Bermuda for 20 years, and last summer granted a further subsidy of £8,000 to have it extended to Jamaica, but with the provision of a 3s. rate between Jamaica and the United Kingdom, the object being to have what is called an "All-British route"—whether there really is any particular advantage in this idea I am not prepared to say—it is more connected with politics than business; but I regret that the Government thought it necessary to stipulate such a low rate, as to be approximately only half of what has existed before, because it is very doubtful if it will lead to any important increase of business; therefore I do not expect that there will be any great bound-up in the number of messages. The 3s. rate over the Halifax-Bermuda line has compelled our Company to reduce to the same figure, which must involve a serious loss of income; and I can only tell you that we shall do our best in the interests of our Company to meet the situation which has unfortunately arisen. Regarding our cables, the Manzanillo - Santiago cable is being laid, and Mr. Keith has gone out to superintend the repair of the Cienfuegos - Santiago 1881 Cable; the other cables are working well. Incidentally the opening of the new line, the Bermuda - Jamaica Cable, has brought about a difference of opinion between ourselves and our allies, the West India and Panama Company. They have placed a construction upon the traffic agreement under which we have worked since the formation of the companies which we are advised is wrong, and accordingly we have con-

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sidered it necessary to take steps to obtain a judicial interpretation of the agreement. I think, gentlemen, that I have covered all the ground to which I wish to refer, but if any shareholder would like to ask any question I shall be very glad to answer it. I now move that the report and accounts be adopted.

Mr. ROBERT KAYE GRAY: I beg to second it.

Mr. W. GRIFFITH: Can you tell us, sir, the exact point of difference between ourselves and the West India and Panama Telegraph Company?

The CHAIRMAN: With regard to the difference between ourselves and our allies, I think that it would be a mistake to make more of it than is necessary. It is, I hope, a matter where they will see that we are right, we have taken the highest legal opinion upon it, and I must ask you to kindly allow the matter to remain in our hands.

Mr. BURROWS: I suppose that we have suffered considerably by the war and the revolution which has been raging in Cuba?

The CHAIRMAN: No; I think I must tell you that, on the contrary, we have gained. The whole of the land-lines were cut, and so we have carried a great deal of the Government work by our lines.

The resolution was then carried unanimously, and the dividends of 10 per cent. on the Preference shares, and 6 per cent. on the Ordinary shares, duly authorised. After a vote of thanks to the Chairman and Directors the proceedings terminated.

Westminster Electric Supply Corporation (Limited).

The ordinary general meeting of the shareholders was held at the offices, Eccleston-place, Belgravia, on Wednesday, under the presidency of the Right Hon. Lord Suffield, K.C.B.

The SECRETARY (Mr. Frank Iago) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, the report speaks for itself, and I will not therefore detain you with a long speech, but I think you will agree with the Directors that there is every reason to congratulate ourselves on the satisfactory working of the past year, and the increase in revenue, which allows us to recommend the payment of a dividend which is an addition of 3 per cent. on that of the preceding year. You will notice from the report that the working of the stations has been greatly affected by building operations owing to the necessary extension of the central stations. Our engineers have, of course, been working under very great difficulties all through the year, and, although the cost of generating shows no saving per unit over the preceding year, we think that in the circumstances we may congratulate ourselves on there not being any increase in the works costs, as there might well have been, had not the greatest care and attention been bestowed on the working of the stations. You will see that the supply of current still continues to increase at a satisfactory rate, and, as far as we can judge, there is no present likelihood of a decrease in the number of applications received, for as the older houses in some parts of our district where no electricity is used have to be pulled down, they are replaced by new buildings—in many places, by large blocks of flats—where electric fittings are put in as a matter of course. I think you will all agree that the result of the negotiations with the holders of the Founders' shares has been satisfactory, and that it is best for all concerned that all the shareholders are now on the same footing. I do not think, Gentlemen, there are any other special points I need draw your attention to, so I will conclude by formally moving:—

"*That the report and accounts for the past year be approved and adopted.*"

Mr. EDMUND BOULNOIS, M.P., seconded the motion, which was carried unanimously.

Mr. J. BROWNE MARTIN proposed and Sir DOUGLAS GALTON seconded, the distribution of 16 per cent. as dividend for the half-year, making, with the 8 per cent. interim dividend, 12 per cent. for the year. This was also carried unanimously.

The retiring Directors, Lord Suffield and Mr. Boulnois, were then re-elected unanimously.

Sir MARK J. McT. STEWART, Bart., M.P., then moved—

"*That the Directors shall be paid out of the funds of the Company, by way of remuneration for their services, the sum of £3,000 per annum, or such other sums as the Company in General Meeting may from time to time determine, and such remuneration shall be divided among them in such proportions and manner as the Directors may from time to time decide.*"

Judging from the unanimity which has greeted all the remarks from the front bench, I cannot help but think that my task is an easy one. In the first place the Company is prosperous. I think that the state of the balance-sheet, as well as the Chairman's remarks in drawing your attention to it, fully support my view. We have 180 miles of ways, £50,000 a year in dividends, and we have also an increasing number of lamps, so that the number may now be expected very speedily to run up to 300,000. All that denotes distinct progress all along the line. Ever since this Company has been started it has been progressive. The first year—very naturally, I think—it paid nothing, but since that not only have the shares gone up in value—as they did, in fact, almost from the beginning, if not from the very beginning—but there has been a steady increase in the amount of the dividend. I remember when I first joined the Company—and I am speaking, I think, as one of the largest and original subscribers—that it was said that it would be a good thing, and that the shares would double in value, whereas they are now approaching four-fold their value. All this denotes prosperity. How did we attain this prosperity? It is not only because we have a good district. We have a district which is continually taking more lamps, and becoming a great customer; but in order to maintain that position we must think of those who have helped this Company so much. I may say that had we not had so good a Board, and so good a Chairman, this Company might have gone the way of many other companies, and have been heard of no more. We find that we are a prosperous Company, and that we owe much of that prosperity to the Board. These gentlemen have given unwearied and devoted attention to their many duties. They have had many matters of extreme delicacy to discuss and to negotiate and carry out, and when we find them in, so to speak, command of so many hundred thousand pounds, we see that the trust reposed in them is very great. The responsibility is also very great, and, according to the old rule, "The labourer is worthy of his hire." I think we have not properly compensated our Board for what they have done. We have the prospect of advancing still further in the future. We cannot reasonably expect the Company to make such strides as in the past, yet we are on the fair road of making even progress all through. The increase in the value of our shares and in the rate of dividend has not been "by leaps and bounds," but in a steady graduated manner. There has been much work done for us by the Board, not at all connected, so to speak, with the Directors' duties. Take, for example, the last issue of £200,000 of debentures. In the usual course the matter would have been referred to some London solicitor, who, no doubt, would have dipped heavily into the pockets of the Company for such a transaction; or it might have been negotiated through some financial company, who would certainly have assured themselves of a very large remuneration. Although it is invidious to particularise any Directors, I cannot help mentioning two names which at once command your confidence, who, on account of their legal acumen and knowledge, have been able to carry this matter through without the assistance of any lawyer—I refer to Mr. Hayes Fisher and Mr. Wallace. I myself thought of this proposal before. I was anxious to move it a year ago, but for reasons I need not refer to I was asked not to do so. I do think, however, that the time has now come when we ought to give our Board some substantial reward, and a regular reward, for their services. These gentlemen have been here continuously; one or two, being close by, have been able to give the closest attention to the affairs of the concern. It is therefore only fair that we should put ourselves in the position of other companies who are not paying dividends equal to those of this Company, companies who have smaller capitals to work with, and therefore less responsibility than our Directors. The present remuneration of our seven Directors is about £1,500 a year, and deducting income tax and other matters, and leaving rather a larger amount to the Chairman, it does not give them £200 a year. I am proposing that they shall have £3,000 a year among them. I hope there will be no dissentient voice in regard to this matter. The Directors have brought us successfully through many troubles, and they have had a very difficult task only this year in bringing all the Founders' shareholders together, and enabling those shareholders to be bought out. No doubt that was effected at a high price, but still at a price which the shareholders will in time, if not at present, fully appreciate. I held one Founders' share, and I think that what was done was the best thing that could be done for the Company, and certainly for the shareholders. With this explanation, I trust you will thoroughly concur in this resolution. In the event of adverse times coming upon us you have a body of gentlemen at your head who would be quite ready to acknowledge such adversity and to consider under those circumstances the question of reducing their fees.

Mr. F. A. WHITE: I second this resolution. There is no doubt that the aphorism to which the proposer gave expression is the true one—that "the labourer is worthy of his hire"; and as shareholders are generally very willing to criticise their Directors when anything goes wrong, it is only right, and as it should be, that when the affairs of the Company are so well conducted as ours are the services of the Directors should be considered. I think that the proposed increase to £3,000 a year is very moderate, and not too much to divide among the Board for such work as they do.

Mr. A. P. SIMPSON: It is always an invidious and ungracious task to take exception to any suggestion to increase the remuneration of the Directors; and I personally should be one of the last to suggest that the Board should not be amply paid. I had hoped to hear from the proposer of the motion some statistics as to what the directors of other undertakings of a similar nature are paid. I have taken the opportunity of obtaining the returns of the City of London Electric Light Company, which controls a very much larger income than this Company does, and I find there, taking the list of the management expenses, that comparing one with the other—I may fairly assume this—their directors are paid at the same rate as our Directors. I entirely concur with the proposer of the resolution that the remuneration should be adequate and ample, but what I do rather take exception to is the form in which the resolution is moved. I shall therefore move an amendment to the effect that the additional remuneration of the Directors for the past year be £1,000.

The CHAIRMAN (after a pause) said: This amendment has not yet been seconded, and therefore it falls to the ground. The proprietor who moved the amendment was a little mistaken, I believe, in regard to the remuneration paid to other directors; but I will not argue the matter further. I will merely once more thank the proprietors for their almost unanimous wish to better our position.

On the motion of Sir MARK STEWART, seconded by Mr. DARNTON HUTTON, a vote of thanks was passed to Lord Suffield for presiding, and the proceedings then terminated.

National Telephone Company (Limited).

The twenty-first ordinary general meeting of the National Telephone Company (Limited) was held yesterday at the Cannon-street Hotel, Mr. James Staats Forbes (the President) in the chair.

The SECRETARY (Mr. Albert Anns) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, one feels at a loss sometimes in dealing with these accounts, owing to their want of novelty. The accounts have been so uniformly stated in the same language, and the increases have been so uniformly progressive, that they become rather matters of course, and for a chairman accustomed to be an

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apologist the position is not quite so exciting as it is when there is something to apologise for and something to defend. On this side of the table, knowing as we do the very great difficulties by which we are surrounded in carrying out this telephone business, we feel that these figures are exceedingly satisfactory, and I trust that those present, and those absent, who have studied them, as either affecting the past half-year or the past year, and who carry their knowledge back to former years, will be as satisfied as we are with the progress the concern is making. The accounts are in the same form and are easy of comprehension, and the gist of them is contained in the first five paragraphs, the fifth being the most important of them all. You will observe that the growth of the business in the half-year has exceeded by £67,600 the receipts of the corresponding half of 1896. The working expenses have increased reasonably in relation to the large increase of the receipts themselves, and the accounts show you that the net result for the half-year, after deducting the Post Office royalties, amounting to £46,000, is an increase of £23,474. Para. 4 is a very interesting one, because it carries us beyond the mere results of the half-year. I have had to explain it a great many times, and perhaps I had better repeat it. We receive in advance a very large amount of our subscriptions. Those subscriptions cover a portion of one year or half-year, and a portion pertaining to later periods. This paragraph means that in respect of subscriptions already received for services to be rendered in the coming year—that is to say, the year we are now in—we have the large sum of £473,586 in hand, an increase you will see of £58,872. That is not *in nubibus*, and has been received in aid of the current half-year's revenue, which is a very large sum. The available balance, £156,435, will enable us, subject to your approval, to do certain things, namely, to pay a dividend at the rate of 6 per cent. per annum, less income tax on the 1st and 2nd Preference shares, 5 per cent. per annum, less income tax, on the 3rd Preference shares, and 6 per cent. per annum, free of income tax, on the Ordinary shares. This is really the long and short of the whole business; that is the outcrop of the working for the half-year. I presume there will be no great difficulty in your agreeing to receive those dividends. Then you will see by para. 6 that we propose to transfer £40,000 to the reserve fund, and to carry the balance of £10,034 forward. That £40,000 that we carry to the reserve is £6,000 more this half-year than we have been in the habit of carrying to the reserve for some time past. The increased balance, after payment of the dividend of 6 per cent., justifies that large amount being carried to the reserve, and we carry forward a sum larger in amount than we brought in for the half-year. We next come to the capital expenditure—a very serious matter, but not unduly serious, seeing the progress of the business. We have expended the sum of £267,375 on capital account, which is a pretty good lump for one half-year; but it is only, after all, the embodiment of a growing business. You will see in the half-year we have erected 5,633 additional exchange and private lines, and, besides that, there has been considerable expenditure in what really comes to a transformation of the system from overhead to underground. One need not enlarge upon the virtues of that. The overhead system is attended with enormous difficulties, which do not get less from day to day, but rather increase. They impose upon the Company certain risks, from time to time, which not only cause a great deal of liability, but a great deal that is harassing in working the undertaking. The underground system is free from those contingencies. It is costly, of course, at the beginning, but as it secures greater efficiency in the conduct of the service and, at the same time, safeguards the Company against serious risks, such as damage to the property from snow storms, and dislocation of the service, we have come to the conclusion that the sooner we can substitute the one system for the other the better will it be for the public and for the Company. The matter is important as showing that, by the march of experience, the thing is being better understood. It is almost impossible to realise that this most intricate most delicate, and most wonderful machinery in the air, and as you see it in the streets, exists on sufferance. The Company have no powers of any sort or kind. We have to find our way the best way we can. That would be bad enough, but in pointing out to public bodies, in different places, the importance of having an efficient service we have sought, from time to time, to convince them that if there were reasonable concessions on the part of those bodies to enable us to spend our money to put the cables—the principal part of the machinery—under the streets, it would be in the interests of the general public as much as in the interests of the Company. Well, happily the difficulties originally experienced in that direction have to a great extent been overcome, owing to the energy and patience of the directors and officials of the Company, and you see that some of the more important centres have been enlightened enough to listen to arguments and to enable us, upon something like reasonable terms, to carry out those transformations in these great centres. The result is that the moment these works are finished there is a very perceptible improvement in the service, and an immediate decrease of the actual ground for complaint. Well, I suppose the example is catching, and although we have not been successful everywhere, we have been successful, as you see, in a great many important places. We have to pay the great Corporation of Manchester the compliment of admitting that they were the first to realise that their duty was not to us, but to their public, and several other places have followed suit. There are now many places where we are suffering greatly from the want of these facilities. London is one of them, and we are not without hope that London will follow the lead of Manchester, and other great towns, in view of the great and growing importance of this service, and that they will grant these reasonable facilities, without which it can never be made perfect. As to the accounts for the half-year, we generally, at the end of December, deal with them for the year, for the reason that the half-yearly accounts, taken separately, do not, with sufficient accuracy, reveal all the facts. For the December half-year we had a much more serious audit, and the accounts are brought up to date, so that the result of the year is really a safer indicator of the position of the Company than if the half-year was taken separately. I want to tell you what we have done during the entire year, 1897, and I am only telling you what you can find for yourselves, because on the second page of the report you will find an exhaustive statement of everything appertaining to the business. Between Dec. 31, 1896, and Dec. 31, 1897, there has been an increase of £113,800. We have paid the Post Office in Royalties £89,238, being an increase of about £10,000 over the corresponding year; the net income has increased by £103,800; and the working expenses have increased by £74,900, which, I confess, is rather a larger proportion of the gross income than is quite agreeable, although, if challenged, we should be able to defend it. It is abnormally large, arising from circumstances affecting those two years, and I hope it will not be taken to be quite normal. The net result for the year shows an increase of £28,929. You get your full dividend for the whole year and £40,000 is carried to reserve. That being so, let us see what we have done for all this expenditure and all these subscriptions. One is obliged year after year, half-year after half-year, to repeat the oft-told tale. There are two things in the world: there is the fact about a thing and the illusion about it. A great many people will live in illusions. One is constantly being told how bad the service is, how costly it is, how extravagant the whole foundation is, and how much better it can be done by other people, and they justify the statements by certain figures. Well, I do not know, but I suppose an ounce of fact is worth a great deal of the other thing, and our figures are eloquent. Either we must be living in perfect illusions, and must be absolutely, densely ignorant of what we have to do, or else the other gentlemen outside must be somewhat ill-informed. I am afraid they are ill-informed. The popular theory is that in London you can get a magnificent telephone service for a capital outlay of about £20, and in the country for five or six pounds. Well, that is not our experience, and we have had now a good deal of experience in the working of this business. In the year we have increased our subscribers' wires in London by 2,671—and, after all, wire is a factor. In all the other centres of the United Kingdom the increase has been 9,110. That makes a total increase in the year of 11,781 exchange wires, and that brings the total, on December 31st last, up to the respectable number of 17,371 wires in London, and of 88,817 in all the other places, or a total of 106,188. That seems a satisfactory progress. It is 18 per cent. in London and 11·43 in other places, or 12·48 upon the mean. Now, this is the nut we have to crack: What does it cost to do this? Here are the figures for which we are responsible, and you must remember that our general manager and district managers and engineers are a qualified scientific staff. They know what they are doing. The 1,219 wires in London cost in actual cash, £53. 12s. 8d. apiece to erect them, and the 4,414 in the country £45. 16s. each—and, mind you, that money has all to be found and buried in the earth, or put into the air, before you get a sixpence of return upon it. Now, what becomes of those fallacies we have drummed into us by a great many people—adventurous persons—and what is more singular, by reputable organs which direct the public intelligence. These figures cannot be controverted, but they are inconvenient for certain people. Now, as to the awful rapacity of this Company in regard to its charges. What do you think the charges really are upon the year? People say: "Oh, they charge £20 in London—what a shameful thing! They charge everywhere else £10 whereas you should have it for £5." Now, these are the facts: the average subscription in London for the whole year is £14. 10s. 6d., and in the country £8. 10s. 10d. That does not seem to be such a very extravagant charge in any case, nor is the disproportion in London so great as they make it out to be, when you consider that London costs £53. 12s. 8d. each wire, and more to work, as against the cost in the country of £45. 15s. The fact is, we want four or five years' subscriptions in hand to pay the first actual cost before a single telephonic message can be sent. Then about the costliness of it—we have had it over and over again. Anybody can use the telephone and talk a hundred words for something under one half-penny, and he can enjoy that blessing every hour of the day and through the night for 6d. Now what is 6d. per day? That is what it comes to, and yet people keep up all this hubbub about it. Remember that these two sums of £14. 10s. 6d. and £8. 10. 10d. are subject to a very large tax. The Post Office royalties, you see by the accounts, came to no less than £89,000 of hard-earned sovereigns. What would be the effect now if the Chancellor of the Exchequer could be persuaded to forego the royalties. Well, it would have the effect of taking £1. 12s. 10d. off the London subscription, and thereby reduce it to a shade over £12, and it would take 18s. 2d. off the subscriptions in all other places. All that is conveniently ignored, and we are told that we should go to Stockholm or Norway, or some remote parts of the world for parallels. Really, one has dwelt upon this matter so often that it seems rather like beating a dead horse to talk about it any more. Circumstances have changed which have seriously affected the comparison for the whole year, because in the year ended December, 1896, we had some portion of the trunk revenue, whereas that trunk revenue has entirely disappeared in the year ended December 31st last. We have, however, made up the loss sustained, which is a considerable figure. I do not know whether the substitution of the dual system for our old one has improved the general convenience. In some places it has, but in other places we hear complaints that it is not quite so good as it used to be when the Company were the sole workers of it. Of course there is now a multiplication of delicate operations, any one of which may fail and cause inconvenience or delay. I now beg to move:—

"*That the reports and accounts be received and adopted, and that dividends be paid for the six months ended December 31st last at the rate of 6 per cent. per annum, less income tax, on the amount paid up on the first and second Preference shares; at the rate of 5 per cent. per annum, less income tax, on the amount paid up on the third Preference shares; and at the rate of 6 per cent. per annum, free of income tax, on the amount paid up on the Ordinary shares.*"

Lord HARRIS (the Vice-President) seconded the motion.

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Mr. A. H. HASTIE thought they had a most excellent telephone service in London now. The present working of the trunk line service was, however, abominable. It was not anything approaching what existed in a fifth-rate State. For years the Post Office had been putting up posts and wires between London and Brighton, but the work still dragged on, and meanwhile the service between London and Brighton was conducted on a single wire. It had taken him an hour or two from the Bedford Hotel to get a trunk connection, and he had seen others similarly delayed. The people he complained of were the permanent officials at the Post Office, with £1,500 a year. He did not know whether they were incompetent or not, but his opinion was that they were about as fit to manage the telephone service as a jackass was to drive a London and North-Western Railway Company's engine. He concluded by suggesting that doctors should be offered the service at private-house rates.

The CHAIRMAN: We are very much obliged to Mr. Hastie for his remarks about the Post Office, but he must remember that our position is a delicate one. We are, in fact, the servants of the Postmaster-General. We are part of the Department, and I am afraid the disadvantages of a dual control we all feel. I live at Brighton myself sometimes, and it costs me some considerable trouble to get the telephone up to my house for the winter. I have given up the idea of "trunking." I have never been able to get it under one and-a-half hours and, sometimes, when greatly pressed, it has been two hours. I need hardly say the character of my business would not allow of the amount of patience and waiting involved in that. I do not know whose fault it is, but I have some sympathy with the Post Office, and I am not prepared to accept, from my knowledge of the permanent officials, the sweeping criticisms which our friend has made. They are the victims also of dual control. Do you suppose the officials of the Post Office can do what they think is necessary for the conduct of the telephone and telegraph? Not at all. They are dominated by another department who have other considerations to dominate them—the Treasury. We are under the Post Office, and the Post Office are under the Treasury, and there is no alternative but to submit. I suppose it is in the nature of the case that it should be so, and they do not care 2½d. for the interest of any telephone subscribers or the Company. They have to look at the thing from a totally different point of view. I agree it might be possible to improve the trunk wire system very much indeed. I am bold enough to say if we had been left alone with the trunk wire in our possession "trunking" now would have been a very different thing from what it is. The question of treating doctors as private rate subscribers shall be taken into consideration. They were a privileged class for some time, but then that excited jealousy amongst lawyers and others. I think, however, there is something to be said for the doctors, and the suggestion shall have attention.

The resolution was then agreed to unanimously.

On the motion of Mr. Campbell, seconded by Colonel Mitchell, a vote of thanks was accorded to the President and Board of Directors, and to the staff, which was briefly acknowledged, and the proceedings terminated.

Northampton Electric Light and Power Company (Limited).

The ninth annual report of the Directors of this Company states that, notwithstanding several adverse circumstances, the Company's progress has been satisfactory. The engineers' strike occasioned much delay and inconvenience, but no mishap occurred during the busiest season. The report refers to the arbitration with the gas company on the question of the removal or alteration of gas service-pipes which interfered with the construction of this Company's culverts. This, as reported in *The Electrician* of December 24th last, resulted in the Company obtaining the facilities asked for, but at the expense of valuable time and a resulting loss of revenue. The new system of charging for current has been much appreciated, and will conduce to the advantage of both the Company and its customers. The special rebate to consumers during the past year has amounted to £488. The immediate result of this is a loss of income, but the use of electricity for lighting and motive purposes has been so popularised that the tendency cannot be otherwise than beneficial. The ordinary charge for current is 8d. per unit (less special rebate), for places of worship 4½d., and for motive power 3½d. Discounts are also allowed.

Further developments are taking place at the Company's works. In addition to the two new engines and dynamos referred to in the last report, one more engine of 240 H.P. has been erected with dynamo complete, making in all six engine and dynamo sets. There has also been fixed a new boiler of a capacity equal to all the three original boilers combined, with an economiser and other subsidiary machinery. Further land and buildings have been acquired and an additional boiler-house has been erected, with a storage tank capable of holding 33,000 gallons of water. A supplemental accumulator battery has been added. The system of supply will be changed over during the present year from two to three-wire, thereby securing greater efficiency and economy. In view of the increasing demand for current further plant has been ordered, consisting of boiler, engine and dynamo, all of large capacity. The mains have been extended in several directions during the year. The machinery has been maintained in a high state of efficiency.

The balances of the revenue accounts for the past seven years are shown as follows:—

	1891.	1892.	1893.	1894.	1895.	1896.	1897.
Loss	£460...	*Profit* £308...	£536 ...	£762 ...	£819 ...	£1,351 ...	£1,409
		Less depreciation		£100 ...	£250 ...	£500 ...	£500
				£662	£569	£851	£909

The equivalent 8-c.p. lamps in use during five years have been 4,600, 5,300, 6,130, 8,014, and 11,084 respectively.

After paying interest on debentures and temporary loans, to the end of last year, there remains £562. 13s. 11d. to be dealt with. It is proposed to pay a year's dividend on all the shares for the year to Dec. 31 last, including 2 per cent. on the Ordinary shares, leaving £64. 10s. to be carried forward.

Further shares were issued last year, viz., 710 Ordinary shares and 3,000 Five per Cent. Preference shares, the total debenture issue not being increased. It is proposed to issue 4,290 further Ordinary shares at par, and also to raise £3,950 in Four per Cent. Debentures, which will be issued at a small premium.

Charing Cross and Strand Electricity Supply Corporation, Limited.

The following is the report of the Directors of this Company, for the year ended December 31st last.

The business of the Corporation has been of an exceedingly satisfactory character. There has been connected up to the mains the equivalent of 34,078 lamps, an increase of 53·7 per cent. on 1896. During the past year, 6½ miles have been added to the mains laid in the combined areas. The combined output in units from the Corporation's stations has increased by about 33½ per cent. for the year 1897 over 1896. The station buildings which have been in course of erection on the wharf at Commercial-road, will shortly be completed. The Directors have obtained consent from the St. Giles and Holborn District Boards of Works to applications being made to the Board of Trade for Provisional Orders for those districts, and the applications are now before the Board of Trade, and, if granted, application to Parliament will be made in due course to confirm the Orders.

The net earnings have amounted to £18,907. 2s. 11d., £491. 10s. 8d. has been paid for income tax, £3,648. 10s. 4d. has been paid in respect of interest on Debentures and temporary loans up to December 31st, 1897, and £4,500 was distributed in payment of an interim dividend at the rate of 6 per cent. for the half-year to June 30, 1897. £10,267. 1s. 11d. remains, which, added to the undivided profit of £2,997. 1s. 8d. from last year's account, makes £13,264. 3s. 7d., which the Directors propose to deal with as follows:—Dividend on 4½ Preference shares apportioned to Dec. 31, £4,249. 5s. 3d.; dividend at the rate of 8 per cent. for the half-year ended Dec. 31 on the Ordinary shares, making with interim dividend 7 per cent. for the year, £6,000; carried forward, £3,014. 18s. 4d.

India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.

The following is the Directors' report for the year to December 31st last:—

After provision for doubtful debts, a net profit for the past year of £41,044. 14s. 9d. is shown. Adding £22,128. 6s. 4d. brought forward, and deducting £12,500. interim dividend paid in July, there remains a disposable balance of £50,673 1s. 1d. The Directors recommend the distribution of 15s. a share, free of income tax, amounting to £37,500, making, with the interim dividend paid in July, a total payment of 10 per cent. for the year, and leaving £13,173. 1s. 1d. to be carried forward.

There has been little cable work during the year. The Company's general business has steadily increased, and the steamships have been moderately. The factories at Silvertown and Persan are in a high state of efficiency. There was a six months' strike in the engineering departments at Silvertown, which caused some inconvenience and expense, but did not greatly affect the Company's business. The block of buildings in which the Melbourne Agency was situated was burnt out on the November 21st. Other premises have been taken and new stock has been sent out.

NEW COMPANIES, STATUTORY RETURNS, &c

BERRENBERG ELECTRIC LAMP SYNDICATE (LIMITED).—This Company was registered on February 11th, with a capital of £10,000 in £1 shares (of which 100 are Founders'), to enter into an agreement with Adolph Berrenberg, and to acquire, devolop, work, and deal with any patents, patent rights, and inventions relating to the manufacture of electric lamps and other electrical apparatus. The first subscribers, with one share each, are: G. H. Brougham Glasier, A. Halford, J. Howard, Adolph Berrenberg, R. J. Preston, W. J. Collyer, J. S. Glass.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS COMPANY (LIMITED).—This Company was registered on Feb. 5, with a capital of £850,000, divided into 40,000 "A" Preference, 30,000 "B" Preference, and 100,000 Ordinary shares of £5 each, to enter into an agreement with the Buenos Ayres and Belgrano Tramways Company (Limited), and to construct, purchase, take on lease, or otherwise acquire, work and develop in the Argentine Republic or elsewhere in South America, any tramways, light railways, rolling stock, cars, omnibuses, engines, electrical and other plant, machinery, rails, stores, &c. The subscribers are: H. Dixon, jun., G. Proctor, P. H. Lyne, A. S. Farmer, B. J. Tunbridge, B. G. Gouk, and E. Temple.

DENNELLE AND COMPANY (LIMITED).—This Company was registered on February 10th, with a capital of £10,000 in £1 shares, to carry on the business of French art metal workers, brass or metal founders, metal chasers, silk shade makers, manufacturers of wires and cables, electricians, suppliers of electricity, &c., and to carry on the general business of an electric light company. The first Directors are: Charles M. Escaré and Robert T. Smith.

ELECTRICAL INVENTIONS MANUFACTURING COMPANY (LIMITED)—This Company was registered on February 12th, with a capital of £5,000 in £1 shares, to enter into an agreement with James Moores and Henry O.

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Farrell, electrical engineers, of Manchester, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, electrical apparatus manufacturers, machinists, wire drawers, &c. The first subscribers are: Henry O. Farrell (electrical engineer), C. H. Cox, J. W. Bennett, J. W. B. Lockwood, James Moores (electrical engineer), J. Woods, M. H. Barber (electrical engineer), and S. E. Linsell (electrical engineer. The first Directors are: James Moores and Henry O. Farrell.

GAS AND ELECTRIC LIGHT CONSUMERS' PROTECTION ASSOCIATION (LIMITED).—This Company was registered on Feb. 14, with a capital of £1,000, in £1 shares, to establish and carry on a system of periodical inspection of the registering index of electric light and gas meters.

LA CAPITAL (EXTENSIONS) TRAMWAYS COMPANY (LIMITED).—This Company was registered on Feb. 7, with a capital of £100,000, in £1 shares, to acquire the benefit of a certain tramway concession for the construction and working of tramway lines in the city of Buenos Ayres to Mataderos, to undertake and work such tramways by electrical or other power, and to carry on the business of an electric light and power company.

PERTH TRAMWAYS (LIMITED).—This Company was registered on Feb. 4, with a capital of £125,000, in £1 shares, to acquire, work, and deal with any concessions, rights and privileges granted for the construction and laying down of tramways in the City of Perth, Western Australia, and elsewhere, and to equip, maintain and work by electricity, or other mechanical power all the tramways owned or leased by the Company. The subscribers, each with one share, are: E. Pope, J. Doyle, Sir James D. Mackenzie, Bart, G. T. Bean, Henry J. Dixon, J. Daynes, and F. R. Wolseley.

SELF-CHARGING ELECTRICAL TRACTION COMPANY (LIMITED).—This Company was registered on February 10, with a capital of £100 in £1 shares, to acquire, work and deal with any patents relating to the production, storage, application, distribution and use of electricity, and particularly in relation to the use of electricity for the purpose of the propulsion of vehicles, and to carry on the business of mechanical engineers, machinists, &c.

AFRICAN TRANSCONTINENTAL TELEGRAPH COMPANY (LIMITED).—The annual return to Dec. 27 states that the whole of the nominal capital (£140,000 in £1 shares) has been taken up. The full amount has been called, resulting in the receipt of £116,450, and leaving £23,550 in arrears.

AMAZON TELEGRAPH COMPANY (LIMITED).—The annual return to Jan. 13 has been filed. The whole nominal capital of £250,000 in £10 shares has been taken up and paid for in full.

AUTOMATIC ELECTRIC RAILWAY SIGNAL COMPANY (LIMITED).—The annual return to Dec. 8 has been filed. The capital is £10,000 in £1 shares, of which 5,940 have been taken up; 4,300 are considered as fully paid.

ELECTRICAL COPPER COMPANY (LIMITED).—The annual return to Jan. 12 states that out of a capital of £500,000 in £1 shares (of which 150,000 are Preference), all the Ordinary have been issued as fully paid, and £1 per share has been called on the others.

LONDON ELECTRIC OMNIBUS COMPANY (LIMITED).—The annual return to Jan. 13 has been filed. The capital is £250,000, in £1 shares (of which 80,000 are Deferred). All the Deferred and 17,818 Ordinary shares have been taken up, and the former have been issued as fully paid; 19s. 6d. per share has been called on the Ordinary, and £33,274. 2s. 6d. has been received (including £17. 15s. paid in advance), £15,500. 9s. is in arrears, and £16,520. 8s. 6d. has been received in connection with the forfeiture of 32,189 shares.

THOS. G. POOLE (LIMITED).—The statutory return to Dec. 27 has been filed. The capital is £3,000 in £1 shares. 507 shares have been taken up, and all are considered as paid.

THOMPSON, RITCHIE AND COMPANY (LIMITED).—The annual return to January 7 has been filed. The capital is £5,000 in 200 Preference and 300 Ordinary shares of £10 each. 200 of the former and 140 of the latter have been taken up, and 100 Preference and 70 Ordinary have been issued as fully paid. The full amount has been called on the remainder.

TOWNSEND, TAMPLIN AND MAKOVSKI (LIMITED).—The statutory return to January 4 has been filed. The capital is £20,000, divided into 1,000 "A" and 1,000 "B" shares of £10 each. 350 of the former and 416 of the latter have been taken up, and 401 of the "B" shares have been issued as fully paid. The full amount has been called on 350 "A" and 15 "B" shares.

VENTNOR ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return, to Nov. 8 last, has been filed. Seven shares have been taken up out of a capital of £10,000, in £5 shares, but no calls have been made.

WESTINGHOUSE ELECTRIC COMPANY (LIMITED).—The annual return to Dec. 23 has been filed. The capital is £600,000, in £10 shares (of which 30,000 are Preference). 18,955 Preference and 27,500 Ordinary have been taken up, 15,800 of the former and all the latter have been issued as fully paid, and the full amount has been called on the remainder.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 25⅛d. per oz. (Feb. 17). Consols (2¾ per cent.) 112½—112¾ for money, 112⅝—112¾ for account; 2¾ per cent. 105¾—106¼ (Feb. 17). Stock Exchange Settling Days: Consols, March 1; Stocks and Shares Continuation Days, Feb. 22 and March 9; Ticket Days, Feb. 23 and March 10; Pay Days, Feb. 24 and March 11; Mining Share Carry-over Days, Feb. 21 and March 8.

BELFAST STREET TRAMWAYS COMPANY (LIMITED).—At the half-yearly meeting of this Company on Friday last, the Chairman (Mr. G. Richardson) announced that the negotiations with the Corporation for the introduction of electric traction had not produced any result. If the Company could get an extension of their lease, or make other equitable arrangements, they were quite willing to adopt electricity as the motive power.

BORDEAUX TRAMWAYS AND OMNIBUS COMPANY (LIMITED).—Dividends of 5s. per share on the Preference and 10s. per share on the Ordinary shares, free of income tax, have been declared payable on and after March 10th.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend at the rate of 6 per cent. per annum on the Preference shares for the half-year to Dec. 31, payable on the March 15.

CICERO AND PROVISO STREET RAILWAY COMPANY.—During the week applications have been invited by Messrs. Van Oss and Co. for $1,700,000 Five per Cent. Consolidated Mortgage Gold Bonds of this Company, which operates about 28 miles of electric tramway in the towns of Cicero and Proviso, U.S.A. The bonds are redeemable on May 1, 1915, and the principal and interest are guaranteed by the West Chicago Street Railroad Company.

CITY AND SOUTH LONDON ELECTRIC RAILWAY COMPANY.—This Company has, it is stated, privately circulated a prospectus inviting applications for 22,500 shares of £10 each, in order to provide the capital required for the completion of the extensions to Finsbury-pavement and Clapham Common.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The Directors of this Company have decided, subject to audit, to recommend to the shareholders the payment of the following dividends: 6s. per share on the Preference shares for the six months to December 31 last, making 6 per cent. for the year; £1 per share on Ordinary shares, Nos. 40,001 to 80,000, and 10s. 7d. per share on Ordinary shares, Nos. 80,001 to 90,000 (equal to 10 per cent. for the year ended December 31, 1897. Both dividends are payable on the March 3.

COVENTRY ELECTRIC TRAMWAY COMPANY.—The half-yearly meeting of this Company was held at Bank-buildings, London, E.C., on Wednesday. The Chairman (Capt. Francis Pavy) stated that the nominal capital of the Company was £112,000, of which £96,000 had been subscribed, and 50 per cent. paid thereon. The existing Company was in liquidation, for the purpose of being amalgamated with and taken over by the company incorporated in 1897. The contract for the construction of the new portion of the tramway had been given to Messrs. Pauling and Co, Victoria-street, and the work was to be pushed on and completed as rapidly as possible. The traffic receipts on the existing electric tramway lines showed an improvement as compared with the previous year.

EASTERN TELEGRAPH COMPANY (LIMITED).—Mr. H. C. Fischer, C.M.G., late Controller of the Central Telegraph Office, has been appointed by the Directors of this Company to a seat at the Board.

EDISON ELECTRIC ILLUMINATING COMPANY OF NEW YORK.—The report just to hand of this Company states that during the past year the gross earnings amounted to $2,466,255.71 against $2,222,757.06 in 1896; the total expenses amounted to $1,369,138.85 compared with $1,280,518.98 in 1896; the total nett earnings for the past year amounted to $1,117,497 against $966,380 in the previous year; the station earnings show an increase in gross of 11 per cent. and in nett. of 16 per cent.; the ratio of operating expenses, including both station and general expenses, but not depreciation charges, to gross station earnings is 49·5 per cent. against 52 per cent. for the previous year. The following table shows the number of customers of the Company, the lamps connected, &c.:—

	Dec. 31, 1897.	Dec. 31, 1896.	Increase.
No. customers	8,711	7,898	813
No. incandescent lamps	382,291	309,369	72,922
No. arc lights	7,201	5,559	1,642
No. motors, H.P.	19,380	15,953	3,427
Total equivalent, 16 c.p.	756,438	613,991	142,447

The report states that the adoption of the enclosed arc lamp has greatly stimulated arc lighting on the low-tension system, the number of low-tension arc lights having increased during the year from 3,225 to 4,775. The Company will shortly offer to the stockholders the privilege of subscribing for $1,200,000 of Treasury stock, in order to provide for extensions of the plant necessitated by the growth of the business.

ELECTRICAL COPPER COMPANY (LIMITED).—Baron E. Leonino, of Paris, and Sir Edward Albert Sassoon have been elected Directors of the Company.

GREAT NORTHERN TELEGRAPH COMPANY.—The coupons falling due on March 1st, on the Company's 1883 (Series B) debentures should be presented for payment at the offices of Messrs. C. J. Hambro and Sons, 70, Old Broad-street London.

LEGAL NOTICE.—An advertisement in another column gives particulars of the order made on the 5th inst. in the High Court of Justice by Mr. Justice Romer in the matter of the House-to-House Electric Light Supply Company (Limited), and the reduction of the capital of the Company from £200,000 to £199,500, consequent upon the extinguishment of the Founders' shares.

METROPOLITAN ELECTRIC SUPPLY COMPANY (LIMITED).—A meeting will be held to-day (Friday) at Winchester House, Old Broad-street, London, E.C., at which a resolution will be proposed approving a Bill "to empower the Company to use lands at Acton-lane for the purpose of their undertaking, and to lay certain cables or wires in streets and along the Grand Junction Canal, and for other purposes."

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NATIONAL ELECTRIC SUPPLY COMPANY (LIMITED).—The general meeting of the Company was held at Preston last week. In moving the adoption of the report, the Chairman (Mr. E. H. Booth, J.P.) said that nearly four miles of additional mains had been laid and £4,560 spent on capital account. An alternating current plant had been put in for the purpose of supplying the outlying districts. An equivalent of 5,000 8 c.p. lamps had been added during the year. The expenses incurred in the reduction of capital had been charged to revenue account. They had 9,050 shares unissued, and future issues would be at a considerable premium. He hoped the Company would be enabled to materially reduce the price of current, but this would greatly depend upon support received. The report was adopted, and a dividend of 5s. per share declared on Ordinary shares.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY (LTD.).—The report of the Directors of this Company for the past year states that the supply of current continues to give satisfaction, and the units sold were more than five times the quantity sold in 1890, the first year of the Company's operations. The lamps connected to the mains now represent a total of 32,600 8 c.p. The gross earnings amount to £5,684, and after paying interest, and providing for depreciation and reserve, the Directors recommend a dividend of 5 per cent. for the half-year, making (with the interim dividend) 7½ per cent. for the year.

NEWCASTLE ELECTRIC SUPPLY COMPANY (LIMITED).—The tenth annual general meeting of the shareholders of this Company was held on Thursday last at Newcastle-on-Tyne. The report and accounts were unanimously adopted, and a dividend at the rate of 7 per cent. for the year was declared, on account of which an interim dividend at the rate of 5 per cent. was paid in July last.

NEW ZEALAND.—A *Times* correspondent states that Messrs. Horn and Bakewell left by the "Orizaba" for London to place the Great Western Railway and Electric Power Company before English capitalists. The Company possesses valuable concessions of land, together with the right to construct a railway connecting Hobart with the Mount Lyell and Zeehan district, in Tasmania.

PACIFIC AND EUROPEAN TELEGRAPH COMPANY (LIMITED).—The Hon. A. G. Brodrick has been elected a Director of this Company.

PAISLEY TRAMWAYS COMPANY.—At an extraordinary general meeting of this Company, on Tuesday, resolutions were adopted empowering the British Electric Traction Company (Limited) to introduce electric traction on the tramways, and to extend the system if thought desirable.

PONTYPOOL ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual report of the Directors of this Company states that since the last report the contract with Mr. J. C. Howell for the running of the station has been terminated, and since March 31st last it has been run by the Company itself, with the result that a considerable saving has thereby been effected; but of the £164. 9s. 5d. debited to the revenue account as having been paid to the contractor for the first quarter's running, £40. 5s. 6d. is in respect of the previous year. During the year the Directors have expended £607. 16s. in "free wiring," which has yielded a satisfactory return, the additional customers thus brought in having put the Company on a most satisfactory profit-earning basis. To meet this increased capital expenditure, they made a second issue of debentures to the extent of £500; but there is still a balance to the debit of capital account amounting to £549. 9s. 6d. During the next year increased plant must be provided to meet the growing demands upon the station, and in order to find the necessary capital to do this and pay off the existing debt, the Directors propose raising a loan large enough to pay off the present debentures, and find such further capital. The running of the station for the year ended December 31st, after carrying a sum £100 to renewal account, has resulted in a net profit, which, with the balance carried forward from last year, amounts to £286. 4s. 5d., out of which the Directors recommend that a sum of £50 be carried to the reserve account, that a dividend of 4 per cent. be paid upon the paid-up capital of the Company, and the balance of £26. 11s. 8d. be carried forward to next year.

SCARBOROUGH ELECTRIC SUPPLY COMPANY (LIMITED).—The Directors' report for the past year state that the Company continues to make satisfactory progress; 32 new customers and the equivalent of 2,340 additional 8-c.p. lamps have been connected to the Company's mains during the period under review, making a total of 330 customers and 20,067 8-c.p. lamps connected at the present time. An additional 150-kilowatt set of generating plant has been ordered, but owing to the recent strike has not yet been delivered. 214,044 units were supplied to customers, at a revenue (including meter rent) of £5,179. 13s. 9d., against 179,360 units and £4,383. 5s. 11d. revenue for 1896. The profit on the year's working amounted to £2,044. 13s. 0½d., against £1,617. 8s. 8d. in 1896, and after adding the balance of £191. 19s. 5d. from previous year there is a sum of £1,845. 1s. 9½d. available for distribution. The Directors recommend a dividend of 5 per cent., which will absorb £1,656. 10s., leaving £188. 11s. 9½d. to be carried forward. £100 has been written off preliminary expenses account (which is now extinguished), and £250 has been put to depreciation account, and £70. 1s. 2d. has been written off furniture and fittings.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed Wednesday, the 23rd inst., a special settling day in 285,157 Vendors' (£1 fully-paid) shares (Nos. 1 to 285,157) of the Cape Electric Tramways (Limited), the Provisional Certificates for a further issue of 10,000 Ordinary shares of £10 each (£2 paid, Nos. 90,001 to 100,000) of the City of London Electric Lighting Company, a further issue of 8,657 Seven per Cent. Cumulative Preference shares of £2 each (fully-paid, Nos. 16,344 to 25,000) of the Electric Construction Company, and 150,000 Six per Cent. Cumulative Preference shares of £1 each (fully-paid, No. 1 to 150,000) of the Electrical Copper Company.

The Committee has also ordered the further issue of 5,072 Ordinary shares (Nos. 14,929 to 20,000) of the Barcelona Tramways Company (Limited), and the Provisional Certificates for the further issue of 10,000 Ordinary shares (£2 paid, Nos. 90,001 to 100,000) of the City of London Electric Lighting Company (Limited), to be quoted in the Official List.

The Committee have been asked to appoint a special settling day in 100,000 shares (Nos. 1 to 100,000) of the National Electrical Free Wiring Company (Limited), and to allow 4,666 Vendors' Ordinary shares (Nos. 1 to 4,666), 3,333 Vendors' Six per Cent. Cumulative Preference shares (Nos. 1 to 3,333) and the further issue of 8,000 Ordinary shares of Babcock and Wilcox (Limited), and 17,400 Ordinary shares (Nos. 1 to 17,400) of Edmundson's Electricity Corporation (Limited) to be quoted in the Official List.

SWANSEA TRAMWAYS COMPANY.—The undertaking of this Company has been acquired by the British Electric Traction Company.

TRAMWAYS UNION COMPANY (LIMITED).—At the annual general meeting of this Company, on Tuesday, the Chairman (Mr. E. M. Underdown, Q.C.) asked the shareholders to consider the report more in the sense of a description of the Company's doings during a period of transition. The step that had been taken at one of their stations was an extremely important one, and in all probability the portion of the system that was intended to be worked by electricity would be in full operation in June next. If, as he had not the slightest doubt would be the case, the results of the new mode of traction proved more satisfactory and gave increased receipts, that increase would come into the accounts for the remaining half of the current year. After explaining the present position of the Madrid lines, and the progress that had been made with the work of conversion, Mr. Underdown went on to say that in Montreal the gross receipts had increased since 1892 (when horses were employed) by 60 per cent., and the net profits had risen from £20,000 to £110,000 in 1897. At Rouen, where there were sharp gradients in the roads—and, in point of fact, under the horse system the tramway traffic was practically paralysed—no sooner was electric traction adopted than they found the net earnings increase from £7,000 to £30,000. In Brisbane, where the works were not yet completed, there also was an increase of 100 per cent. in the gross earnings. As regards conversion from one system to the other, at Hamburg, where no dividend was paid on the Ordinary shares of the Tramways Company under the old horse system, now 10 per cent. was being paid on a largely increased capital, and the Ordinary shares stood at something like 150 per cent. premium. They were establishing electric traction on the very best system at Madrid. They had taken the precaution of engaging the very best technical assistance that could be obtained, and they were satisfied with the services that had been rendered by their engineers, Messrs. Alfred Dickinson and Co. Their capital had been increased by the issue of £150,000 Five per cent. B Debentures.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Feb. 11 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,146.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Feb. 12	3,518	+288	...	...	...
Bristol Trams & Carriage	„ 11	2,296	+175	6	14,125	+ 2,709
City & South London Ry.	„ 13	1,058	- 4	7	7,514	- 159
Dover Tramways	„ 12	105	...	23	2,574	...
Dublin United (Southern)	„ 11	375	-58	6	2,478	+ 15
Liverpool Overhead Rly.	„ 13	1,380	+161	7	9,510	+ 689
Sheffield Tramways	„ 13	967	+ 89	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price	Price Wednesday, Feb. 16.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 12. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	3/0	Central London Ordinary	9¾ 10½	10⅝ 11	2 14 1	June and December	10 7/8	10 7/8
143,706	10	1/9¾	Do. (£6 paid)	5⅝ 3⅝	6⅛ 7	2 11 6	„ „	6⅛	6 7/8
£630,000	Stock	1¾%	City and South London Railway Con. Ordy. ...xd	69 71	69 70	2 13 7	January and July	70⅛	70
8,419	£10	5%	Do. 5% Perpetual Preference .....xd	15 16	15 16	3 2 6	„ „	15⅝	...
£135,701	Stock	4%	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	138	137
54,000	10	2/8¾	Waterloo and City Ordinary	13½ 14	13⅝ 14¼	2 2 1	June and December	14	13⅞
57,500	10	3½%	Liverpool Overhead Railway Ordinary ....xd	11½ 11⅝	10 13/16 11 1/16	2 14 2	February & August	–	–
10,000	10	5%	Do. 5% Preference .....xd	16 16½	15½ 16½	3 1 6	„ „	–	–
125,000	Stock	4%	Do. 4% Debenture	108 110	108 110	3 11 5	January and July	–	–

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Feb. 9.	Price Wednesday, Feb. 16.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 12. Highest	Lowest
			TELEGRAPHS			£ s. d.			
£923,960	Stock	19,6	Anglo-American ..... xd	62 64	61 63	4 15 3	Feb., May, Aug., Nov.	63⅝ ..	..
£3,038,020	Stock	39/0	Do. Preferred	112½ 113½	111 112	5 7 2	" "	113⅝	111½
£3,038,020	Stock	5/0	Do. Deferred	13¼ 13⅝	12⅝ 13⅛	—	—	13⅛	13⅛
£137,400	£100	4%	*African Direct Telegraph (Red)	100 104	100 104	3 16 11	January and July ..	—	—
£25,000	10	..	Amazon Telegraph	6 7	6 7	..	—	..	..
130,000	10	3/0	Brazilian Submarine	16⅝ 17½	16⅝ 17½	4 1 2	Mar., June, Oct., Dec.	17	16⅛
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112 116	112 116	4 6 2	June and December	..	—
1,000,000	$100	$2½	Commercial Cable Capital Stock	187 192	187 192	4 3 6	Jan., Apr., July, Oct.	197	—
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	106 108	106 108	3 14 1	" "	107⅞	108⅜
16,000	10	8/0	Cuba Submarine	8 9	8 9	8 17 10	February and August	8⅝	..
6,000	10	10%	Do. Preference 10 per Cent.	18 19	17½ 18½	5 8 1	" "	..	—
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October ..	—	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞ 106⅞	103⅞ 106⅞	4 4 11	January and July ..	—	—
60,710	£20	3/0	Direct United States Cable, 1877	10¾ 11½	10⅜ 11½	5 15 7	Jan., Apr., July, Oct.	11½	10⅞
400,000	£10	2/6	Eastern	18 18½	18 18½	3 10 3	" "	18⅜	18⅛
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference ..	19 20	19 20	3 0	" "	19 1/16	19
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131 134	131 134	2 19 11	May and November	133½	131½
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100 103	100 103	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension	18⅜ 19½	18⅜ 19½	3 13 8	Jan., Apr., July, Oct.	19½	18⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	130 133	130 133	3 0 2	February & August	—	—
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 ..	99 103	99 103	4 17 3	January and July ..	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900 ..	99 103	99 103	4 17 3	" "	101⅜	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102 105	102 105	3 16 2	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞ 111⅞	108⅞ 111⅞	3 12 1	May and November	0⅜	108½
180,227	10	1/9	Globe Telegraph and Trust	12 12½	12¼ 12⅝	3 14 6	Jan., Apr., July, Oct.	12⅝	12 3/16
180,042	10	6%	Do. 6 per Cent. Preference	17⅞ 18¼	18 18¼	3 4 10	" "	18 3/16	18
150,000	10	5/0	Great Northern of Copenhagen	27 28	27½ 28½	3 10 3	January, April, July	..	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B" ..	101 104	101 104	4 17 7	March & September	..	..
17,000	25	12/6	Indo-European	52 55	52 55	4 10 11	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	108 111	108 111	5 10 1	March & September	—	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105 108	105 108	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	8 9	8 9	4 8 11	April and October ..	—	—
3,381	£100 Cert.	6%	Submarine Cables Trust	140 145	140 145	4 2 9	" "	142	—
15,609	10	6/0	West African Telegraph	4 5	4½ 4¾	5 0 0	" "	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103 106	103 106	4 14 4	March & September	—	—
30,000	10	..	West Coast of America	¾ 1½	¾ 1½	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	106½ 107	105 107	3 14 9	June and December	—	—
88,321	10	1/0	West India and Panama	⅝ ¾	⅝ ¾	—	May and November	⅞	—
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7⅝ 8¼	8 8½	7 1 2	" "	8¼	7⅛
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5 7	5 7	8 11 5	" "	—	—
£30,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105 108	105 108	4 12 2	January and July ..	—	—
64,256	15	3/0	Western and Brazilian	10½ 11	10½ 11	2 14 10	May and November	10 1/16	10⅝
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7⅛ 8	7⅛ 8	3 15 2	" "	7⅜	—
33,129	7½	1/6	Do. Deferred Ordinary	3½ 4	3½ 4	..	" "	3 13/16	3⅝
£382,230	—	4%	Do. 4 per Cent. Debenture Stock	105 107	105 107	3 14 1	June and December	..	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105 110	105 110	6 7 10	Feb., May, Aug., Nov.	—	—
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	—	—
			TELEPHONES.						
44,030	£5	4/0	Chili Telephone (fully paid)	3 3½	3 3½	5 14 4	August	—	—
224,850	10/0	2¾d	Consolidated Telephone Const. & Maintenance ..	1/16 1/16	1/16 1/16	..	July	..	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference ..	2 2½	2 2½	8 0 0	October	..	—
484,597	5	3/0	National	6⅞ 7	6⅞ 7⅛	4 4 3	February & August	7	6⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15 17	15 17	3 10 7	" "	—	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid) ..	14 16	14 16	3 15 0	" "	..	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6 6½	6 6½	3 16 11	" "	6⅜	6 3/16
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104 109	104 109	3 4 0	June and December	106	104½
171,504	1	6/4	Oriental	⅜ ⅝	⅜ ⅝	6 13 4	April and October ..	⅜	—
58,000	5	5/0	United River Plate	4 4½	4 4½	5 11 1	July	—	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101 106	101 106	4 14 6	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.						
£150,000	5	4½%	Birmingham Electric Supply (fully paid)	1½ ..	1⅝ ..	—	March	..	—
£50,000	5	..	Do. (New Issue) £3, 10s. paid			..	..	..	—
50,000	£10	14/0	City of London Electric Lighting (fully paid) ..	28½ 29½	28½ 29½	2 7 5	February & August	29½	28½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17½ 18½	17⅛ 18⅛	3 4 10	January and July ..	18 1/16	17⅛
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129 134	129 134	3 14 3	June and December	132½	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp ..	14 15	14 15	2 3 6	February & August	14 7/16	14
20,000	5	2/3	Do. 4½ per Cent. Preference ..... xd	6½ 6¾	6 6½	3 9 3	" "	6 7/16	—
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	January and July ..	—	—
£26,000	5	2 6	Chelsea Electricity Supply Ordinary	11¼ 11¾	11⅜ 12⅛	3 1 3	March	11 1/16	11⅛
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	112 114	114 116	3 18 3	June and December	—	—
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	15⅜ 16⅛	15⅜ 16⅛	..	..	16⅛	15⅞
20,000	£10	6/0	Do. 6% Cumulative Preference	15⅞ 16⅛	15⅞ 16⅛	3 13 10	March & September	16 1/16	15 13/16
10,000	£5	..	House-to-House Electric Lighting Supply Ord. ..	10⅛ 11⅛	10⅛ 11⅛	..	..	10⅛	10¼
10,000	£5	7%	Do. 7 per Cent. Preference	11⅛ 12	11⅛ 12	2 18 4	March & September	—	—
111,000	£5	..	London Electric Supply Ordinary	4⅜ 4⅝	4⅜ 4⅞	—	—	..	—
48,050	£5	..	Do. Preference	6⅞ 7⅛	6⅞ 7⅛	..	..	..	—
49,900	10	5/6	Metropolitan Electric Supply Ordinary	20 21	20 21	2 12 4	April and October ..	20⅝	20⅛
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	19½ 20½	19⅛ 2⅛	..	" "	..	—
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117 121	117 121	3 13 6	June and December	..	—
6,452	10	8/0	Notting Hill Electric Ordinary	18 19	18⅛ 19⅛	2 1 0	March	—	—
275,000	1	..	Rand Electric	1½ 1⅝	1⅜ 1⅝	..	—	—	—
£125,000	Stock	5%	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90 95	90 95	5 5 3	..	..	—
150,000	$100	$2	Royal Electric Company of Montreal Shares ..	145 147	145 147	..	..	..	—
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105 107	105 107	4 4 1	April and October	..	—
19,980	5	11/0	St. James and Pall Mall Electric Ordinary .. xd	18½ 19½	18⅛ 19⅛	3 14 4	February & August	19⅛	18 13/16
20,000	5	3/6	Do. 7 per Cent. Preference	10 11	10 11	3 3 6	" "	10 1/16	10⅛
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	104 107	104 107	3 15 2	June and December	..	—
67,900	5	4/0	Westminster Electric Supply (fully paid)	18 19	18 19	3 3 2	March & September	18⅛	17⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	£3	5%	Brush Electrical Engineering	2⅛ 2⅜	2 2⅛	—	—	2 1/16	2⅛
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	5 1 1	—	2⅛	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109 113	109 113	4 0 9	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102 105	102 105	4 6 2	June and December	—	—
10,000	£10	..	British Aluminium Ordinary	— ..	— ..	—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference			..	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares ..	8½ 9½	9 10	5 0 0	June and December	9½	8⅞
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	108 111	109 112	4 1 1	" "	..	—
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	2½ 2¾	2½ 2¾	—	—	2⅜	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.) ...	86 91	86 91	5 6 5	January and July	—	—
99,261	5	1/6	Edison and Swan United ("A" Shares) (£3 paid). xd	2½ 3	2½ 3	5 10 0	February & August	2⅞	2⅝
17,139	5	2/6	Do. (£5 paid) ..... xd	4 5	4 5	5 10 0	" "	4⅛	—
£200,000	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.).....	103 105	103 105	3 16 2	June and December	..	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅞ 3	2⅞ 2⅞	3 13 1	February & August	2 15/16	2⅞
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½ 3⅝	3½ 3⅝	4 3 4	August	..	—
91,196	1	10/0	Elmore's Patent Copper Depositing	⅜ ½	⅜ ½	..	..	..	—
10,000	10	6/0	Henley's Telegraph Works Ordinary	22½ 23½	22½ 23½	4 5 1	February & August	23¼	22⅞
3,000	10	7/0	Do. 7 per Cent. Preference	19 20	19 20	3 10 0	" "	19½	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.) ..	110 115	112 117	3 18 5	" "	..	—
80,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	22 23	22 23	4 6 11	" "	22⅞	22½
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)..	103 107	103 107	3 14 9	March & September	—	—
£7,350	15	12/0	Telegraph Construction and Maintenance	39 42	39 42	4 2 5	March and July...	40⅜	39½
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102 106	102 106	4 15 3	January and July	—	—
£22,500	£5	3/6	Willans and Robinson Ordinary	8 8½	8 8½	4 2 4	April and October ..	8⅝	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	6½ 7¼	6⅞ 7¼	4 2 9	" "	7⅜	7¼
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.						

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NOTES.

A sympathetic gathering of Mr. F. H. Webb's well-wishers on his retirement from the Secretaryship of the Institution of Electrical Engineers was held on Monday evening last at the Whitehall Rooms of the Hôtel Métropole. About sixty of their intimate friends entertained Mr. and Mrs. Webb at dinner, after which the company were joined by some 120 others, who came to witness the presentation of the testimonial. Sir Henry Mance, Chairman of the Executive Committee, opened the formal part of the proceedings, and called upon Major-Gen. Webber, as sole survivor of the original founders of the Institution, to give a sketch of Mr. Webb's career. We may remind our readers, in this connection, that not only did Mr. Webb complete, on the 12th inst., his twentieth year as Secretary of the Institution, but, prior to his entering upon that period of valued service to the telegraphic and electrical profession, he was associated with several other important, electrical and engineering concerns, including that pioneer telegraphic concern, the Electric Telegraph Company.

Mr. Henry Edmunds, the Hon. Secretary of the Committee, gave a brief account of the development of the testimonial, which had originated with the Executive Committee, consisting of Sir Henry Mance, Dr. John Hopkinson, Mr. E. Manville, Mr. Alex. Siemens, and Mr. Edmunds, and had been carried out by a Committee of no less than 63 leading members of the electrical profession. Subscriptions to the fund had flowed in from all parts of the world in hearty response to the invitation of the Committee, and a sum of about £750 had been contributed. The form given to the testimonial is described in the address to Mr. Webb, which is embodied in an album of autograph signatures of members, associates and students of the Institution. The text of this address is as follows:—

Dear Mr. Webb: Upon the occasion of your retirement from the secretaryship of the Institution of Electrical Engineers, we, the undersigned, members, foreign members, associates, and students of the Institution, desire to give expression to the deep sense that we entertain of personal and corporate indebtedness to you. For 20 years you have devoted the whole of your untiring energy to that office with a single mind to the interests of the Institution, and the increase in the number of members during these years from 800 to nearly 3,000, coupled with the soundness of the financial position to which the Institution has attained in the same period, sufficiently attest the value and the success of your labours. In conducting the work of the office your uniform and unfailing courtesy, tact, sympathy, and kindliness have endeared you to all with whom you have been brought in contact. And now, in presenting you with this address, together with a sum of money amounting to upwards of £600, and a diamond brooch, which we beg Mrs. Webb to accept as a token of our esteem, we earnestly hope that for many years you may be spared, with her, to enjoy the rest that you have earned so well, and we trust that the Institution may long be permitted to have the benefit of your experience, which has proved so valuable to it in the past. We beg also that you will regard the autograph signatures in this album as those of true and sincere friends.

The address is signed by the members of the Executive Committee. After the presentation of this address and the several tokens of esteem embodied in the testimonial, Mr. Webb spoke in heartfelt terms of the gratification and pleasure the event afforded him, concluding with an affectionate "God bless you all!"

We agree with the contention made by Mr. Housman, in our Correspondence columns this week, that the distortion and the magnetic flux, which is a measure of the impedance E.M.F. in an armature, are due to the same cause; but not with his statement that "there are not two effects, but merely different ways of stating the same fact"; or, that "the diminution of the reversing E.M.F. is due to its being cancelled by the impedance E.M.F." It is, of course, partly due to this cause, but not entirely so. The most perfect conceivable commutation would be obtained if it were possible to arrange a contact to slide along the armature winding; but even in this imaginary case there would be an impedance E.M.F. the value of which would be quite independent of the total value of the armature field, but varying in proportion to the current in the wire. In front of the running contact the field round the wire would be in one direction, and behind it

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in the opposite direction. This change would not take place instantaneously, and the current would therefore tend to crowd into the trailing portion or tip of the contact. Now this effect, which might be negligible in the ideal example we have taken, becomes a principal cause of sparking in practical machines.

In a practical machine with a commutator there is a time when the current is flowing through the whole winding, the two half-currents meeting in one commutator sector, and there is a time when one section of the winding on each side has no current flowing in it; while, in the ideal case, the current changes continuously and smoothly relatively to the wire, in the other it dies down, changes value, and rises again simultaneously throughout a whole section of the winding. We are satisfied from our own experience that it is the impedance of this section of the winding, taken separately, which is the main—we do not say the whole—impedance factor. Furthermore, it is only that portion of the magnetic circuit through the coil in the more immediate neighbourhood of the armature conductor, not the region of choking currents, which practically neutralises impedance; so that the impedance E.M.F. depends upon the character of this circuit and is for instance greater in a toothed armature than in a smooth core. Although this field around the armature conductors forming the section of the winding under commutation is doubtless part and parcel of the armature field, its effective value is quite independent of the resultant field of the armature and field windings.

Columns of titles of patent specifications are usually among the useful rather than the ornamental and entertaining features of technical literature, but we venture to think our readers will find more than ordinary interest in the lists of patents embodied in our abstract of Dr. Magnus Maclean's lecture on "Lord Kelvin's Patents," which we publish this week. Dr. Maclean has rendered valuable service in compiling a classified list of the patent specifications of one who is not only the leading physicist of the day, but also one of its most prolific and versatile inventors.

In the current number of the *Engineering Magazine*, Mr. Dugald Clerk makes a clear statement of the difficulties in obtaining good economy and efficiency with very large gas engines. Chief among these difficulties is the tendency of the gaseous charge in a large cylinder to ignite prematurely, especially when the high compression essential to good economy is resorted to. Another difficulty arises from the enormous stresses which must occur in large-sized gas engines, these stresses exceeding the mean stress in a far greater proportion than in steam engines. Consequently, although highly efficient from a theoretical point of view, the gas engine rivals the steam engine in comparatively small sizes only. Mr. Dugald Clerk has long been an advocate of high compression and the use of a scavenger charge of pure air, and his article indicates that he believes these would help to overcome the first of the difficulties just mentioned. That further increase in the compression pressure would lead to improved economy if premature ignition can be avoided cannot be denied in the face of the accumulated direct evidence that supports this view. Scavenger charges, on the other hand, are not so certainly beneficial; and we are disposed to think that in the customary way of using them they are as much an evil as an advantage.

Scavenging, however, can be made to effect a marked economy in the working of a gas engine, and, at the same time, it will permit of an increased compression with less risk of premature ignition if it is used on a principle first suggested by Dr. Proell. Instead of allowing cool air to rush through the cylinder, doing no mechanical work, but rather absorbing energy, and only cooling the cylinder by virtue of the heat it directly carries away, it were much better if the scavenger charge could itself be made a thermodynamic agent. Dr. Proell used compressed air, which, having first absorbed the heat that is commonly wasted in the water jacket, was caused to expand, thereby not only cooling the cylinder, but also doing useful work with the heat it had absorbed. In a cycle recently invented the compressed air is caused to do this work in the same cylinder as that in which the explosion operates, the heated compressed air being admitted into the cylinder from the jacket alternately with the explosive charge, on a 4-stroke cycle. Thus scavenging is turned from a purely thermal into a thermodynamic operation. It is a matter for surprise that the larger firms of gas engine manufacturers have not hitherto developed the engine on the lines of Dr. Proell's researches, the more especially as the cycle we have just described does not seem to be restricted by existing patents.

Although the gas engine may some day be developed on these or other lines so that it will oust the steam engine from our largest electric supply stations, we are not so hopeful as Mr. Worby Beaumont that it will prove in general a serviceable and economical motor on tramcars and other vehicles. In his Presidential Address for the new Session to the Society of Engineers, Mr. Beaumont gave the cost of gas cars, "like those running on the Blackpool, Lytham and St. Anne's line," as 4·5d. per car-mile, "including gas, oil, sundries, maintenance and repairs, and driver—every cost except directors' fees"; while the same cost for electrically-propelled cars was said to be "not less than 6d. per car-mile, including driver." We do not know upon what tramways Mr. Beaumont has based his comparison, but we decidedly demur to the statement that electric traction on tramways must cost "not less than 6d. per car-mile," unless, indeed, the cars are large enough to carry many more than the usual number of passengers, or unless the trailer car is included. The term "car-mile" is vague, and it would be unfair to compare the expenditure on running a 60 or 80-passenger trolley car with that for a 30-passenger gas car. We allude to this, not that we suggest Mr. Beaumont has intended any such comparison, but because it is the tendency nowadays to build trolley cars for a greater number of passengers than was formerly the custom, and because all the gas cars we have seen have been quite small affairs. Our suspicion that Mr. Beaumont has unwittingly based his conclusions on lines running unusually large cars, or else running wastefully, is

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supported by the further statement he made, that with electric traction the cost of fuel exceeds 1·13d. per car mile. We again ask upon what tramways this estimate is based? Considering that quite a small electric supply concern, with only a 7 or 8 per cent. load factor, can turn out electric energy at less than ¾d. per unit *sold*, and bearing in mind that an average-sized trolley car running under ordinary conditions will consume only from 1 to 1½ units per mile, we do not see why the coal burned at the power-house should cost as much as Mr. Beaumont states, the more especially as the load factor of a traction power station is so much higher than that of the most favourably placed electric light station.

The Manchester Steam Users' Association have just issued a new sheet entitled "Advice to Boiler Attendants." In view of the reference in the recent Board of Trade report to the negligence of boiler attendants, the Association are to be congratulated on having included in this new publication, under the heading of "Warnings," needful and very precise instructions as to what a fireman should do *after*—as too often happens—he has neglected his duty. Up to the present he has generally been left to rely solely on his own judgment and resources to guide him in the event of finding himself face to face with a threatened explosion. We strongly advise all users of steam boilers to post up in their boiler house a copy of "Advice to Boiler Attendants," and to see that their firemen make themselves thoroughly familiar with the rules therein given. The valuable warning in connection with the admission of steam to pipes in which water is trapped seems, strictly speaking, more relevant to the engineer responsible for the arrangements of the plant, except in cases where an ill-arranged range of pipes has to be drained by hand. The excellent advice given not to disturb the fire when the water has disappeared from the gauge, but to cool the plates of the crown by both opening the fire door and promoting priming before increasing the feed supply is sadly needed, as experience in the past has frequently shown.

Royal Institution Lectures.—Prof. J. A. Fleming, M.A., D.Sc., F.R.S., will commence his course of five lectures on "Recent Researches in Magnetism and Diamagnetism" on Thursday next, March 3rd.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Emden—Vigo	Feb. 7, 1898	Feb. 18, 1898.
Latakia—Cyprus	Feb. 10, 1898	—
Bolama—Bissao	Feb. 19, 1898	—

All-British Cable.—At a congress of the Afrikander Bond, held last week, a resolution in favour of supporting the proposed all-British cable from the Cape to England was approved by a majority of 44.

Lord Kelvin's Portrait for the Royal Society.—A fund has been started for the purpose of placing a portrait of Lord Kelvin in the gallery of the Royal Society. Subscriptions, limited to five guineas, should be sent to Prof. T. E. Thorpe.

Electricity Meters.—Mr. Louis J. Steele will deliver a special course of five lectures on electricity meters, at the City and Guilds' Technical College, Finsbury, on Thursday evenings, beginning March 3rd next. Some particulars are given in an advertisement elsewhere.

Personal.—In the report of the council of the University College, read at the general meeting of the members of the college on Wednesday, it was announced that Prof. G. Carey Foster, F.R.S., who has occupied the Chair of Physics for more than 30 years, will resign at the end of the present session.

Telegraphic Interruptions.—Mr. J. Chamberlain, in the House of Commons last week, stated in reply to a question as to the alleged interruptions in the cable service between Australia and this country, that there had been no interruption in the submarine service, but that the land-line service had been several times disturbed. A deputation of the Melbourne Chamber of Commerce were recently informed by Mr. J. G. Duffy, the Postmaster-General, that the Eastern Extension Telegraph Company had offered to extend the proposed new all-British cable from the Cape to Mauritius, and thence to Albany and Adelaide, provided the Australian Governments would agree to renew their present subsidy of £32,400 per annum for 20 years.

Patent Expiring.—On the 27th inst. a patent granted to E. T. Truman for "Improvements in the Manufacture of Electrical Conductors for Telephonic or other Purposes" will expire. This patent describes a cable formed by laying-up wires a certain distance apart on a hard core of insulating material or on a core formed by an insulated conductor. These wires are spaced at such a distance apart that there may be no surface leakage from wire to wire. The cable is then further insulated by any of the usual processes.

How to Prevent Arc Lamps from Freezing.—In view of the recent severe weather the following hint by Mr. W. Fowden in the *Electrical Engineer* of New York may be found interesting, even if it comes too late to be of use this time. The lamp trimmer is provided with a number of thin sheets of cardboard having holes punched in them of the same size as the upper carbon. These are slipped over the upper carbon of the lamp when a sleet storm is anticipated, and act as a shed for the water. Mr. Fowden states that at his station in Camden, N.J., much trouble was formerly experienced through lamps freezing, but since the adoption of this simple device such an event rarely occurs.

A Novel Secondary Battery.—At the meeting of the St. Petersburg Electrotechnical Society, held under the presidency of Mr. J. Rebikow, on the 24th ult., an interesting communication was made by F. A. Jeremin regarding a special form of accumulator constructed by him. Serious defects which it is necessary to overcome in secondary batteries are the formation of too strong a deposit of sulphate of lead, and the separation or falling out of the covering composition of the plates. These defects the inventor claims to have done away with by separating the plates and filling the intervening spaces with crushed glass. The cells are filled with sulphuric acid somewhat more concentrated than the solution used in ordinary accumulators, and are then hermetically sealed.

The Hargreaves-Bird Electrolytic Process.—A correspondent writes us that the form of anode illustrated in Fig. 2 on p. 548, the invention of which is attributed to Mr. Connor, of Belfast, was substantially described as follows, in a patent (No. 19,953) granted to Richardson in 1892:—

> I take the pieces of carbon as they come from the retort, and I drill or pierce them with holes or sockets, wherein I place a rod or rods, so as to secure a number of pieces together to form an electrode. The adjacent surfaces of the carbon pieces may be smoothed, or shaped so as to fit together as far as possible, and cement or similar filling-in material may be inserted between the pieces of carbon. In this manner the rod or core, which may be of metal, may be entirely covered by the carbon and filling material, and thereby protected from the destructive influences of the products of the electrolysis, even when totally immersed in the electrolyte. At the same time, the bar forms a good electrical conductor between the pieces of carbon, and a rigid mechanical attachment for the same.

The Webb Testimonial.—We describe in another column the interesting proceedings last Monday in connection with the presentation of a testimonial to Mr. F. H. Webb. Many present on the occasion of this event have expressed a hope that a second volume of autograph signatures of members, associates, and students of the Institution of Electrical Engineers might be compiled, giving an opportunity to those who have not already done so to send in their signatures. There must be a considerable number of our readers living in remote parts of the earth who would wish to express their regard for Mr. Webb, but whom distance has prevented from being able to take part in the testimonial on Monday last. Should these lines meet the eye of any such we would suggest that he should send his autograph on a slip of paper to Mr. H. Edmunds, 39, Victoria-street, S.W., and we may add that the

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Executive Committee of the testimonial are still open to receive contributions towards the fund. The amounts received will, from time to time, be duly announced.

The Resistance of Silicon.—In a communication to the Académie des Sciences, M. Fernand Le Roy gives the results of some tests he has made on the electrical resistance of silicon. In view of its high specific resistance M. Le Roy suggests that this non-metal should prove of service for electric heating. (As the communication is to a scientific society the question of cost was, of course, not referred to.) Another advantage of silicon for this purpose would be its high specific heat and great emissive power. In the experiments the best results were obtained with the crystallised silicon, or graphitoid, originally obtained by M. Sainte-Claire Deville. During the experiments, which have been continued for nearly three years, M. Le Roy has not yet been able to determine the exact specific resistance of the material, as he finds that it varies greatly with the state of pulverisation, the compression and with its preparation. Whatever it may be, it is easy to obtain rods of pure agglomerated silicon of a sectional area of 40 sq. mm. and a length of 10 cm., which have any resistance of 25 and 200 ohms. The resistance of a rod of electric light carbon of these dimensions would be 0·15 ohm, and that of a rod of german-silver of the same size 0·0008 ohm. The experimenter also found a decrease in resistance with increase of temperature. When such a rod was raised to 800°C. its resistance decreased about 40 per cent.

Action Against the German Post Office.—The town of Ostritz, in Germany, is becoming famous, for its 2,000 inhabitants have a grievance, and are bringing an action against the Imperial Postal Administration. The town authorities erected an electric lighting station, the working of which created disturbances in the telephone lines, and was promptly *verboten* by the Imperial Postal Administration with the threat of a fine of £50. Evidently not wishing to incur this fine, which it is seen actually amounts to 6d. per inhabitant; or, as is perhaps more probable, overawed by the *verbot* of an Imperial department, the Ostritzers have provisionally stopped the working of their station; but, instead of burying their heads in the sand they have preferred to stand at bay, and are bringing the action alluded to. It appears that in order to make the alterations in their electric light installation to meet the demands of the Postal authorities an expenditure of over £250 would be necessary, an outlay which the little town ought certainly not be called on to make under the circumstances. If Ostritz wins its action it ought to be the first step towards the death and possibly the partial burial of the single-wire telephone system in Germany. Litigation is cheaper in that country than here, but, taking into account that their adversary is a Government department, on whose side an important question of the creation of a precedent is involved, it is doubtful whether a poll-tax of 2s. 6d. would not have been a cheaper way out of the difficulty.

Work of the Physikalisch-Technische Reichsanstalt.—The Berlin Reichsanstalt has presented a memorandum to the Reichstag concerning the work undertaken by them from the spring of 1895 to the summer of 1897. It is interesting to note that, on the suggestion of the Verein Deutscher Ingénieure, the Reichsanstalt is engaged on such problems as an investigation of the density of saturated steam, especially at high temperatures, and the finding of laws and reliable numerical data for the radiation and conduction of heat. Work is also being done in the direction of finding means to measure extreme temperatures, both high and low. Since the previous memorandum three copies of the standard ohm have been made in the form of tubes of mercury of different sections, in addition to the two already possessed by the Reichsanstalt, and the work in this direction is now considered as complete. Experiments on the constancy of resistance standards have shown that not only have the mercury copies of the standard ohm remained remarkably constant, but also the wire copies, the variations having, it is stated, been less than one-thousandth per cent. The wire resistances are all made of manganin. The report states that a few final improvements are still to be made in the methods employed for measuring current, potential difference, and light, and the Reichsanstalt congratulates itself on the useful work it has already done in evolving a standard for the latter measurement, which is accessible for most technical purposes. We have already referred to the work done by the Reichsanstalt in connection with the mercury-cadmium standard cell, which is now used largely by this Institution, it being found that it is constant and reproducible to within one-hundredth per cent. An absolute determination of the E.M.F. of a Clark cell has also been made by means of the Helmholtz electro-dynamometer, and the result agreed to within one-tenth per cent. of that obtained with the silver voltameter, assuming the usual value for the electrochemical equivalent of silver. Experiments have been made on the magnetisation of iron and steel in weak fields, in order to determine how far the usual assumption holds that the induction is proportional to the magnetising force at the lowest part of the curve. In the case of annealed and hard cast-steel and of cast-iron this assumption is found to be correct up to magnetising forces of about 8·5, 2 and 3 C.G.S. units respectively, whereas for hard and soft wrought-iron the curve gradually leaves the straight line already at 1 C.G.S. unit, and deviations from the straight line are also noticeable for magnetic forces lower than that of the earth's field. An investigation into the conductivity of solutions has also been undertaken. From the report, Section II. of the Reichsanstalt, in which tests of apparatus and material are undertaken for manufacturers, seems to have done much good work as well.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 25th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6.30 p.m. Students' visit to the Shoreditch Electricity Supply Station, Coronet-street, Shoreditch.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "The Problem of Train Resistance," by C. E. Wolff.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Theory of Colour Vision Applied to Modern Colour Photography," by Captain Abney, F.R.S.

SATURDAY, February 26th.

PHYSICAL SOCIETY OF LONDON.

4 p.m. Meeting in the Chemistry Lecture Room, Keate's Lane, Eton College, when the Rev. T. C. Porter will describe (1) A New Theory of Geysers; (2) A New Method of Viewing Newton's Rings; (3) Experiments bearing on the Sensation of Light; (4) A Method of Viewing Lantern Projections in Stereoscopic Relief; (5) Winter Observations on the Shadow of El Teide, with a New Method for Measuring Approximately the Diameter of the Earth; (6) Temperature of the Water of Niagara.

MONDAY, February 28th.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to the Westinghouse Brake Company's Works, York-road, King's Cross.

TUESDAY, March 1st.

RÖNTGEN SOCIETY.

8 p.m. General Meeting at the Rooms of the Medical Society, 11, Chandos-street, Cavendish-square, W. Mr. J. H. Gardiner will read Papers on the Photographic Activity and Penetration of Röntgen Rays at different vacua. Other Papers by Mr. Wilson Noble and Mr. Hall Edwards. Mr. Isenthal will show some new apparatus.

THE INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be further discussed: (1) "The Theory, Design and Practical Working of Alternate-current Motors," by Ll. B. Atkinson; (2) "Dublin Electric Tramway," by H. F. Parshall.

THURSDAY, March 3rd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture, I.: on "Recent Researches in Magnetism and Diamagnetism," by Prof. J. A Fleming, F.R.S.

FRIDAY, March 4th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "An Outline of Patent Law and Practice," by Arthur H. Stanley.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Some Recent Results of Physico-Chemical Inquiry," by Prof. J. E. Thorpe, F.R.S.

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday noon.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Theory of Röntgen Rays.—An important contribution to this subject is made by J. J. Thomson. He bases his theory upon the known laws concerning the generation of an electromagnetic field by a moving electrified particle. Such a particle " is surrounded by a magnetic field, the lines of magnetic force being (as in the case of an ordinary current) circles having the line of motion of the particle for axis. If the particle be suddenly stopped, there will, in consequence of electromagnetic induction, be no instantaneous change in the magnetic field; the induction gives rise to a magnetic field, which for a moment compensates for that destroyed by the stopping of the particle. The new field thus introduced is not, however, in equilibrium, but moves off through the dielectric as an electric pulse." The electrified particle in question is the " cathode ray"; the pulse generated by its sudden stoppage is the Röntgen ray. The author calculates the magnetic force and electric intensity carried by the pulse to any point in the dielectric, and arrives at some most suggestive and, indeed, corroborative conclusions. When the velocity of the particle approaches that of light, two pulses are started when it is stopped. One of these is a thin plane sheet whose thickness is equal to the diameter of the charged particle; this pulse is propagated in a direction in which the particle was moving; there is no corresponding wave propagated backward. The other is a spherical pulse spreading outward in all directions, whose thickness is again equal to the diameter of the charged particle, and thus, if this particle is of molecular dimensions or smaller, its thickness is very small compared with the wavelength of ordinary light. In vacuum tubes, the particles, whatever they are, are stopped by the walls of the tube, possibly after rebounding several times. The greater their velocity, and the smaller their mass, the more instantaneous will be the stoppage, the thinner and stronger will be the pulse, and the less of it will be absorbed it its passage through substances. The Röntgen rays are therefore not waves, but a rattle of irregular but intense impulses, something like bad musketry.

[Thomson, *Phil. Mag.*, February, 1898.]

Distinction between Cathode and Röntgen Rays.—A. Battelli brings a string of experiments to prove that there is no distinction between cathode and X-rays, and that, above all, the latter are not generated by the impact of the former. But the only test described consists in photographic impressions inside a vacuum tube, and it has yet to be proved that these cannot be produced by a number of fundamentally different agencies. Battelli uses a kind of bulb in which plane and spherical reflectors, and cylinders of sensitive paper covered with black paper can be mounted in various positions with great ease, the stoppers of the bulb being removable. The experiment chiefly relied upon as against the impact theory, is that which shows the photographic influence, emanating from the reflecting surface facing the cathode rays, is the more feeble the less the thickness of the sheet. This would, however, be an obvious conclusion from the impact theory if the projected particles are of less than atomic dimensions. Regarding S. P. Thompson's experiment, showing the probable existence of a special kind of rays identical with cathode rays in all respects except as regards regular reflection, Battelli proves that cathode rays themselves are not regularly reflected. But according to Thomson's theory, above referred to, there would be nothing strange in the coexistence of cathode rays and X-rays, or in the production of the latter even on the cathode itself, due to rebounding cathode particles.

[Battelli, *Phil. Mag.*, February, 1898.]

Chemical Electrification.—A Paper on "The Electrical Properties of Newly-prepared Gases" is published by J. S. Townsend, of the Cavendish Laboratory. The Paper contains a mass of valuable experimental data, sufficient for three or four ordinary Papers. It is shown that the gases given off by the electrolysis of sulphuric acid or caustic potash carry with them an electric charge, a large percentage of which remains in the gas after it has been bubbled through a liquid and passed through glass wool to remove the spray. Another property of these gases is their power of condensing moisture to form a cloud, the weight of which is proportional to the charge. The electrification resides in the drops forming the cloud, and the drops are evidently therefore formed round the carriers of the electric charge. These results were used to find the charge on each carrier, and it was found to coincide with what we can calculate as being the atomic charge, on the supposition that at ordinary temperature and pressure there are 10^{20} molecules in each cubic centimetre of a gas. In the experimental arrangement the positively-charged oxygen and hydrogen given off from a dilute sulphuric acid cell were first bubbled through a solution of potassium iodide and then through distilled water, kept at a fixed temperature. The charged gas formed a cloud on emerging, and carried it through a paraffin block into a series of sulphuric acid bulbs, which absorbed the cloud. The bulbs were connected with an electrometer, which measured the charge given out. An ingenious method was devised for estimating the size of drops of the cloud formed by charged oxygen or hydrogen. It was led into a Florence flask, and as the cloud slowly settled it was repeatedly photographed. The oxygen cloud fell 10mm. in 3min., giving a radius of $6{\cdot}8 \times 10^{-5}$ for the drops. For hydrogen the radius was $7{\cdot}9 \times 10^{-5}$, as calculated from the fall of a body through an elastic fluid. The charge on each oxygen carrier was approximately 8×10^{-10}, on each hydrogen carrier $\frac{3}{2} \times 10^{-10}$. The radius of the oxygen carrier is, roughly, 12×10^{-7}, and of the hydrogen carrier $4{\cdot}5 \times 10^{-7}$. Hence the carriers are larger than molecules, and much larger than cathode-ray carriers.

[Townsend, *Phil. Mag.*, February, 1898.]

Calculation of Conductivities.—J. G. McGregor and E. H. Archibald discuss the possibility of calculating the electrolytic conductivity of an aqueous solution containing two electrolytes with no common ion, say sodium chloride and potassium sulphate. According to the dissociation theory of electrolysis the specific conductivity of a complex solution may be calculated from the concentration, the coefficient of ionisation, and the specific conductivity. The process of calculation is very simple. Take each electrolyte separately; multiply its concentration by its ionisation and by its specific conductivity at infinite dilution; add up the products so obtained, and the result is the conductivity. This rule is capable of being tested, but to give it a fair chance, very dilute solutions should be taken. The authors assume that any dissolved electrolyte which is in equilibrium as regards dissociation may be regarded as being so not only in the whole volume, but in any finite part of it. Also, that each electrolyte, with its dissociated and undissociated parts, may be regarded as occupying a definite portion of the volume, which may be spoken of as its region. These assumptions lead to certain simple equations, from which the required constants can be calculated. The observed values agree with the calculated values to within about 0·5 per cent. At higher concentrations the ratio of the actual molecular conductivity to the conductivity at infinite dilution is no longer equal to the ionisation coefficient, and the formulæ above quoted is no longer true.

[McGregor and Archibald, *Phil. Mag.*, February, 1898.]

Zeeman Effect Measurements.—P. Zeeman himself has made some measurements of radiation phenomena in the magnetic field by photographing the outer components of the magnetic triplets, quenching the light of the middle line by means of a Nicol. By this means it is also possible to measure accurately the magnetic effect in lines not entirely separated into triplets. Finally, measurements of the distance between the outer components of the triplet will also put to test the possible hypothesis that it is only one kind of ions, having charges proportional to their respective masses, that are free to vibrate in the atom or molecule. But this particular point the author does not at present enter upon. Measurements were made on spectrum lines of zinc, cadmium, copper, and tin. Satisfactory results were only obtained with

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the sharp-lined spectra of zinc and cadmium. A peculiarly interesting observation was that the zinc lines 4,811, 4,722, and 4,680 showed a distance between the components of 18, 21, and 25×10^{-3}cm. respectively on the negatives (0·1cm. = 4·41 Angström units), whereas the lines 3,345, 3,303, and 3,282 showed no magnetic influence at all. The field in both cases was 32,000 units. The former three lines belong to the second subordinate series of Kayser and Runge's formula, whereas the latter three belong to the first subordinate series. This, so far from disagreeing with the accepted theory of the Zeeman effect, was actually predicted by it.

[ZEEMAN, *Phil. Mag.*, February, 1898.]

ELECTRICAL ENGINEERING IN SPAIN: THE ELECTRIC LIGHTING OF MAZARRÓN.

(BY OUR OWN CORRESPONDENT.)

Mazarrón, a provincial town of some 14,000 inhabitants, is situated in the south-east of the province of Murcia, and is the most important centre of the mining district of the south-

FIG. 1.—Market Place and Municipal Buildings at Mazarrón, showing 2,000-c.p. Arc Lamp.

east coast of Spain, midway between Carthagena on one side and Aguilas on the other. The town of Mazarrón is approached from the Mediterranean by the "Puerto de Mazarrón," or port, which latter has a population of some 3,500 inhabitants, and is under the same municipal government as the town itself. The port is 6¼ kilometres distant from the town, and the Mazarrón Electric Light Company intend shortly to extend their high-pressure cables from the generating station at Mazarrón, in order to supply the light also to the port, the lighting of which is included in their concession. The exclusive concession for the electric lighting of Mazarrón for 50 years was obtained by the Mazarrón Electric Light Company (Limited).

In Mazarrón, as in most provincial towns in Spain, the only illuminant obtainable is petroleum, and in consequence of the very high price of this illuminant in the country, due to heavy Government taxes on its introduction, refinery and consumption, the danger in its use and the difficulty in procuring the thoroughly-refined oil, except at excessive prices, [illegible] special advantages to electric light undertakings—a fact which can be seen by the rapidly-increasing number of concessions being taken up by English and other companies for the supply of electric light to Spanish towns.

The contract of the Mazarrón Electric Light Company with the municipality of Mazarrón was concluded in May, 1897, and already the equivalent number of lamps of 10 c.p. connected up is over 1,000, the present plant being capable of supplying 3,500 lamps of 10 c.p. The municipality at present

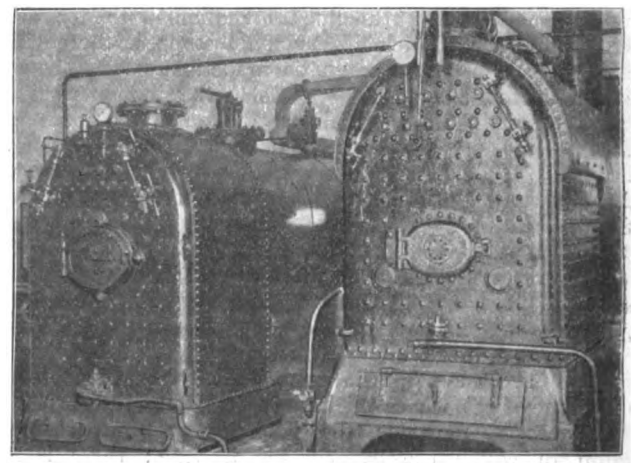

FIG. 2.—Portion of Boiler Room, showing Locomotive Boiler and Semi-Portable Engine and Boiler Set.

use 300 lamps, including 10 c.p. and 16 c.p. glow lamps in the streets of the town, and one 2,000 c.p. arc lamp in the plaza, or market-place (Fig. 1). For these they pay at the rate of 50 centimos per 1,000 watt-hours, or, taking the mean of the rate of exchange equivalent to about 4d. per British B.O.T. unit. The present price paid by private customers is

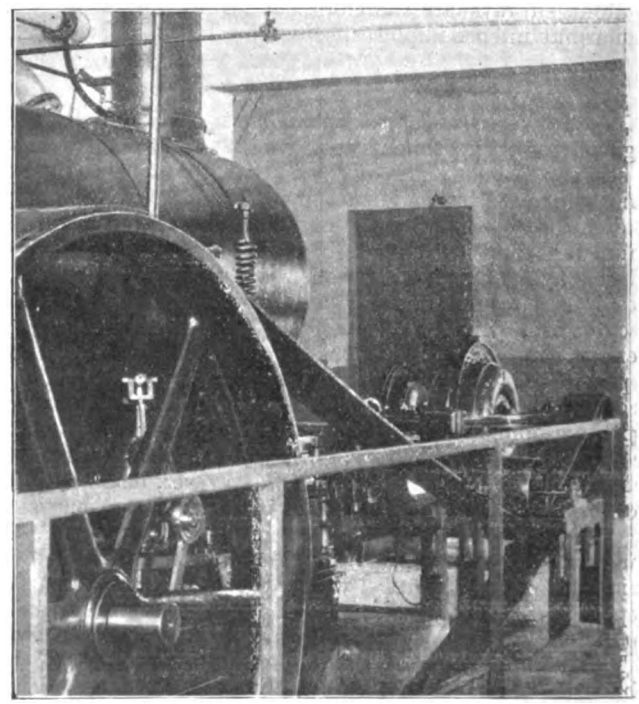

FIG. 3.—View of Mordey-Victoria Alternators.

at the rate of 6 pesetas per month per 16 c.p. lamp if by contract, or, if by meter, 80 centimos per 1,000 watt-hours, which in a similar manner averages 6·4d. per British B.O.T. unit. The cost of the same intensity of light as that of one 16 c.p. incandescent lamp, if produced by the ordinary petroleum obtainable in the town, is about 7 centimos of a peseta per hour; while the present charge to private consumers for the

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electric light is equivalent, at the above rate, to 5 centimos per 16 c.p. lamp-hour. Thus the advantages in economy and superiority of the electric light over petroleum are at once evident to the residents, rich and poor, and the light is being rapidly taken up by all classes.

In view of the extension of the Company's cables to the port, and the lighting of the same for the municipality and for private consumers, the system adopted at Mazarrón has been the high-pressure alternate current system, with transformers, the motive power adopted being steam, in consequence of the absence of any available water power in the neighbourhood. The alternators are of the well-known Mordey-Victoria pattern of 2,000 volts, 100 periodicity, with direct-coupled exciters, constructed by the Brush Electrical Engineering Company (Limited), and at present the plant comprises two alternators of 30 kilowatts each, and one alternator of 35 kilowatts, intended for parallel working. The engines include a 60 H.P. vertical compound high-speed engine built by Messrs. Robey and Co., Lincoln, with Pickering governor and variable expansion gear, and a 60 H.P. locomotive type of boiler by the same makers (Fig. 2). Messrs. Hornsby and Sons, of Grantham, have supplied a 75 H.P. undertype automatic expansion engine and boiler, and this latter engine at present drives one of the 30 kilowatt alternators (Fig. 3) by link-belting and jockey-pulley gear. The third alternator is at present kept for reserve.

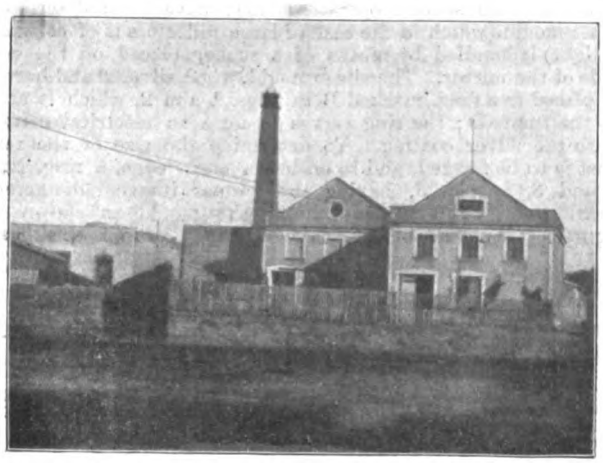

FIG. 4.—Exterior View of Electric Light Works, Mazarrón, showing High-pressure Feeders leaving the Station for the Town.

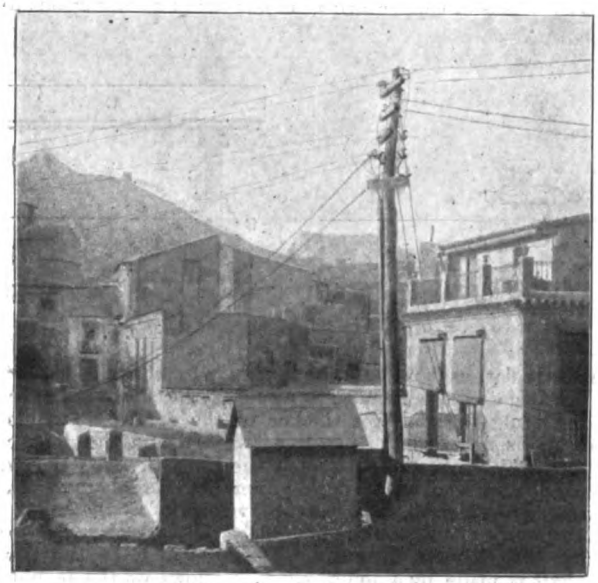

FIG. 5.—Transformer Street Box and Distributing Pole.

The power station, shown in Fig. 4, is situated at the extreme north-east of the town, a more central position having been unobtainable. From this station the line of cables is carried overhead, the high-pressure feeders and cables being rubber-insulated and carried on specially constructed insulators attached either to upright posts or to wall brackets. The low-pressure house service system is similarly carried in lines of aërial cable with insulated covering and special porcelain insulators. At present there are nine transformers working on the town circuits, the units chosen being mostly 2 and 3 kilowatt transformers arranged in parallel and feeding the low-pressure network. The transformers are placed in overground chambers in the streets in convenient situations (Fig. 5), and at each transformer-box a distributing post is fixed, to which also is attached the branch cables connecting with the high-pressure feeders, these, of course, entering the transformer chamber. The transformers were supplied by Messrs. Crompton and Co., and by Messrs. Johnson and Phillips. In consequence of the phenomenal dryness of the climate in Mazarrón, rain rarely falling throughout the whole year, and the intense heat, it has been found quite easy to effect perfect insulation of the transformers and overhead circuits; and the overhead system has been universally adopted in such parts of Spain as it gives the best results with the greatest facility and cheapness of construction. The old form of petroleum lamps, or "faroles," in the market-place have been replaced, as seen in Fig. 1, by a 2,000-c.p. alternate-current arc lamp, connected through a supplementary arc-lamp transformer to the house service line, which is worked at 110 volts throughout the town. The Company have already supplied light to the San José mine, and it is expected that contracts will be entered into shortly with the other mines in the district for supply of the light both above the surface and underground. The great industry of Mazarrón is that of the mines, which lie immediately round, many being partly within the town itself. These mines are among the richest in the country and in Europe in lead and silver, the lead ore being conveyed for smelting to the lead works at the port, from whence it is shipped to England and abroad.

Our description of the Mazarrón electric supply system, and the accompanying illustrations, are from details and photographs sent us by the Mazarrón Electric Light Company's resident engineer and manager, Mr. E. G. Cruise, formerly of the Brush Electrical Engineering Company (Limited).

AN ELECTROLYTIC PROCESS FOR THE MANUFACTURE OF PARABOLIC REFLECTORS.*

BY SHERARD COWPER-COLES, M.I.E.E., ASSOC. M. INST. C.E.

Glass mirrors at the present time are almost exclusively used for projectors for search lights and similar purposes, on account of the difficulty that has been experienced in producing a true metallic reflector that will not readily tarnish when exposed to the heat of an arc light. One advantage of a metallic reflector is that the rays from the carbon points are collected into a parallel beam by means of refraction only, and is not catadioptric, as most glass mirrors are. Spun reflectors are never true, as it is found in practice impossible to spin them quite true to the moulds. Experiments have been made with a view to substituting cast metal for glass, but the cost of grinding and polishing, and the unsatisfactory surface that is obtained, have resulted in the attempts being abandoned. Stamped reflectors have also been tried, but with no more satisfactory results. The present process I propose to describe to you is an electrolytic one, one of the chief features being that the surface produced requires no after polishing or trueing up. When once a true mould has been produced, any number of reflectors can be taken from it at a nominal cost. A glass mould is prepared, the convex side of which is accurately shaped and polished to form a true parabolic, or other reflecting surface. As the mould only requires shaping and polishing on the convex side, it is comparatively cheap as compared to a glass reflector, which has to be ground on both sides. On the prepared surface is deposited a coating of metallic silver, which is thrown down chemically on the glass and then polished, so as to ensure the copper backing being adherent to the silver. The mould thus prepared is placed in a suitable ring

* Paper read before the Institution of Electrical Engineers, Feb. 9, 1898.

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and frame (which I will describe later on), and immersed in an electrolyte of copper sulphate, the mould being rotated in a horizontal position, the number of revolutions being about 15 per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature of the water to 120°F., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The concave surface of the reflector obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent tarnishing. Palladium is found to answer this purpose best, as a bright coating can be deposited rapidly to any desired thickness; the palladium resists tarnishing and the heat of the arc to a wonderful degree.

Palladium is a silver-white hard metal, and is sufficiently ductile to be rolled into thin sheets. Its specific gravity is 11·4, being about half that of platinum. The present price of palladium is about double that of platinum, but, its weight being only one-half, the same area can be covered at the same cost. It melts at an extremely high temperature—about the same as wrought iron. When only slightly heated in hydrogen gas, it has an extraordinary power of absorbing mechanically large volumes of this gas. Graham

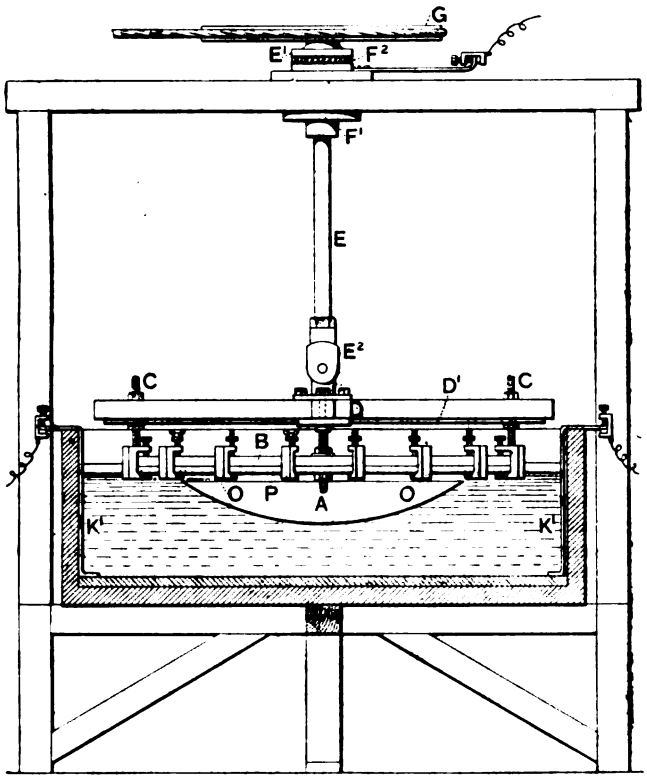

Fig. 1.

investigated this very curious phenomenon, and found that a piece of palladium foil, when heated below 212°F., takes 240 times its volume of hydrogen, but that it had not the power of absorbing oxygen or nitrogen. At a moderately high temperature palladium assumes a blue colour, and the formation of a thin film of oxide, which it loses at a higher temperature, due to the decomposition of the oxide. Palladium is not readily attacked by sulphuric or hydrochloric acid.

In carrying out the manufacture of reflectors by this process, it is essential that the glass mould be perfectly clean and free from grease before the silver coating is applied. It has been found, however, that, if the cleaning is solely effected by chemical means, there is a great liability of the silver adhering too firmly to the glass, whereby the mould is in danger of being broken during the removal of the reflector. This difficulty has been overcome by cleaning the glass mould with a suitable paste or powder, such as peroxide of iron, then removing such paste or powder by washing the glass with a 50 per cent. solution of ammonia. It is necessary that this cleaning operation be repeated prior to the production of each reflector. After the convex side of the mould has been properly cleansed as described, a thin coating of metallic silver is applied as follows: ammonia is added to a solution of nitrate of silver until the precipitate that is first formed is redissolved, then reprecipitating by caustic soda, again dissolving in ammonia, then adding a glucose to the solution. Excellent results have been obtained with a silvering solution of the following composition, equal parts of each being used: Silver nitrate, 0·5 per cent.; caustic potash, 0·5 per cent.; glucose, 0·25 per cent. The surface of the mould to be coated is immediately dipped into the solution, when it becomes coated with a film of silver. The silver coating is thoroughly washed and then allowed to dry, and the silver which has been deposited is burnished bright with a piece of cotton-wool and peroxide of iron, preferably precipitated by ammonia from a dilute solution of ferrous sulphate. The cost of the silvering is found to vary from 2d. to 4d. per inch diameter. I have here a film of the silver and copper stripped from a glass mould which is quite transparent to transmitted light having a green tinge, but is capable of reflecting light.

During the several operations that have been described, the glass mould (which in the case of large reflectors is of considerable weight) is handled by means of a sucker placed on the concave side of the mirror. The silver mould, when silvered and burnished, is placed in a ring, marked B in Figs. 1 and 2, which is attached to the frame D; the ring serves to form an electrical connection with the silver coating. To determine the size of the reflector that is to be formed, and to ensure a clean edge, a ring, N, Figs. 2 and 3, is placed, having the proper internal diameter, and bearing at its inner edge against the mould as shown in the figures. Wooden blocks, N¹, of the required thickness are

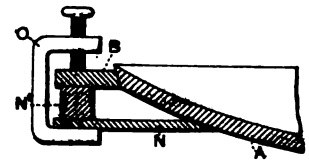

Fig. 2.

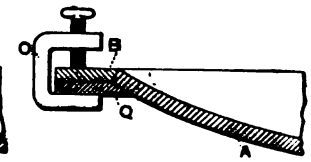

Fig. 3.

inserted between the rings B and N, and the ring is secured in place by clamps O, as shown on Fig. 2. The ring N may be made of insulating material, or it may be a brass, copper, or lead ring, having its lower face protected by suitable varnish to prevent the deposition of metel upon it. The ring B, Fig. 1, is suspended by bolts, C, and cross-bars, D, forming a frame which is connected to vertical shaft, E; the said shaft is carried on the main frame E¹ of the apparatus by a bearing fitted with ball bearings marked F², which supports the shaft by means of a collar, and is allowed to rotate freely. G is a pulley through which shaft E and mould A may be rotated by a belt or cord. The depositing tank is carried by a frame, to which the mould is suspended, so as to be in contact with the electrolyte, which is a solution of copper sulphate; the anode is arranged at the bottom of the tank, and the current conveyed to it by means of copper strips. It was found advantageous to have

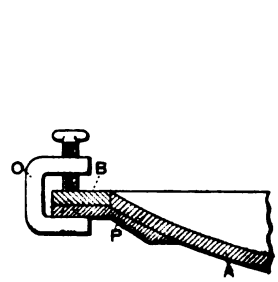

Fig. 4.

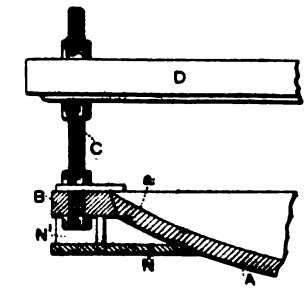

Fig. 5.

the anode flat, as it reduces the tendency for the copper to "tree" at the edge of the mould; it also has the additional advantage of rendering the reflector thicker in the centre. The electrical connections between the negative terminal and the silver coating of the reflector is made through the ring B, bolts C, strips of metal, D¹, on the arms of the frame D, the shaft E, the ball bearing F². Fig. 6 is a perspective view of the cross frame for suspending the mould, and shows the metal strips for conveying the electric current. The connection of the frame to the shaft is made by a joint, E², that allows of the mould being tilted, for the reason that I will now describe to you. When first lowering the mould into the solution, it is advisable to avoid throwing the work of carrying the whole electric current on the silver alone, so the shaft E is raised by means of pulley blocks, or otherwise, to suspend the mould. The mould is then tilted and the shaft gradually lowered, bringing the edge of the mould in contact with the electrolyte, the circuit being thus established. A thin film of copper is deposited on the mould at the place of contact near the edge of the mould. The shaft is then lowered until it rests on the bearing; at the same time the mould is allowed to gradually assume its horizontal position. The operation I have just described occupies a very brief interval of time, and the current for a

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few minutes is worked at a pressure of about 9 volts, which is ultimately reduced. It is very important that the silver be flashed over with copper immediately on immersion in the copper sulphate solution. At this stage the ring N is not applied, and the mould simply rests on the ring B. The shaft is then rotated, and the operation of depositing the base metal continued with a current-density of about 19 amperes per square foot, and is proceeded with

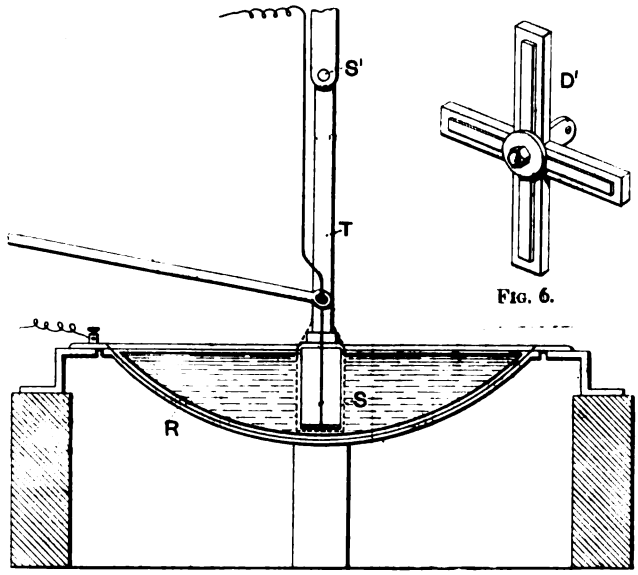

FIG. 6.

FIG. 7.

until a sufficiently thick coating is obtained to act as a good conductor to the electric current. The copper solution generally used is of the following composition :—Copper sulphate, 13 per cent. ; sulphuric acid, 3 per cent. ; water, 83 per cent. The ring B, with the mould in it, is then lifted out of the bath, and the ring N applied to determine the size of the reflector that is to be

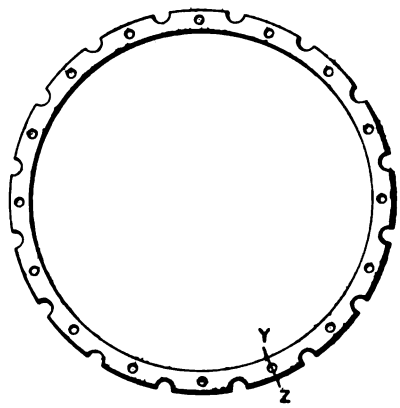

FIG. 8.

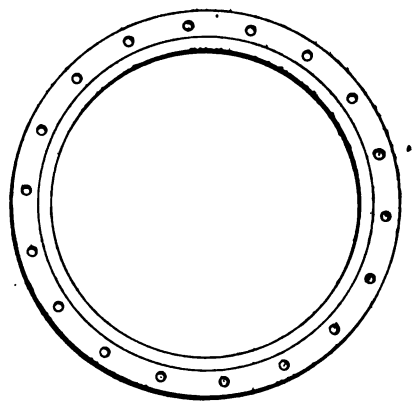

FIG. 9.

formed ; after which the mould is again placed in the bath, and the operation of depositing the backing proceeds until the required thickness is obtained. During this stage the copper is deposited on the mould up to the inner edge of the ring N, which thus determines the diameter of the reflector, and also ensures a clean, even edge to the reflector, which requires no further treatment. In place of the ring N, shown in Figs. 2 and 5, a leaden ring, P, Fig. 4, may be employed. The leaden ring is secured to the ring B by the clamps O ; this ring, being soft and pliable, will bend to the angle of the mould and the ring B, and therefore does not require to be blocked up as does the ring N. Fig. 3 shows a modification of a mould having its edges bevelled in the direction indicated—that is to say, in the reverse direction to that shown in Fig. 2. In such cases the mould is supported by a number of narrow rigid supports, Q, clamped to the ring by clamps O. After the thin coating of copper has been applied to the mould in the

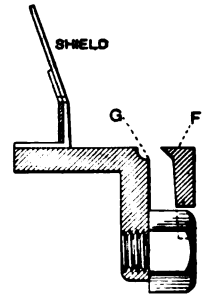

FIG. 10.

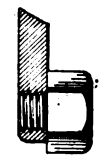

FIG. 11.

FIG. 12.

manner already described, the ring B, with the mould in it, is removed from the bath and turned over. The supports Q are then removed, and a ring such as P, Fig. 4, is applied to the mould to determine the size of the reflector. Or, instead of removing the supports Q and applying the ring P, if a ring such as N (Fig. 2) can be applied to the mould, it is then replaced in the bath and the depositing continued. As soon as the requisite thickness of metal has been deposited, the mould, with the reflector attached to it, is removed from the ring B and placed in a bath of cold or lukewarm water, which is then raised to a temperature of 120°F., whereupon, owing to the difference of the expansion of the glass mould and the metal backing, the latter separates from the mould. The only thing that requires to be done now is to coat the reflector with an untarnishable metal. This is accomplished by placing the reflector in an earthenware pan (Fig. 7)

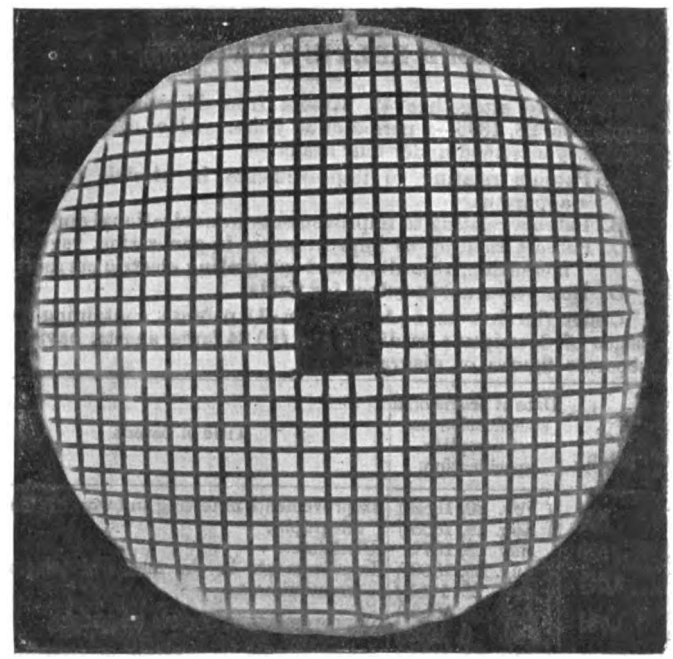

FIG. 13.

containing a 0·62 per cent. solution of palladium ammonium chloride in about a 1 per cent. solution ammonium chloride. The solution is used at about 75° Fahr., the current used for a 2-foot reflector being about 0·5 of an ampere, the E.M.F. at the terminals of the bath being 4 to 5 volts. An anode, S, made out of carbon, and curved approximately the shape of the reflector, is attached to a rod, marked T, which is connected by an arm to a rotating disc which causes the anode to swing to and fro, thereby ensuring an even coating of palladium, and agitating the solution and preventing the depositing upon the reflector of particles of foreign matter which may be present in the solution.

The back of the reflector is usually varnished before placing it in the bath, to prevent local action setting up between the copper and the silver or palladium. The reflector is removed from the

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bath and dipped in boiling water, and then placed in boxwood sawdust, which is kept hot by means of a steam jacket. The reflector is then ready to be mounted in a suitable ring, such as shown in Figs. 8, 9, 10, 11 and 12. The clamping ring shown in Fig. 8 is provided with a knife-edge, marked F, Figs. 10 and 12. The knife-edge forces the reflector against a ring of asbestos, marked G, and retains it in position after the reflector has been carefully centred whilst resting on the asbestos ring.

Reflectors made by the process which has just been described have been subjected to a number of tests, and found to withstand excessive heat without tarnishing. Salt water has been thrown on the reflectors when they have been too hot to touch, the result being that the water was driven off as steam, and the salt left as a white deposit on the reflector, which was easily removed with a wet cloth. A reflector recently tested at Portsmouth had a number of rifle bullets passed through it, when the beam was found to be little affected. On the other hand, the first shot fired at a glass reflector splintered it to pieces. Although palladium does not reflect light as well as a silver surface which is perfectly clean and bright, silver is found quite unsuitable, as after being in close proximity to an arc light for a short time the silver tarnishes, and the light is greatly reduced in intensity. With a palladium-faced reflector the intensity of light is found to remain practically constant, as little or no tarnishing takes place.

Some of the reflectors have been tested optically by the process which has been extensively used by Thikolff. The method consists of photographing the image in a reflector of a white screen covered with black square network, as shown in Fig. 13. The screen is of white material, having a black square network, the lines being 0·2in. thick and 0·6in. apart. In the centre of the screen a square opening is left, through which the photograph of the image of the network is taken. The first steps in the process are as follows: The reflector is placed at a distance of from 3ft. to 5ft. from the screen, which should exceed by at least 35 per cent. the height and breadth of the reflector, so as to ensure the image of the network covering the whole surface of the mirror. The test of the reflector is carried out as follows: The surface of the mirror in all planes is tried by a template, to ensure that the exterior curves of the surface are not far distant from the parabola; the image on the screen is then photographed, and the irregularity of the lines indicate any serious errors of the parabolic surface.

LORD KELVIN'S PATENTS.*

There are altogether 47 patents from February 20, 1858, to September 28, 1896—a period of 38 years. All of them can be conveniently classified under four heads:—

A. Patents relating to improvements in electric telegraphic apparatus.
B. Patents relating to improvements in navigational apparatus.
C. Patents relating to improvements in generating, regulating, measuring, recording, and integrating electric currents.
D. Improvements in valves for fluids.

Under the first head (A) there are 11 patents, containing (i) 221 pages of descriptive reading; and (ii) 24 large sheets, having 127 separate figures or diagrams.

Number of patent.	Date of provisional specification and of complete specification.	Title of patent.
329	Feb. 20, 1858 Aug. 19, 1858	Improvements in testing and working electric telegraphs.
329	May 19, 1871	Disclaimer.
2,047	Aug. 25, 1860 Feb. 25, 1861	Improvements in the means of telegraphic communication.
1,784	July 6, 1865 Jan. 6, 1866	Improvements in electric telegraphs.
2,147	July 23, 1867 Jan. 23, 1868	Improvements in receiving or recording instruments for electric telegraphs.
3,069	Nov. 23, 1870 Not allowed	Improvements in electric telegraph transmitting, receiving, and recording instruments, and in clocks.
252	Jan. 31, 1871 July 31, 1871	Improvements in transmitting, receiving, and recording instruments for electric telegraphs.
810	Mar. 25, 1871 Void	Improvements in clocks and apparatus for giving uniform motion.
2,086	June 12, 1873 Dec. 12, 1873	Improvements in telegraphic apparatus.
1,095	Mar. 13, 1876 Sept. 13, 1876	Improvements in telegraphic apparatus.
24,868	Dec. 28, 1895 Sept. 28, 1896	Improvements in recording instruments for telegraphic and other purposes.

* Abstract of Paper read by Dr. Magnus Maclean before the Philosophical Society of Glasgow on February 23rd.

Fleeming Jenkin was associated with Lord Kelvin in patents 2,047 and 2,086; and Cromwell Fleetwood Varley was associated with him in patent 1,784.

Under the second head (B) there are 10 patents, containing (i) 89 pages of descriptive reading; and (ii) 27 sheets, having 151 separate figures or diagrams.

Number of patent.	Date of provisional specification and of complete specification.	Title of patent.
1,539	Mar. 29, 1876 Sept. 27, 1876	Improvements in the mariner's compass and in the means for ascertaining and correcting its errors.
1,339	Nov. 30, 1877	Disclaimer and memorandum of alteration.
3,452	Sept. 1, 1876 Mar. 1, 1877	Improvements in apparatus for navigational deep sea soundings.
4,876	Dec. 18, 1876 June 15, 1877	Improvements in the mariner's compass and in appliances for ascertaining and correcting its errors.
679	Feb. 20, 1879 Aug. 20, 1879	Improvements in the mariner's compass and in appliances for correcting its errors.
781	Feb. 23, 1880 Aug. 23, 1880	Improvements in navigational sounding apparatus.
5,675	Dec. 8, 1883 June 7, 1884	Improvements in navigational sounding apparatus.
5,676	Dec. 8, 1883 June 7, 1884	Improvements in mariner's compass and in means for ascertaining and correcting its errors
12,240	Oct. 14, 1885 July 12, 1886	An improved navigational sounding machine.
8,959	June 10, 1890 Mar. 10, 1891	Improvements in the mariner's compass.

Under the third head (C) there are 24 patents, containing (i) 177 pages of descriptive reading; and (ii) 123 sheets, having 286 figures or diagrams.

Number of patent.	Date of provisional specification and of complete specification.	Title of patent.
3,032	July 9, 1881 Jan. 9, 1882	Improvements in regulating electric currents and in apparatus or means employed therein.
5,668	Dec. 26, 1881 June 26, 1882	Improvements in dynamo-electric machines and apparatus connected therewith.
2,028	April 21, 1883 Oct. 20, 1883	Improvements in apparatus and processes for generating, regulating, and measuring electric currents.
4,617	Sept. 28, 1883 Mar. 27, 1884	Appparatus for generating, regulating, measuring, recording, and integrating electric currents.
4,655	Mar. 10, 1884 Oct. 8, 1884	New or improved suspensions for electrical incandescent lamps.
5,355	Mar. 22, 1884 Nov. 10, 1884	Improvements in dynamo electric machines.
6,410	Mar. 10, 1884 Oct. 28, 1884	Improvements in breaking electric contact to prevent overheating by imperfect contact.
10,530	July 24, 1884 April 25, 1885	Safety fuses for electric circuits.
11,106	Aug. 9, 1884 May 7, 1885	Improvements in apparatus for measuring electric currents.
9,016	July 10, 1886 April 9, 1887	Improved apparatus for measuring efficiency of an electric circuit (amended Oct. 4, 1887).
18,035	Dec. 11, 1888 Sept. 7, 1889	Electrostatic apparatus for measuring potentials.
18,035A	Dec. 11, 1888 Sept. 7, 1889	An improved ampere gauge and connections.
18,035B	Dec. 19, 1888 Sept. 7, 1889	Improved apparatus for continuously measuring potentials or currents.
15,768	Oct. 8, 1889 July 7, 1890	Apparatus for measuring and recording electric currents (allowed to lapse).
1,004	Jan. 20, 1891 Oct. 20, 1891	An improved indicator for electric potentials.
18,436	Oct. 27, 1891 July 22, 1892	Improved apparatus for measuring and recording electric currents.
10,230	May 30, 1892 July 2, 1892	An improved electric condenser.
2,198	Feb. 1, 1893 Nov. 1, 1893	Improvements in balances.
2,199	Feb. 1, 1893 Feb. 1, 1893	An instrument for measuring electric currents.
5,733	Mar. 17, 1893 Dec. 16, 1893	Improved arrangements for reading the deflections of electric instruments.
24,471	Dec. 20, 1893 Oct. 20, 1894	Improvements in electric supply meters.
24,979	Dec. 29, 1893 Dec. 29, 1894	Improvements in instruments for measuring and recording electric pressures and currents.
15,034	Aug. 7, 1894	Improvements in instruments for measuring electric currents.
22,661	Nov. 27, 1895 Sept. 28, 1896	Improvements in apparatus for indicating and recording electric supply.

James T. Bottemley is associated with Lord Kelvin in patent 10,530.

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Under the fourth head (D) there are 2 patents, containing (i) 10 pages of descriptive reading; and (ii) 8 sheets, having 25 separate figures or diagrams.

Number of patent.	Date of provisional specification and of complete specification.	Title of patent.
5,471	Mar. 30, 1889 / June 8, 1889	Improvements in valves for water, steam or other liquids or gases.
3,864	Mar. 4, 1891 / Dec. 3, 1891	Improvements in valves for water, steam or other liquids or gases.

There are up to September 28, 1896, 47 patents, containing (i) 497 pages of descriptive reading; and (ii) 182 sheets, having 589* separate figures or diagrams.

Under the first head reference was made to the "retardation" occasioned in electric impulses through long submarine cables by "electrostatic capacity," and the necessity of having a receiving instrument so sensitive as to be able to indicate or record continuously every variation in the strength of the received current. The mirror galvanometer and the siphon recorder, which were briefly described, fulfilled these conditions.

Under the second head, the sounding machine, the depth recorder, and the compass, were exhibited and described. The three principal errors to be corrected in the compass, viz., the semicircular, the quadrantal, and the heeling errors, were referred to, and the methods by which these are corrected in the Kelvin compass were explained. Short reference was also made to the tide gauge, tidal harmonic analyser and tide predicter.

Under the third head reference was made (i) to electrometers, (ii) to electromagnetic instruments for measuring currents and differences of potentials, (iii) to electrodynamic instruments for measuring currents and differences of potentials, and (iv) to instruments arranged for recording and integrating electric currents.

A METHOD OF DETERMINING MAGNETIC HYSTERESIS LOSS IN STRAIGHT IRON STRIPS.†

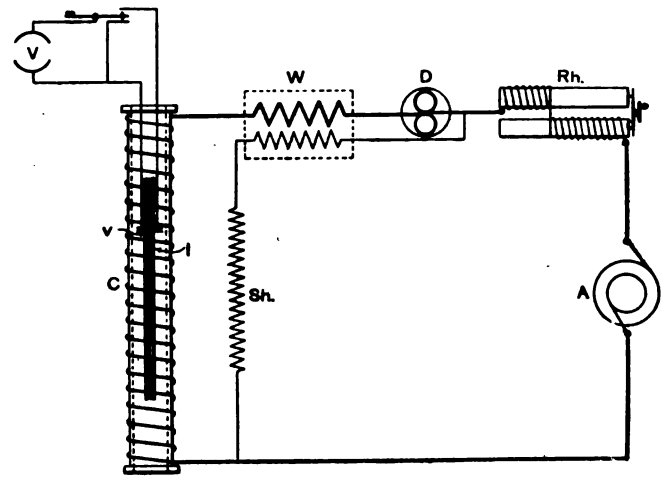
BY PROF. J. A. FLEMING, M.A., D.SC., F.R.S.

The exact determination of the magnetic hysteresis loss in sheet iron as used for alternating-current transformer construction has become of commercial importance of late years. Owing to the obvious necessity for reducing the core loss in transformers to the lowest attainable limit, it is now the custom to carefully test the iron to be used and to express the determined hysteresis loss in the iron sheet, in watts per pound per 100 frequency, at a maximum induction during the cycle of 2,500 C.G.S. units. Two processes are in ordinary use for effecting this measurement. The most accurate but most tedious is by the employment of a ballistic galvanometer and the graphical delineation of a number of (B H) cycles. This method has the advantage that it can be conducted with either small or large samples of iron, but the reduction of the observation to give the required hysteresis loss is very tedious; and, including the construction of the necessary ring-coil, the actual observations, and the reductions, a single determination of the hysteresis value of an iron can hardly be carried out, even by a couple of industrious workers, in less than a day.

The method employed by Prof. Ewing and Mr. F. Holden of rotating a laminated specimen of the iron in a magnetic field, or rotating a field round the specimen and comparing the torque produced on the field magnet or on the specimen with that produced by a similar sample of iron of known hysteretic value or else measuring it by a calibrated torsion spring, is very much more rapid. This last method is, however, open to the great objection that if used merely to compare a sample of iron with a standard sample the user of the instrument is at the mercy of his instrument-maker. He receives with it one or more samples of iron which he is told have certain hysteretic values, but he cannot check the truth of the statement. Moreover, if he happens mechanically to injure the standard samples he may seriously change their hysteresis constant. The writer therefore sought for a method which should combine the advantages of both the above processes whilst eliminating their disadvantages, and which should be an absolute method, like the ballistic method, but at the same time a rapid method like the rotating-field method.

The following Paper contains a description of a process which is based upon the use of the bifilar reflecting wattmeter, and operates upon samples of iron, large or small, in the form of straight strips which are simply slipped into a long magnetising coil. All the actual practical work and the numerous calculations involved in putting this process to test have been conducted under the author's direction by Mr. A. R. Peart and Mr. W. M. Park, working in the Electrical Laboratory of University College, London; and to these gentlemen belongs the full credit for all this portion of the research as well as for the labour required in much tedious numerical and graphical work.

The method is based upon an interesting discovery with regard to the distribution of the induction in a bundle of straight iron strips or iron or steel wires, when placed in a uniform magnetic field. If a long, straight, magnetising coil is prepared by winding insulated wire upon a paper or vulcanised fibre tube, and if the length of the solenoid is, say, ten times its mean diameter, then for a distance equal to at least three-quarters of the total length of the coil we have a practically uniform magnetic field in the interior of the bobbin, when a constant current is sent through the wire. If into this uniform magnetic field a bar of iron or straight bundle of iron strips or iron wire is introduced, the length of the iron being not greater than the uniform portion of the interior field of the coil when the iron is not there, this iron has magnetic induction created in it which varies in density from point to point in the bar, but is symmetrical in value about the central point of the bar. The induction density (B) is greatest in the centre of the bar, but falls off towards each end. If the magnetising coil is traversed by an alternating current, and if the iron is laminated, the maximum value of the induction density in the bar can be easily determined at any point in its length by placing upon the bar a flat bobbin of fine insulated wire, which is connected with an electrostatic voltmeter capable of reading from 1 to 20 volts (*see* Fig. 1). The first portion of this investigation was concerned with the study of the mode in which this induction density varies from point to point in the length of a bundle of iron strips or iron wire or steel rods



C. Magnetising Coil. I. Iron Strip. v. Exploring Coil.
V. Electrostatic Voltmeter. W. Wattmeter. D. Dynamometer.
Rh. Rheostat. A. Alternator.

FIG. 1.

of various lengths and diameters, thus placed in the centre of a long magnetising solenoid. A magnetising coil was prepared, wound on a paper tube, 5·7cm. in internal diameter and 99cm. long. On this tube was wound, in three layers, a coil of 1,235 turns of cotton-covered copper wire, 0·064in. diameter or of No. 16 size S.W.G. The resistance of this coil was 1·069 ohms at 15°C. The number of turns per centimetre length of this coil was 12·47. Hence, since the interior central field is 4π 10 times the ampere turns per unit of length of the coil, we have thus the value of the field H in the central regions of the interior of this bobbin given by the equation $H = 15{\cdot}66A$,

where A is the ampere current through the coil.

The secondary or exploring coil consisted of a flat bobbin wound up of silk-covered copper wire 0·0024in. in diameter and having 2,000 turns; the thickness or length of the bobbin being 0·7 centimetre and the external diameter about 4 5 centimetres. The exploring coil was wound on a circular ebonite former having a rectangular hole in it so as to closely fit the bundle of iron strips to be used, but at the same time it could be slid along the bundle. The voltmeter used with it was one of Prof. Ayrton's low-reading electrostatic instruments of the idiostatic type and read from 1 to 25 volts, the reading being taken by a mirror and scale. The voltmeter was calibrated when required by means of standard cells or a potentiometer.

The first experiments were conducted with strips of transformer iron, kindly furnished to us by Messrs. Sankey. This sheet iron was 0 0121in. or 0·0307cm. in thickness and the strips were each 1in. or 2·54cm. wide. The strips used were of various lengths: 60cm., 30cm., 15cm., down to 5cm. A bundle I (*see* Fig. 1) of a certain number of strips was made and the secondary coil *v* slipped

* The number of separate diagrams is under-estimated here, for in some cases the diagrams are numbered 1*a*, 1*b*, 1*c*, &c., and these in the above counting are reckoned as 1.

† Paper read before the Physical Society.

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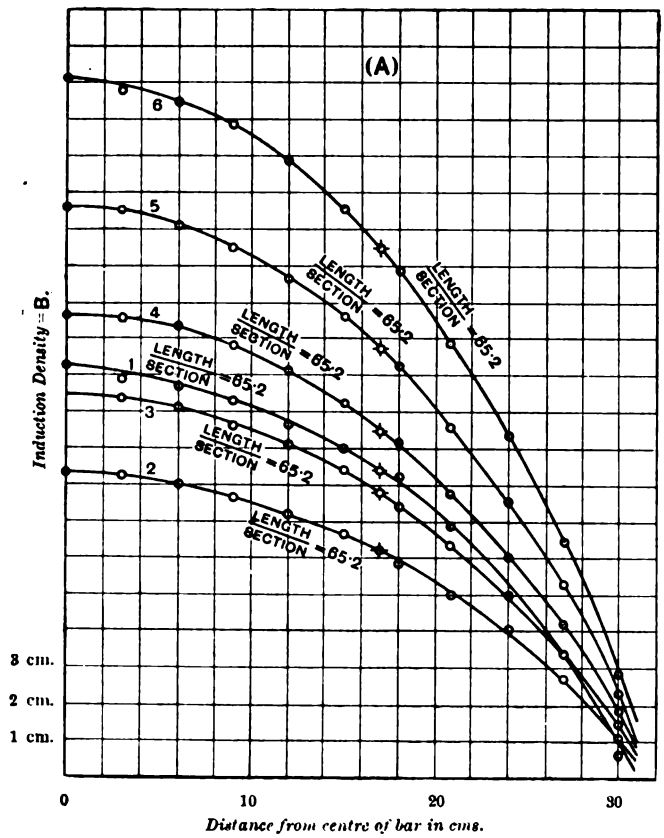
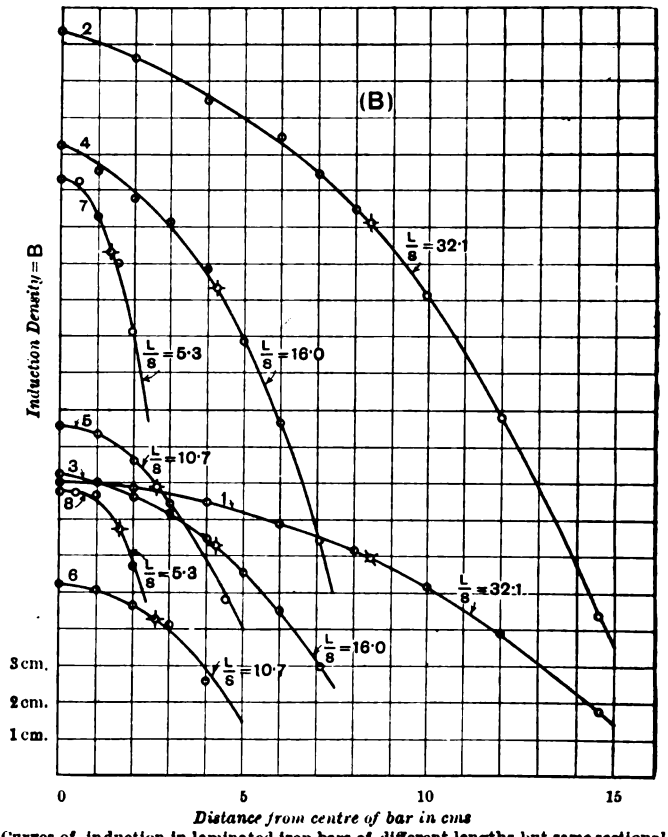


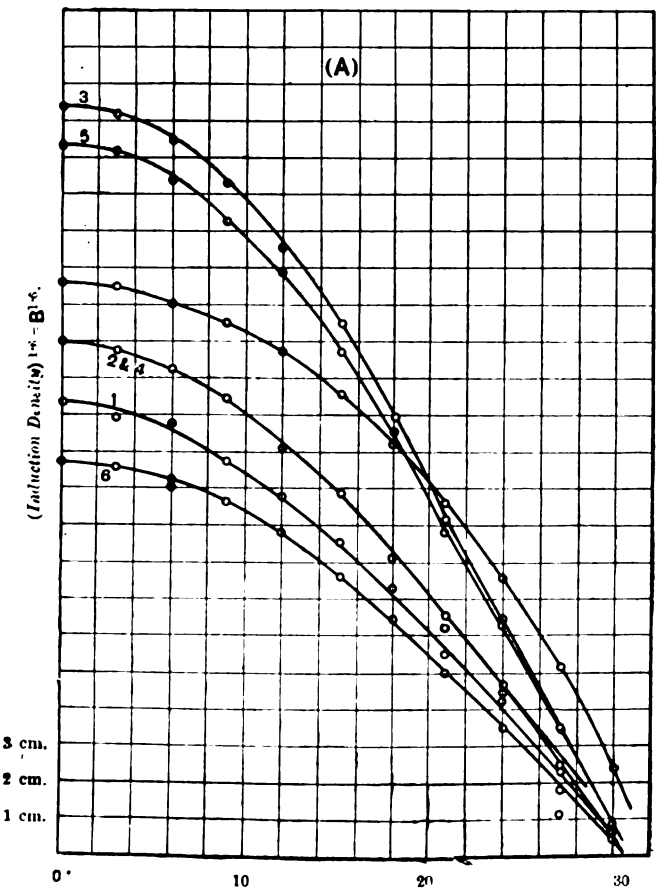
Curves of induction in a laminated iron bar 61 cms. long and having varying central maximum inductions.

Scales: Curve No. 1. 1 cm. = 50 C.G.S. units of induction.
,, No. 2 to 6. 1 cm. 200 ,, ,,



Curves of induction in laminated iron bars of different lengths but same sectional area, having various central maximum inductions.

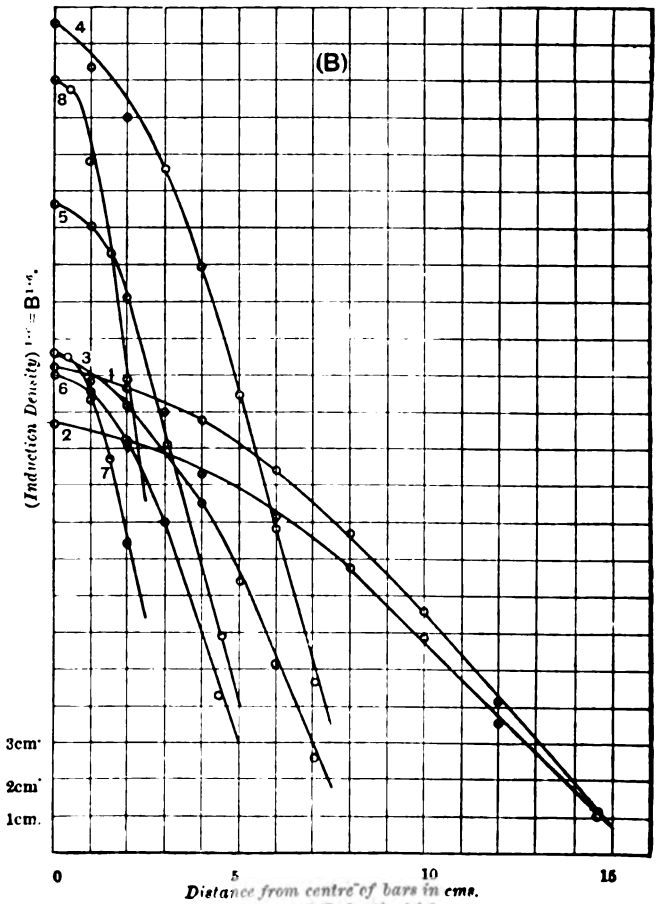
Scales :—Curves Nos. 1 to 6 1cm = 200 C.G.S. units of induction.
,, 7 and 8 1cm. = 100 ,, ,,
$S = \frac{L}{\text{sectional area}}$ length.



Curves of (Induction) 1·6.

Scales: Curves No. 1, 1 cm. = 2,000 C.G.S. units of induction.
,, Nos. 2 and 3, 1 cm. = 10,000 ,, ,, ,,
,, Nos. 4 and 5, 1 cm. = 20,000 ,, ,, ,,
,, No. 6, 1 cm. 50,000 ,, ,, ,,

FIG. 2.



Curves of (Induction) 1·6.

Scales :—Curves Nos. 1, 3, 5 and 7, 1cm. = 10,000 C.G.S. units of induction
,, 2 1cm. = 50,000 ,, ,,
,, 4 1cm. = 20,000 ,, ,,
,, 6 1cm. = 5,000 ,, ,,
,, 8 1cm. = 2,000 ,, ,,

FIG. 3.

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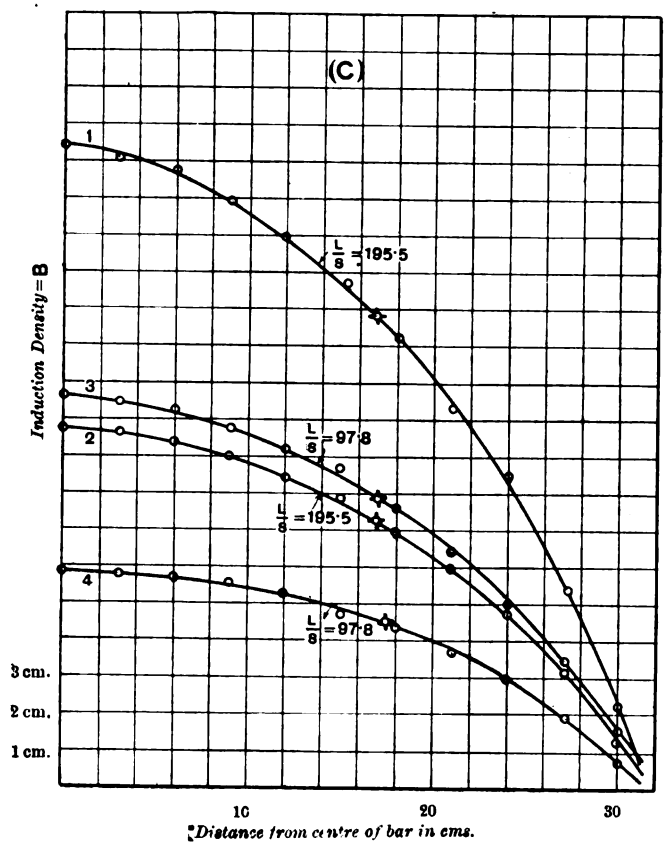
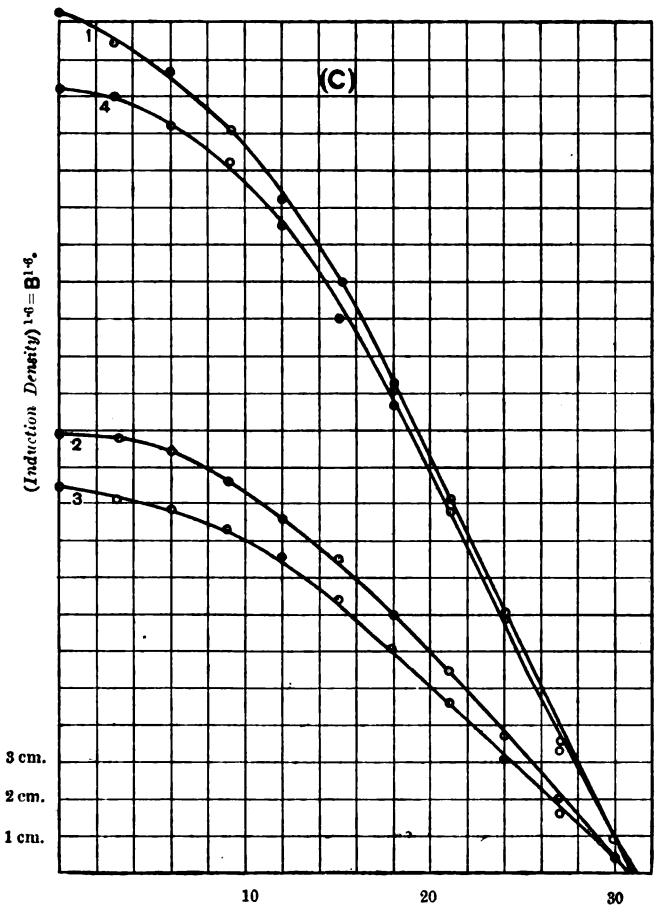


Curves of induction in laminated iron bars of the same length, but of different sectional areas and having different central maxium inductions.

Scales :—Curve Nos. 1 and 3, 1cm. = 200 C.G.S. units of induction.
,, Nos. 2 and 4, 1cm. = 1,000 ,, ,,



Curves of (Induction)$^{1·6}$.

Scales :—Curves Nos. 1 and 3, 1cm. = 20,000 C.G.S. units of induction.
,, 4 and 6, 1cm. = 50,000 ,, ,,
,, 5 ,, 1cm. = 500,000 ,, ,,
,, 2 ,, 1cm. = 200,000 ,, ,,

FIG. 4.

on to it. The magnetising coil C was then traversed by an alternating current having a frequency of 80 $\sim$, and the R.M.S. (root mean square) value of the current was read by a dynamometer D or Kelvin balance. The electrostatic voltmeter V being connected to the ends of the secondary coil gave the R.M.S. value of the induced electromotive force set up in the exploring coil. The form of the curve of the primary current was very nearly a true sine curve, and the variation of induction density in the iron at any point closely followed the same law. In any case, if f is the *form factor** of the secondary voltage curve, which in these experiments was 1·13, and if

N = the number of windings in the secondary coil,
S = the total cross-section of the iron,
B = the maximum value of the induction density in the iron in C.G.S. units at that point in its length at which the secondary coil is placed, and
n = the frequency of the induction cycle; then if e_2 is the R.M.S. value of the secondary electromotive force in volts as measured by the voltmeter, we have always

$$10^8 e_2 = 4fNSBn.$$

Hence the maximum value of the induction density B can be calculated from the known value of all the other quantities. In this manner a large number of measurements of the value of the induction density B were made at different points in the lengths of various bundles of iron strips of different lengths and total cross-sections.

These values were then laid down in a series of induction density curves so drawn that the ordinates represented the maximum value of the induction density in the bar at different transverse sections along the half-length of the bar, taken as corresponding abscissæ. It has been shown by Steinmetz and fully confirmed by others that for most varieties of iron used for electrotechnical purposes the hysteresis loss in the iron, per cycle of induction per cubic centimetre varies as a power of the maximum value of the induction density, which is very nearly 1·6, when that maximum value of the induction density has any value below about 9,000 C.G.S. units. Hence if the ordinates of the above-mentioned induction curves are all raised to the 1·6th power, and a new curve plotted showing the variation of $B^{1·6}$ along the half-length of the bar, we have another curve which represents the variation of the hysteresis loss per unit of volume along the half-length of the bar from point to point. A large series of such curves showing the variation of B and $B^{1·6}$ were drawn for bundles of iron strips and steel of different lengths and sections, and the results are collected and represented in the form of curves in the diagrams.

The upper curves in each case in the Figs. 2 to 4 represent the variation of B along the half-length of the bar, and the lower curves the corresponding curves for the variation of $B^{1·6}$. The first pair of diagrams represent the result of varying the maximum induction density in the centre of a bundle of strips of iron of the same length and section. The second pair of diagrams give the curves showing the same results for bundles of iron strips of varying lengths but the same section. The third pair for various samples of iron strips of the same length but different section. It is clear from these diagrams therefore that such a bar or bundle of iron strips placed in an originally uniform magnetic field has a non-uniform induction density produced in it at its various points, which is symmetrical about the centre; and a non-uniform hysteresis loss per unit of volume also symmetrical about the centre. The maximum values of each being at the centre of the bar.

If we take the true mean value of the varying distributed hysteresis loss per unit of volume, it is obvious that at some point in the half-length of the bar there must exist an actual induction density B_1 such that the true mean hysteresis loss in the whole bar is proportional to $B_1^{1·6}$. Let this value of the induction density be called the *effective value*, and the point in the bar at which it occurs the *effective point*. Then the effective value B_1 must be equal to the 1·6th root of the mean of the 1·6th powers of the actual induction densities taken at equidistant points all along the bar, or

$$B_1 = \sqrt[1·6]{m \,.\, B^{1·6}}$$

where m. $B^{1·6}$ stands for the mean ordinate of the curve representing the varying values of $B^{1·6}$ all along the half-length of the bar.

If, then, this effective value B_1 of the induction density is calculated for each of the samples of iron strip used, and the position at which the actual induction has this effective value is marked off on the half-length of the bar (this position is represented by the *cross* on the curves), we have noticed the remarkable fact that *whatever the length or section of the iron strip may be, the point in the bar at which the actual induction density has a value equal to the effective value, always comes at the same proportional distance from the centre of the bar: and this distance is very nearly equal to* 0·56 *of the half-length of the bar from the centre or at* 0·22 *of the whole length of the bar from one end.*

(*To be concluded.*)

* *See* "The Alternate Current Transformer," Fleming, Vol. I., new edition, p. 583, for a reference to this term.

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MUNICIPAL ELECTRIC SUPPLY AT A PROFIT.

Judging from correspondence which has reached us recently, and from the opinions expressed to us in conversation with a number of electrical experts, financial matters connected with municipal electrical supply are occupying considerable attention at the present moment, and there would appear to be divided opinions on more than one important point connected with the satisfactory working of a system of electrical supply by municipal or other local authorities. Considering the growing preponderance of such concerns over supply systems owned and worked by limited liability companies, and having in view the fact that the annual accounts of many of both classes of concern have recently been published, while others are appearing almost daily, it is only natural that the attention of engineers and local authorities should be directed at this season of the year to the financial details of management and working of municipal concerns.

Among the many matters in which electrical financiers appear to be interested in this connection, are two which may call for special notice, viz.: firstly, the vexed question as to when a municipal electric supply concern may be regarded as having turned the corner between the profit and loss account, or as having actually made a profit; and, secondly, the equally debated problem as to what to do with the profit when it has been realised. The opinions of individuals, in regard to the first of these two questions, appear to range between very wide limits, represented on the one hand by a staunch adherent of company working, who, when describing to us a glorious scheme of electrical distribution that was to absorb the little provinces of municipal authorities by the dozen, avowed his belief that scarcely any municipal concerns were being worked except at a "dead loss"; and represented, on the other hand, by the enthusiast who distributes

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puff paragraphs in the daily newspapers, booming the "success" of a municipal concern because there happens to be a balance of revenue over expenditure to carry to the net revenue account. Between these wild extremes there exist curious shades of opinion. To take a single instance: as our readers are aware, the Town Council of the borough of Luton has been contemplating the starting of an electric supply system, and Mr. ALBION T. SNELL has submitted a report recommending the adoption of a low-pressure three-wire system to start with, and giving estimates of the probable expenditure and revenue. Will it be credited that certain members of the worthy Town Council regarded the sum to be set aside annually for the redemption of capital borrowed for the construction of works as a *dead loss*, and would fain bemoan the "losing" of the £960 it was proposed to set aside each year for this purpose? This one instance will serve to illustrate the curious attitude of mind in which local authorities often regard many matters connected with the operation of an electric supply system, and especially the questions of sinking fund and depreciation.

Turning now to the second of the two problems referred to, we have to consider what is the most advantageous thing to do with a real surplus in hand after all charges have been paid. The question, unfortunately, is not one of immediate practical interest to the majority of municipal concerns; but it is to be hoped that the number of municipalities who will have to face it will speedily and continuously increase. Suppose, then, that after paying the year's expenses, setting aside proper amounts for depreciation, contingencies and sinking fund, and paying interest on loans, there is a substantial balance in hand—what should be done with it? Should it be expropriated for the relief of local rates, or added to the sinking fund so as to hasten the day of final redemption, or appropriated to the revenue account for the next year in such manner as will permit of a reduction in the charges for electrical supply? Of these three conceivable means of outlet we confess our decided preference for the last named. A municipal electric supply concern should not, in other words, be allowed to work in such a way as to accumulate a substantial profit; the prices charged should be so adjusted as to prevent this, while at the same time being kept high enough to obviate the calamity of a loss. It has been argued that since a municipal concern must receive assistance from the rates when it does not pay, it is reasonable that the surplus, when it does come, should, by a process of amiable reciprocity, assist in relieving the rates. The argument is not without force, but it may be met by one still more vigorous. It will doubtless be conceded that the whole *raison d'être* of a municipal electrical concern is that it is advantageous to the community to be so supplied with electricity. Granting this, it will follow that it is the duty of the local authorities to confer this boon upon as many members of the community as can be done without injury to other members. To grant it to everyone at the outset would be economically injurious, if it should require an increase in the rates; but when an extension of the benign influence of electric supply is rendered possible by the internal resources of an electricity department's own finances, it surely behoves those who are responsible for the administration of that department to put the extension into effect. He who asserts to the contrary is face to face with the dilemma—that it is the duty of those charged with the welfare of the *whole* community to make invidious and arbitrary distinctions between its several sections, for that is what a refusal to lower the price really means when it may be lowered without actual loss in working the concern.

STORAGE BATTERIES.*

BY E. J. WADE.

(*Continued from page 446.*)

Volkmar or "Plugged" Electrodes.

The feature common to all electrodes of this class is their metallic packing, consisting of portions of lead which are quite independent from the support proper and not in true connection with it. This packing has to be electro-chemically "formed" just as an ordinary Planté plate to give the electrode any storage capacity, and for this purpose it is arranged so as to offer a large exposed surface within a small space. It is in the form and disposition of the plugs or packing that the chief difference between the various electrodes of this type lies, for the support is generally a large holed grid or other simple form of frame possessing no very distinctive features.

The origin of these electrodes followed closely on Faure's discovery of the large capacity to be obtained by the use of applied active material, and appears to have been largely due to an endeavour to obtain equivalent results without infringing his patents. In 1881, at about the same time that Swan and Sellon patented their cellular grids and thin sheet supports in England, Volkmar also patented substantially the same devices in France, but he only proposed to fill the cells or receptacles of his supports with metallic lead either in the form of powder, dust, granules, filings, threads, wires or foil, or else in a chemically subdivided or spongy state. The latter form of the metal differs from all the others, in that it is fully prepared active material ready for use, and it is doubtful

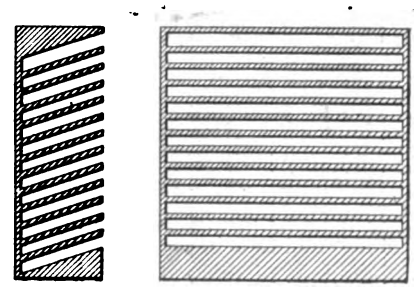

FIG. 62.

therefore whether it did come within Faure's claims; but the ultimate combination effected between the Faure, Sellon and Volkmar interests obviated the necessity that might otherwise have arisen for close inquiry into this or similar points.

In the same year Tomassi described a form of electrode, in which the support consisted of a rectangular frame of lead divided up by a number of horizontal shelves (*see* Fig. 62). Apparently he only contemplated using two such electrodes in a cell, for, as shown in the illustration, they were closed in at the back and the shelves sloped upwards towards the open face. The long, narrow pockets thus formed between the shelves were packed with layers of lead foil about $\frac{1}{250}$th of an inch thick or even thinner.

A third electrode of 1881, also belonging to the class under consideration, was De Kabath's well-known form, composed of a number of strips of lead $\frac{1}{250}$th of an inch thick, packed side by side, and enclosed in a perforated lead case or support. The strips were alternately flat and corrugated in order to keep their surfaces apart and expose as much of them as possible to the action of the electrolyte.

It is usual to treat these electrodes of Tomassi and DeKabath as being modifications and improvements upon Planté's original plates, but seeing that the lead foil employed was so exceedingly thin, that it was not in any way directly attached to its support, and that nitric acid was used to hasten its oxidisation, it would appear that the object was rather to convert the whole of the foil into masses of active material and thereby produce electrodes possessing all the characteristics of Faure's

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rather than of Planté's method of construction. This, at any rate, would be the ultimate result, whether desired or not, provided that the supporting frames or cases, which were themselves of a very slight nature, were not first destroyed.

In 1885 Elieson patented a grid electrode, in which every hole or cell was plugged with a round pellet made up of a strip of lead and a strip of asbestos cloth rolled up spirally together, the object of the asbestos being to keep the

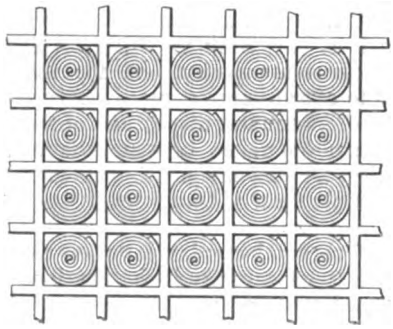

Fig. 63.

layers of lead apart and allow for access of the electrolyte and growth of active material. Fig. 63 shows a portion of such an electrode with square cells in the grid, but they could be of other shapes if desired.

In the following year Smith also proposed to fill a grid support with alternate strips of lead foil and asbestos, but

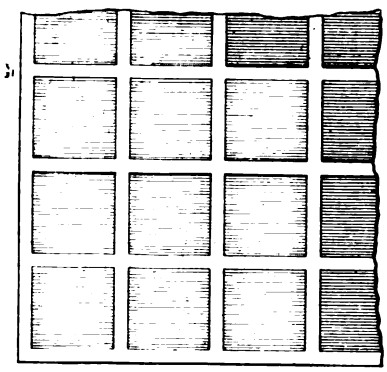

Fig. 64.

instead of rolling into a spiral he packed a number of them alongside to form rectangular blocks which were then forced into the holes in the grid under pressure. Fig. 64 illustrates a portion of his electrode. An alternative method of construction was to coat the lead strips with lead peroxide in place of the asbestos strips, and to put their ends in direct

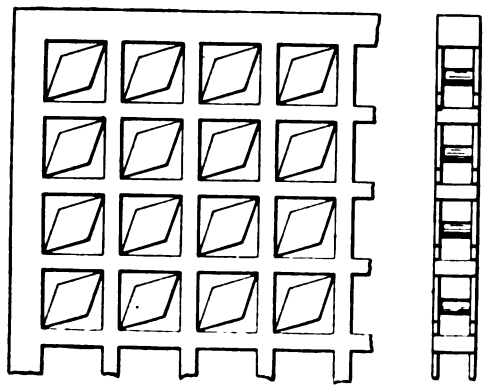

Fig. 65.

metallic connection with the frame. In 1892 Griscom described an electrode somewhat similar to that of Smith, but in this instance the strips of lead foil were spaced a small distance apart without any separating material between them, and the grid frame cast direct on to their ends. Although the strips are at first in direct contact with the support, it is specially mentioned that they shall be thin enough to be rapidly eaten through during the working of the cell, and be finally converted into active material, merely having shreds of detached metallic lead left scattered here and there in its midst.

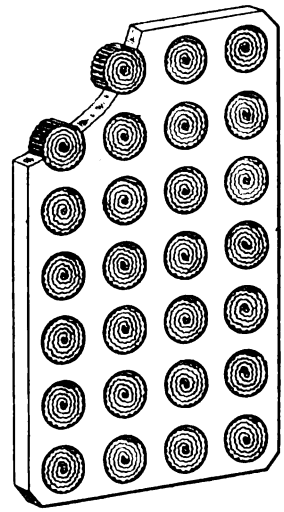

Fig. 66.

In a form of electrode patented by Gibson in 1888 a double-headed stud of lead was jammed into each hole of a grid support, and then the remainder of the space between the stud and the frame filled in with active material (*see* Fig. 65).

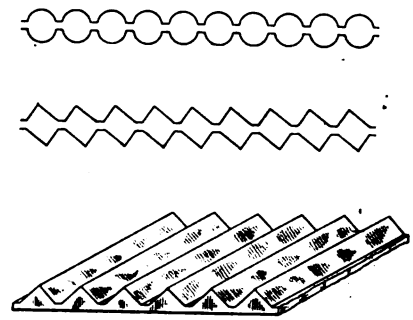

Fig. 67.

Strictly speaking, this plate belongs to the pasted grid type, as the purpose of the studs is chiefly to afford better support to the active material, but the device of plugging the holes with independent pieces of metal suggests a certain similarity.

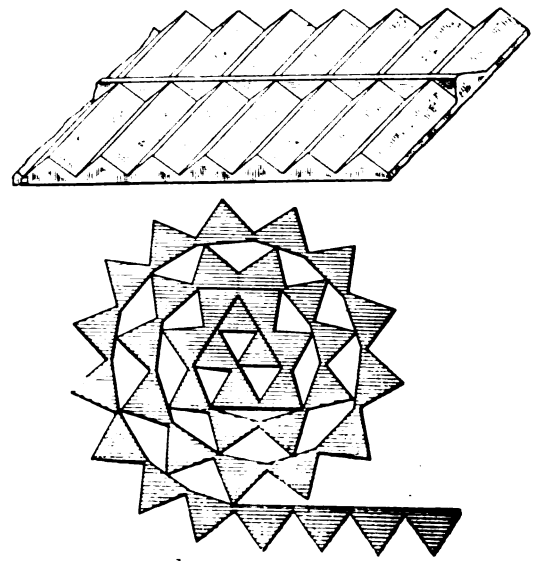

Fig. 68.

In 1891 Walter proposed to plug a round holed grid with spirals made up of strips of lead, crimped or corrugated to give them a rough or irregular surface (*see* Fig. 66), and in

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1894 Hall described the use of strips with smooth surfaces in a similar way, burring over the edges of the holes to keep the spirals in position in the frame.

A still more recent patent for electrodes of this class is that of Rhodin in 1895, which is the basis of the standard type of positive plate now manufactured the Chloride Electrical Storage Syndicate. The object he aimed at was to plug the holes in a grid with bundles of separate wires, as proposed by Volkmar, but in order to carry this out in a practical and commercial way sheets or strips of lead were pressed to form the equivalent to a number of wires joined by thin bands, or fins, of metal. Fig. 67 shows a portion of a strip of triangular wires, the shape used in practice, and two cross-sections of alternative shapes, the one round and the other rectangular. The fins of metal connecting the wires were to be thin enough to be soon eaten through by the formation and subsequent local action during working, leaving practically detached wires surrounded by oxides in each hole, but this feature is modified in a patent of Grindle's in 1896, according to which the whole of the wires are united, in addition to the fins, by a central tranverse rib as substantial as the wires themselves. Fig. 68 shows a portion of this modified form of strip, and also a side view of a rolled-up spiral, the latter equally illustrating either the earlier or more recent construction.

Planté or "Formed" Electrodes.

The chief characteristic of most Planté electrodes is a support offering a large exposed surface in proportion to its weight and bulk. Just as there are certain classes of construction, *i.e.*, the grid supports, almost exclusively confined to pasted electrodes, so there are others, as for instance, the

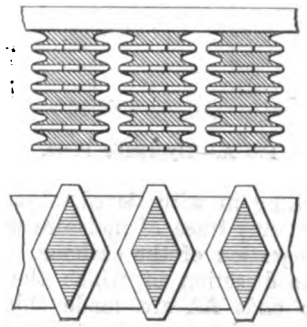

Fig. 69.

strip or ribbon supports, which are chiefly suitable for formed plates; but the generality of arrangements can be almost equally well adapted to meet the requirements of either type by a proper modification of the proportions and dimensions of their various parts.

Of this kind are the ribbed or grooved supports. Brush, in a United States patent filed in June, 1881, appears to have been the first to propose a perforated, ribbed or slotted support, specifically designed for electro-chemical formation; but in a second patent, filed one week later, he described and illustrated exactly the same supports for pasted electrodes. Some of the grooved forms of these have already been illustrated in Fig. 33, page 194.

Swan's ribbed support, also previously shown (*see* Fig. 32), was patented earlier than Brush's, but only seems to have been intended for the reception of applied active material. In a second patent of 1881, however, Swan described a support to be electro-chemically formed, and having its surfaces divided up into a series of ribs or grooves so minute as to produce the effect of a fine mat or pile of lead. This result could be obtained either by scraping smooth surfaces with a cutting tool, or by pressure between engraved plates, but in any case, solid strips or ribs were to be left at intervals between the laminated portions to maintain the strength of the electrode.

Sorley, in 1882, patented a support for electro-chemical formation, with ribs of saw-tooth section similar to that already described by Brush (*see* Fig. 35, page 194) for pasted electrodes.

In Germany, grooved supports were employed by Tudor at an early date, and they have been used ever since for the well-known electrodes associated with his name, first in a pasted and afterwards in a Planté type of plate. The former of these, with horizontal grooves and burred-over edges, was illustrated in Fig. 34, page 194.

In 1891 Tudor proposed to increase the exposed surface of his supports by running a series of fine grooves at right angles across the deeper grooves, which were now by preference placed vertically. A modification of this arrangement was to build up the electrode of a number of bars covered with a series of grooves at right angles to their length, the bars being fixed vertically and parallel to each other in a surrounding frame. Fig. 69 shows in elevation and cross-section a portion of such an electrode constructed of diamond section bars, and it will be perceived that the juxtaposition of the bars produces the effect of the larger vertical grooves, except that they pass right through from side to side instead of being divided by a central partition.

Müller, in 1892, described another method of obtaining increased exposed surface by cutting away alternate sections of adjacent grooves so as to leave rows of projections and intervening spaces, as shown in Fig. 70.

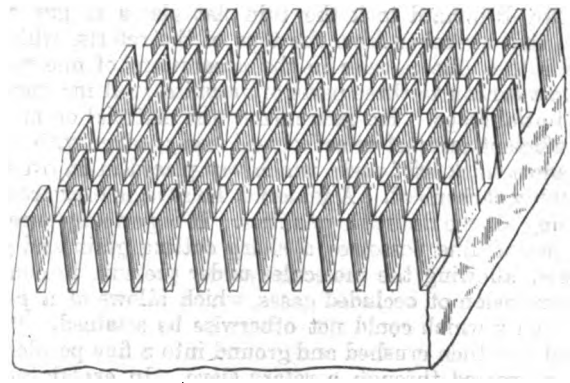

Fig. 70.

In 1890-91 Cheswright patented supports with vertically grooved faces, the speciality being their hollow construction either in the form of a number of hollow tubes placed alongside, or as a hollow rectangular plate strengthened internally with cross-sections.

(*To be continued.*)

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES

BY FRANCIS JEHL.

(*Continued from page 478.*)

Pritchard's Experiments.—Mention must also be made of the experiments and work done by O. G. Pritchard, who published in *The Electrician* in 1890 a series of articles upon the manufacture of carbons, which appeared later on in the form of a pamphlet. The process described by Pritchard was the result of eight years of experience, and the writer may state that the above-mentioned pamphlet contains much interesting information, of which the following are some extracts. The raw material used mainly by Mr. Pritchard was the foliated graphite which comes from Ceylon, which he tested as follows, in order to determine the amount of pure carbon it contains:

"Take and pulverise a small sample taken from the bulk, and dry it well at a temperature of 380°F., so as to make sure that all the moisture has been driven off. Take one gramme of this powder and 20 grammes of oxide of lead, also well dried; mix them thoroughly together and pour them into a hard glass test-tube, 5in. or 6in. long, and ½in. diameter. Weigh the tube and its contents carefully, and submit the tube to a white heat under a Fletcher's blow pipe until all gases are driven off and the contents completely fused. Allow the tube to cool, and weigh the residue in the tube. The weight lost in carbonic acid, the oxygen of which has been taken from the

* From a forthcoming book to be published by *The Electrician* Printing and Publishing Company (Limited). All rights reserved.

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lead oxide, while the carbon is all that there was in the graphite. For every 20 parts of loss there must have been 12 parts of carbon." After having obtained the desired quality of graphite, it was "ground to a fine powder in a mortar of pug mill, and then placed in iron crucibles, and mixed with chlorate of potash in the proportions of 18lb. of graphite to 11b. of the chlorate, and 2lb. of sulphuric acid (sp. gr. 1·8) to 1lb. of graphite. The mixture was then moderately heated until the last fumes of the chlorous gas were evolved, and then allowed to cool, when the excess of the sulphuric acid should be decanted. Upon this sulphated and oxidised mass pour a small quantity of fluoride of sodium, stir well together, and after the chlorous vapours have passed off, the hydrofluoric acid set free by the combination of the sodium with the sulphuric acid will convert any silica present into a gaseous fluoride of silica, which passes away in vapour and leaves the mixture pure. This mass should afterwards be thrown into water and well washed, placed again in crucibles, and submitted to a red heat in a furnace. This will cause the whole mass to swell and disintegrate, forming a light flocculent powder floating on the surface, which must be collected and dried." In order to impart a sharp cutting grain to the mass, Mr. Pritchard took the thin flat plates of gas retort carbon, that are taken from the tops of the retorts, which he ground into a fine powder in the proportions of one part of gas retort carbon to three parts of graphite, well incorporated in the initial stage. He then mixed this material or mixture with sufficient caramel or carbonised sugar, mixed with water, and made a thick, stiff paste, which was placed in an oven and thoroughly carbonised. A material, he says, is thus produced possessing all the desirable qualities. It is perfectly pure, and when ground fine possesses a sharp cutting grain and great hardness, allowing the molecules under pressure to combine to the exclusion of occluded gases, which allows of a perfect homogeneity which could not otherwise be attained. "This material was then crushed and ground into a fine powder that was then passed through a rotary sieve. In explaining the method of the preparation of the saccharine matter employed in combining the material to form the paste," he says, "all materials hitherto experimented upon and used to combine the powdered graphite, such as tar, oils, gums, hydro-carbons, resin, oil, &c., swell the carbons, after being subjected to a drying heat, inducing porosity; and no available after-process is satisfactory." The material he found to give the best results, which he used to incorporate with the prepared graphite powder, was crystallised lump sugar, although he mentions that he failed when using beet sugar, because when converted into caramel it decidedly loses the adhesive, sticky property belonging to cane sugar. Sugar heated to 400°F. loses two equivalents of water, becomes brown, cannot be recrystallised, and then is known as caramel. At 410°F. the third equivalent of water is set free, and complete carbonisation commences. In this state the specific gravity is 1·594.

The carbon powder was then pugged by adding a sufficient quantity of the liquid caramel to form a paste, which was then allowed to rest and again pugged until it possessed the proper conditions for forming carbons.

The hydraulic press used by Mr. Pritchard for squirting his carbons is shown in Fig. A. The plunger is keyed into the ram at E, so as to be removable. The weights FF consists of iron slabs, 1cwt. each, suspended from the chains NN. Five slabs on either were sufficient to raise the piston. The chains were fastened to the lugs BB, which are part of the casing. The cylinder L, with collar C, drops into the framing MM fitting tight. The piston is shown at A, while DD is a small groove. With this press he squirted carbons at about 120 atmospheres pressure, which were cut into the required lengths by a sort of shears operated by hand as the carbon rods issued from the press. The cut carbons were then placed in grooved plates, made of sheet tin, which were stored on racks in the press room. These plates and carbons were then transferred after some time to a drying room, and gradually subjected to a higher temperature until about 200°F. was attained. After the carbons were well dried and showed no tendency to bend by trying them, they were packed in kilns to be carbonised. Fig. B shows the type of kiln used by Pritchard, and of which he says:—"My system is to lay firebricks on the flat, and well grouted with cement; upon which two long sides of the kiln BB, with bricks on edge, well laid in cement, composed of three parts of Stourbridge clay and one part of iron grindings. The sludge arising from the grindstone, well mixed, forms a valuable cement, and will not crack under extreme heat. A crack in the kiln admits air, and disintegrates the carbons. The short ends of the kiln are built with bricks on the flat, AA; the thicker the ends are the better, but 4½in. are sufficient. The kiln must be 2in. longer than the width of two of the plates, and 2in. wider than the length of the plates, which should be 2in. longer than the carbons.

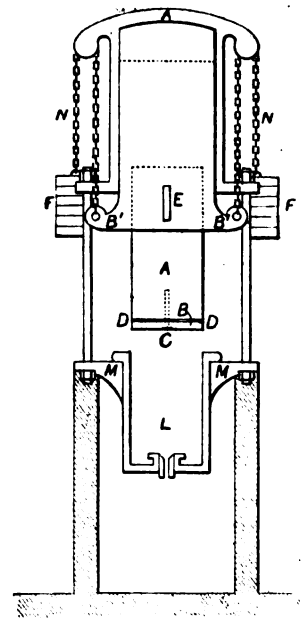

FIG A.—Hydraulic Press.

This allows for filling in with sieved ashes, which should be kept perfectly dry; any trace of moisture will show itself in the partial disintegration of the carbons. The lines at CC (Fig. B) show the direction in which the carbons are to be packed. The ends AA are made thick to avoid any lateral heat; the fires being made at DD tend to keep the carbon straight. Any heat in the direction of AA would inevitably twist them. After the kilns are packed and covered over to a depth of 2in. with the ashes, the surface had better be covered with a sheet of tin, and built in with

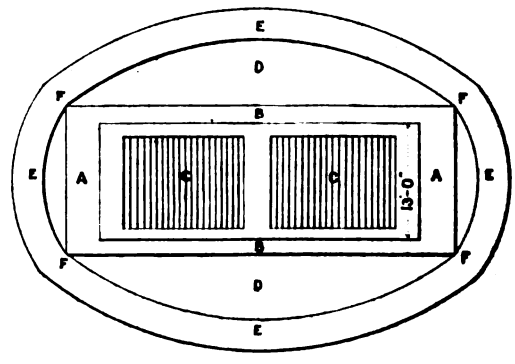

FIG. B.—Kiln (Ground Plan).

firebricks, well filled in between the joints with the prepared cement, and pointed before using the kilns. After constructing the kiln a fire should be made in and around, so that it may be perfectly dry when used. The trays in which the carbons are fired must be kept solely for that purpose. The furnace consists of a ring of firebricks, built as shown at EEEE (Fig. B), with interstices between them of about 2in., EE (Fig. C). This circular wall should impinge upon the kiln at FF (Fig. B) to keep the heat from the sides AA. The bricks are laid loose without cement, and are built to the height of the kiln.

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The fires must be lighted at DD, gradually adding coke as the fire advances, eventually increasing the height of the walls about a foot higher than the kiln. If the fire is lighted the first thing in the morning it should not be piled over the top until the evening, and this done only by covering with coke and banking over with cinders and clay. Allow this fire to die out, and the carbons will be found, on opening, when cold, sufficiently carbonised for the after-process. The second or final firing has for its object the contraction of the carbon molecules, and therefore an increase in density and conductivity. The first firing, however, must be sufficiently prolonged to effect the carbonisation of the caramel, otherwise when placed in the hot saturating bath the carbons would become partially disintegrated. The second firing should be conducted as follows:—Bank up as before mentioned in the evening; on the following morning rake out the lower holes all round, and keep a strong fire all day all over the kiln. Bank up partially in the evening, and more completely the following morning. Three days after, on opening, the kiln will be found at a white heat. When it is desired to withdraw the carbons, pull down the retaining wall, and clear away the fire and accumulated ashes, and expose the kiln to the air. Do not open before you can bear your hand on the outside. The top bricks may be taken

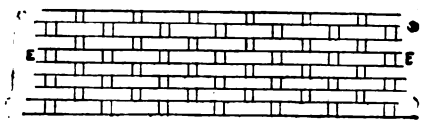

FIG. C.—Brick Wall of Furnace.

off, and the kiln emptied, if the carbons are not too hot to hold. I should mention that straight carbons will twist if exposed to the air hot from the kiln, but if once allowed to cool no after-firing has the least effect upon them." It may be mentioned that Mr. Pritchard saturated his carbons in a sugar solution, or rather syrup, while one of his methods of coreing is similar to the manner in which carbons are nowadays cored, with the exception that he uses a different coreing mixture and fired his carbons after coreing.

(*To be continued.*)

NOTES ON THE ELECTRO-CHEMICAL TREATMENT OF ORES CONTAINING THE PRECIOUS METALS.

The following is an abstract of the discussion which took place, at the Institution of Electrical Engineers, on January 27th and February 9th, in connection with Major-General Webber's Paper. Speakers who have returned their proofs revised are denoted by an asterisk:—

*Dr. F. L. TEED thought it was difficult to discuss a Paper like this because of its inolved nature. In the preliminary portions, for instance, they had processes for the electrolytic removal of gold from solvents mixed up with processes of making solvents by means of electric treatment. The Siemens and Halske process was mentioned. This was a process for removing gold from the solvents, and not a process for getting the gold into the solvent. The Pelatan process seemed to be a process for making a solvent by means of electricity, and dissolving the gold by means of the solvent so produced. That was quite apart from the deposition of the dissolved gold by means of the electric current. There was one process described in the Paper which he could not understand. The author said, "Although a preliminary mixing of the solution in a separate tank may be thus implied, there is nothing to prevent the mixing being carried out in the treatment tank itself." Taking that statement in conjunction with the tabulated list in the Paper, he would like to know what part of the gold was alleged to be extracted direct from the vat, and what part was extracted from the liquor after it had left the vat. With regard to the chemistry of the process, he thought this a little involved. There was nothing in the Paper which differentiated between one sort of ore and another. They could possibly treat a quartz ore by the process—that was to say, an ore containing nothing but quartz and gold—but neither M. Pelatan or anyone else could treat iron pyrites like this. It would be simply impossible. With regard to "agitation," he would like to know what it would cost per ton to "agitate" five-ton lots of ore, how much electric current per ton was required, and what it cost in cyanide of potassium, of which the author had said 2lb. may be required, and then, further on in the Paper, that this would be wasted. Two pounds of cyanide of potassium was an important consideration; it would probably cost 3s. On the Rand they were extracting their ore with cyanide of potassium alone, and using 4oz., or possibly 5oz., to the ton of ore; the cost was 5d., as against 3s. for chemicals, and nothing had to be added for "agitation." Nothing that anybody could say could be a greater condemnation of the Pelatan-Clerici process than the facts put forward by the author in the following passage: "Although, when not in excess, it is a useful oxidiser, this formation of sodium hypochlorite has little advantage; and when potassium cyanide is added to the solution it is, when in excess, even when alkaline, likely to oxidise some of it into potassium cyanate—a decided disadvantage, as it is a salt which is easily decomposed, and much less useful." Could any opponent of a process have said anything more virulent or more to its damage than this statement, which he was glad to see had been honestly put forward by the promoter? The author then went cheerfully on to describe how the chlorine, which was produced at such an enormous expense, united with the metallic base iron or copper, the sulphur, selenium, or arsenic being oxidised by the combined action of the chlorine and hypochlorite above alluded to, into sulphuric, selenic, or arsenic acids. If this was a process for oxidising iron and copper, how could it claim to be a gold process? The two things were incompatible.

*Mr. E. F. HERROUN thanked Major-Gen. Webber for mentioning him in the Paper. He would merely mention that, with reference to Dr. Teed's remarks as to the treatment of pyritic ores, the process mentioned by Major-Gen. Webber could be used for ores containing gold pyrites, and large quantities of pyrites could be dealt with quite easily for a moderate amount of electrical energy.

*Mr. H. L. SULMAN had listened to the Paper with great interest. The inventors of the Pelatan-Clerici process had set themselves to do what so many people had been trying to do for many years past—that was to make electricity aid a solvent of gold. With reward to the application of electricity in precipitating gold, that was, of course, past the experimental stage, and was one of the best means at present known. Major-Gen. Webber had given them a most interesting history of the electrical metallurgy of gold, but there were a great many other names which would occur to them as other workers in that direction. Prof. Crookes, he believed, took out patents some time ago for hastening the solution of gold from gold ores by means of cyanide and electricity. Atkins was, years ago, also treating pyrites with a solution of salt and electricity, but with what permanent success he did not know; but Gen. Webber had really summed up the whole question in saying that at present the only process which had achieved any success—and they must admit, from the list of ores treated in the table in the Paper, that this process seemed to have met with some success—was the process which he (the author) had described that evening. With regard to the Pielsticker process mentioned in the Paper, it was a noteworthy thing that during the trial electricity had been thrown overboard as being no aid whatever to the solution of gold. Danckwardt's idea, mentioned at length by the author, of putting a *sulphide* of ammonium into a cyanide solution was amusing, to say the least of it. In Clark's patent, mentioned in the Paper, they had the ever-recurring extraction of gold from gold pyrites by means of the electrolysis of salt, which, as a process, was as old as the hills. Dr. Keith's Paper, again, was really a *réchauffé* of the work done by Crookes and many others before him. The speaker and his colleague, Dr. Teed, had worked along the same line for some time, but it had been the invariable experience that though there was a very rapid solution of gold for an extremely short time, after this period the gold became covered with mercury, and the action of cyanide stopped. But coming again to the Pelatan-Clerici process in which "agitation" was an essential feature, he thought this a retrograde step. Agitation, especially with cyanide, had been tried from the first, but it had been found that the energy consumed was so great as to render it speedily useless as a process, and it was only when agitation was given up that the cyanide began to be the successful process it had been. A further disadvantage, beside the consumption of energy demanded, was the increased decomposition of the solvent. Then they had to consider the plant that was required to deal with a given mass of ore. In the Transvaal, and many other places, it was by no means uncommon to see one vat treat 300 tons of ore in a single charge. But if they wanted to treat 200 tons by this Pelatan-Clerici process, they required no less than 40 tanks; and he would ask what there was to make people wish to take up this process when a far simpler one was giving better results. It might be that the author of the Paper had done himself and the inventors an unwitting injustice, but he had given no single figure of cost. The consumption of cyanide was very high, however, while with the Sulman-Teed process they were extracting ore in Canada, which sometimes contained 40 per cent. of arsenic, with only 1lb. of cyanide, and in 36 hours they had extracted 90 per cent. of the gold without any electricity whatever. Under the process advocated in the Paper it would take 10 of these tanks to deal with the same amount of ore, and admittedly with a much larger amount of cyanogen. Dr. Herroun had just stated that it was practicable to use a system like this for extracting gold from pyrites ore. In many of these pyrites ores the gold was found in films between the pyrites crystals. It was in such ores as these that he would consider the Pelatan process useless.

Prof. BAUERMANN said that he looked upon this Pelatan process with extreme sympathy. So far as he had been able to make out from what he had seen of the process, the mill illustrated in Fig. 10 seemed to be rather a large development of their old friend the Hungarian mill, with the use of their potent friend electricity to keep the mercury alive. This was a very brilliant combination, but he would like to know how so large a surface of mercury kept itself alive even with the aid of electricity. He hoped it did.

*Mr. H. C. JENKINS said the Paper seemed to have invoked discussion upon one process alone, but they must thank General Webber for having put together a *résumé* of what had been done in the past. It was quite possible that, in the Pelatan-Clerici process, by keeping away from the use of an excessive amount of chemicals and sticking rather closely to the common salt solution, the inventors might solve the problem of how to get a quick surface of mercury under conditions where that would be otherwise impossible. No doubt they loaded up their mercury with a certain

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amount of sodium, and, like Molloy, used this to keep the surface of the mercury perfectly clean while the stream of crushed ore was passing over it. The energy used in the plant seemed to be very large indeed from the figures that they had and also from those in the Paper. They seemed to require something like 36 H.P. hours per ton of ore, which was a considerable thing in itself, let alone the enormous cost represented by the two or more pounds of cyanide per ton of ore crushed. At the Crown Reef they were working at something like 3s. 9d. per ton, and altogether, with the cost of cyanide, the ore ran out at about 6s. per ton. At the Wemmer mine the treatment of the pyrites cost about 4s. per ton and the cyanide something like 2s. 4d., making a total of 7s. per ton of ore. On the face of these costs, he thought it was out of the question to contemplate the use, for poor ores, of so costly a plant as this seemed to be. At the same time it was possible that some rich ores, slightly refractory, could be treated by this process.

*Mr. PELATAN said that it had been asked if the mixing vats which had been alluded to by Major-Gen. Webber were not part of the process, and if the gold was taken partly in one vat and partly in the other. The explanation was this: The ore was gradually crushed in a stamp battery, and 2½ tons were treated at a time in the vat. They could not afford to let the pulp go from the screens to the vats, so that they had a mixing vat which collected a certain quantity of pulp to be charged. When the charge was emptied from one vat they filled it from the mixing vat, but this mixing vat was no process at all. It was only a vat to contain the ore. The explanation of the fact that part of the gold was got in one way and part in another was this: When they charged the pulp in the treatment vat they always ran for about two hours with water, salt, ore, and current, but no cyanide, and when they took the sample of pulp after two hours they found a certain quantity of gold in the mercury. They then used cyanide. The operation was always the same. They knew by experience from large works that it required ½ H.P. to stir up 5 tons in the vat. As regards the expenditure of electrical energy, the usual pressure was 7 volts, and the number of amperes varied according to the quantity of gold to be precipitated. With the ore usually taken in a vat about 70 amperes were employed. Well, then, 70 by 7 was 490 watts, which was about ⅔ H.P. According to the Paper, 36 H.P. extra was necessary for the extra 50 tons, but that included the milling, and he knew of hardly any process that could treat ore without milling. They used a special cyanide as a solvent. They did not pretend to form a cyanide; they used it as a solvent. It was unfair to compare such ores as the tailings of the Rand with very rich ores, so far as consumption of cyanide was concerned. In Russia they had a mill where they were constantly treating ores with 4 or 5 per cent. of arsenical pyrites, and yet did not use more than ½lb. of cyanide.

A number of questions concerning the Pelatan-Clerici process had been sent by Mr. H. L. Sulman to *Mr. Pelatan, and, the latter gentleman having kindly communicated answers of these to the Institution, both questions and answers were read out by the Assistant Secretary on the resumption of the discussion on February 9th:—

Question 1.—What is the capital cost of each tank and the total tankage necessary, and what is the installation cost of this on a scale to treat 100 tons per 24 hours *without crushing plant*?—*Answer:* One treatment tank, with connections and appliances, costs £60 (*i.e.*, a 9ft. diameter tank of 5 tons capacity per 24 hours); 20 such tanks are required to treat 100 tons of ore per day. The cost of an installation having a capacity of 100 tons per 24 hours does not exceed £5,000, everything complete and ready to work, but *without* crushing plant.

Question 2.—The sludge having been stated to contain 60 per cent. of water only, and being therefore very thick, how is it possible to agitate thoroughly such a mass at an expenditure of only ½ H.P. Would not this imply that the whole mass, resting upon a layer of mercury, would be revolved *on the mercury* as on a turn-table, and hence efficient agitation reduced to a minimum? Where agitation of an ore charged with cyanide in a stationary vat, under like conditions of liquor contents, has been hitherto tried, it has generally been found to consume energy to an extent approaching 1 H.P.—*Answer:* A sludge with 60 per cent. of water may still be very thin. All depends upon the density and nature of the ore. It is true that sometimes, with slimy and light ores, as much as 100 per cent. of water must be used. At all events, a very good agitation is obtained with only ½ H.P. per tank corresponding to ½th H.P. per ton of ore. The trials alluded to, in which as much as 1 H.P. per ton of ore was required to ensure agitation, must have been made with revolving barrels, with which friction is very great.

Question 3.—What is the total cost required for treating a double charge (of five tons) of ore in one tank for 24 hours, including the following items:—(1) Cost of electrical energy; (2) Cost of the agitation energy; (3) Cost of salt; (4) Consumption and cost of cyanide; (5) Details as to the use and necessity of the consumption and cost of the organic acids which are mentioned as essential parts of the process; (6) What is the weight of the charge of mercury for each tank, and the loss of mercury on each operation? (7) What is the cost of labour and supervision per tank? (8) Total cost per ton exclusive of crushing?—*Answer:* The cost of treatment per ton for the average ores, on the basis of 100 tons treated per 24 hours will vary, according to the consumption of chemicals and the circumstances, between:—Cost of chemicals including salt, cyanide, lime, mercury, &c., 2s. 6d. to 4s.; cost of power, 1s. to 1s. 6d.; cost of labour, 6d. to 1s.; total, 4s. to 6s. 6d. In the case of slimes the cost may be still further reduced. 600lbs. of mercury are charged in each tank. The loss is purely mechanical, and amounts to no more than 2oz. of quicksilver per ton of ore at the outside.

Question 4.—What is the fineness of the bullion from the mercury obtained from ore varying in character?—*Answer:* The bullion obtained from average ores contains at least 800 fine, unless they are oxidised and yield copper oxides or copper salts, when the copper is dissolved to a certain extent, and afterwards deposited in the mercury, together with the gold and silver.

Question 5.—Is any cyanide recovered from the spent liquors, and how are these dealt with?—*Answer:* The exhausted sludge is thrown away without the liquors being separated, and no attempt has been made to recover any cyanide, as it would not be worth while.

Question 6.—What would be the cost of dealing with 100 tons of pyritic concentrates or heavily pyritic ore containing copper and arsenic, such as is being treated by the bromo-cyanide process at Deloro, in Canada, including cost of clean up?—*Answer:* No accurate figures can be given, nor even approximate ones, for an ore the composition and nature of which are only given in a very general way, and which has not been tested.

Question 7.—Information as to the nature of the ores scheduled on page 551 with reference to the mineralised contents, and the nature of the gold contained therein; also as to the coarseness or fineness, and how far such could be amalgamated (before solution treatment) by ordinary methods?—*Answer:* The ores scheduled in Gen. Webber's Paper (page 551) are respectively:—Rose: oxidised iron ore with very fine gold (very slimy). Delamar: decomposed feldspar and quartz with some pyrites and some argentite. Oaxaca: Rusty quartz with some pyrites. Bassick tailings: quartz with pyrites and tellurides. Baby: soft conglomerate with iron pyrites (very slimy). Phœnix: talcose quartz (slimy). Leroi: diorite with an abundance of iron and copper pyrites. Alma: talcose quartz with good quantity of iron pyrites. Miller: oxidised iron ore with some manganese. All these ores give very poor and in some cases no result by the ordinary methods of amalgamation.

Question 8.—In the treatment of an arsenical copper ore how much arsenic and copper go into the mercury, and how is it thus purified for re-use?—*Answer:* Practically no arsenic at all goes into the mercury and almost no copper when found as copper pyrites. Only copper oxides and soluble salts are really objectionable. The mercury in a vat can be used over and over again, the amalgam being drawn from it every fortnight or every month, as the case may be.

Question 9.—We are told at the bottom of page 551 that iron and copper go into solution to a considerable extent under the action of chlorine and hypochlorites, and that these metallic salts are precipitated by lime before the cyanide is added. What becomes of the ferrous and cupric hydrates that form in the sludge, and how is this cyanide destroying effect overcome, and at what expense?—*Answer:* The former answer deals partly with this question as well. Nothing more than adding lime is done to prevent destruction of cyanide, and the result proves to be both good and cheap.

Question 10.—As to the second footnote on page 551 with reference to the production of slimes, I would point out that the *actual extraction* by fine crushing does not become less effective *but more effective*. It is the difficulty of *percolation* that is the bar. As to the readiness of makers of milling machinery to supply plant for crushing ores to 80 or 100 mesh, there can be no question of this; they would be only too glad to get the order for such greatly increased crushing plants as would be necessary. It is those who would have to pay for the milling of the ore to such extreme fineness who would look blank at the prospect.—*Answer: All percolation processes* are limited in their efficiency, as far as the extraction of gold is concerned, by the fact that it is impossible to percolate the solutions properly through slimes. The Pelatan-Clerici process does not resort to percolation, and therefore its extracting power is much greater. For medium grade and rich ores very fine crushing will lead to an extra expense, which will be amply repaid by the gain made in the recovery. After having tested the ores of more than 200 mines in the United States, we find that in crushing from 80 to 100 mesh only 10 per cent. of the ores treated will yield less than 80 per cent. of the gold contained therein.

Question 11.—At the top of the second column of p. 552 it is stated that the dissolved *cyanogen* will readily unite with the slightest particles of gold; this is quite incorrect. A solution of cyanogen as potassium cyanide is *quite* without effect on gold; it is only *nascent* cyanogen which acts in this way.—*Answer:* The cyanogen alluded to here is "*formed at the anode*" (by the electric current); it is therefore in the nascent state, and, according to Mr. Sulman himself, it can unite with the light particles of gold.

Question 12.—Finally, an essential point has been missed in relation to slime treatment. The author of the Paper has not shown in any way that slimes can be more readily dealt with by this than by any other processes. The tabulated results on page 551 show an average extraction of 80 per cent.; the balance of 18 per cent. would easily correspond to the gold contained in from 30 to 40 per cent. of slimes produced from such ores, and the invariable experience is that electric amalgamation or electric deposition of gold from cyanide slime will not work at all whilst the mass remains turbid with suspended slimes. If the contrary were the case there would have been (for the past ten years) no slime question at all. Hundreds of experiments have been made with the view of electro-depositing the gold from a cyanide solution in which the depleted slimes still remain suspended, but a clear solution is imperatively demanded to effect this. The same difficulty applies in as great a degree to electro-amalgamation. I could instance at least a dozen cases within my own knowledge in which this has occurred, and would again ask what evidence the inventors have that they have overcome this difficulty?—*Answer:* The fact that the Pelatan-Clerici process can deal with ores crushed to 100 mesh, 150 mesh and more, is sufficient evidence that it can deal with slimes. This is equal to saying that if the tailings of the Rand could be cyanided together with the slimes, the gold in the slimes would not be dissolved at all, or we fail to understand it. We have extracted 82 per cent. of the gold from the ores scheduled on page 551 (said ores being crushed at 40 mesh). If the crushing had been made at 60 or 80 mesh, we would have extracted more, and consequently left less in the tailings. The entire remark about electric amalgamation or electro-deposition is exceedingly valuable, especially as it is expressed by an inventor. The novelty of our process could not have been established and emphasised by a more competent authority.

Mr. V. A. LOUIS (communicated) asked for further information to show that the process was even as good as, or better than, other processes in use. There was nothing to show the extent of the operations from

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which the results were obtained, nothing to show how the operations progressed in each case, no estimate as to the time, power, and labour, and nothing to show whether the extraction was good, bad, or indifferent, from the point of view of the product obtained.

Mr. C. F. COOPER said that if the action of chlorine was, as described, essential to the process, it would be somewhat better if it were added mechanically. It could not be said to be nascent after it had once left the anode.

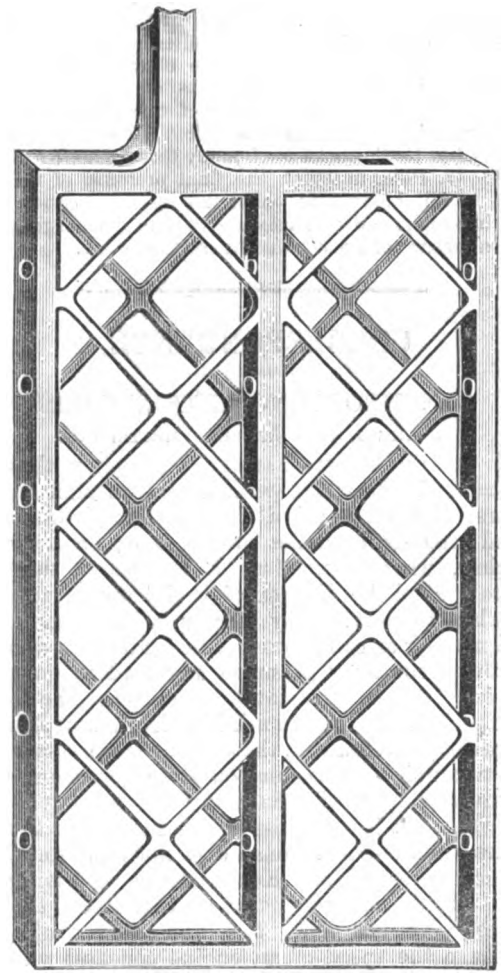
*Major-Gen. WEBBER, in reply, said that they had been told that his figures gave an expenditure of energy of 36 H.P. hours per ton of ore treated. This was not the case, and there was no foundation for the statement. He had been reproached for not having given costs; but the Paper had been intended to elicit information on the scientific aspect and not the commercial side of the subject. In answer to Mr. Jenkins' remarks, the treatment of tailings and slimes at the Rand were quite separate questions. The treatment of the tailings was an operation which had long been in full work by means of the McArthur Forest process, but the treatment of the slimes, of which enormous heaps had been accumulating for years, was a question that had only quite recently approached practical solution. Mr. Jenkins had given them some costs—viz., 6s. to 7s. per ton for milling and cyanide treatment—which did not include the further cost of the treatment of the slimes, and this was a question which could only be approached from the point of view of those costs when very large quantities were dealt with. For instance, 500 to 1,000 tons per day was the figure they totalled at the Rand, which was an extremely rare state of affairs in other parts of the world. In making any further comparison of costs, that of milling being equal, there remained on one side (the side Mr. Jenkins had in his mind when speaking of 6s. to 7s. per ton) three processes, viz., concentration, treatment over the amalgam plates, and cyanide and deposition of the tailings, as against only one treatment, viz., electrolysis and agitation as he (Major-Gen. Webber) had tried to describe. Mr. Jenkins had also failed to tell them that the time occupied in the process and the space covered by the plant was three or four times greater in the former than in the latter instance. Besides this there was a factor which varied everywhere, viz., the cost of labour, and he thought this condition was a sufficient reason for his having avoided costs. It was only the low cost of labour that made the treatment of the enormous masses of tailings on the Rand commercially possible. The Kaffir hand labour employed to fill and empty the percolating vats on the Rand, each containing 600 tons, cost about 2s. per day, as against 10s. to 12s. in the mining camps, where white labour is available. It was also notable that Messrs. Sulman and Teed, who were themselves inventors of the process they had mentioned, while anxious for information as regards the cost of his system, had not given them any cost of their own system, which would have been extremely interesting to all of them, so that they could have drawn comparisons between the two processes. He believed theirs was a percolation system, and the only report he could get as to the cost of it was from a mine in West Australia, belonging to the Broombill Gold Mining Company. The ore contained 4 ounces of gold to the ton, with an estimated extraction of 80 to 90 per cent., but the dusts which were formed in the mill, and which when wet formed the slimes, had to be treated separately by what was known as the "filter press" process, and crushing also had to be used before the extraction began. This ran the total cost up to 18s. per ton with the price of labour at present in West Australia. This was far beyond anything he had contemplated as coming within the range of the practical treatment of low-grade ores, and they would observe that the list he gave in the Paper were all of an extremely low grade. He had only referred to these matters to show the Institution that costs were governed more by local conditions than anything else. If his Paper had been an engineering description of the work at any particular mine or mill, naturally costs would have been given. With regard to Mr. Teed's remarks, the precipitation or settlement of the free gold took place in the mill during the 10 hours' treatment mentioned.; there was no subsequent treatment, electric or otherwise. Whether the ore contained quartz or was pyritic, it was subject to the same electro-chemical action, only varying in length of time, quantity of chemicals and current. The reason for his not having referred to the good work of Sir William Crookes in connection with the treatment of ores was that Sir William had not published anything about the electro-chemical treatment of ores combined with agitation. One of the very few points that had been raised in the discussion, and which appeared to him to bear specially on the subject, was the work done between the anode and the cathode. It was the effect of a turbid solution as compared with a clear one on the electrolytic actions and reactions. They knew that turbidity must be absent from the Siemens and Halske process, in which the gold was deposited from a clear solution. That was quite certain. It was probable that in what may be called the circulation processes generally some addition was necessary to success. In his Paper he had alluded to two or three of the circulation processes, so far as they were illustrative of his own particular subject, but there were a great many more. Probably the Siemens and Halske was the best process of the circulation of clear liquid. It appeared to him that the objectors to agitation had forgotten that amalgamation and not deposition was the main object, and he thought that Mr. Sulman's statement that amalgamation could not be produced electrolytically required proof. If electricity was of no use in this direction, then his Paper should never have been read before that Institution. In reply to Mr. Cooper's question as to whether chlorine was essential to the process, Major-Gen. Webber said he was afraid he could not answer the question directly. Chloride of sodium was essential to the electrolytic conditions required in the early stage of the process and throughout for reducing the resistance in the electrolyte, and naturally chlorine was given off. The idea of his Paper had been to show why chlorine was added and what it was likely to do, and so the addition of chlorine direct instead of being added electrolytically would be out of place.

*The PRESIDENT (Mr. J. W. Swan) said the Paper that Major-Gen. Webber had read dealt with a very important subject, viz., the advantage of electricity in promoting the extraction of gold from its ores. They already knew that in South Africa electricity was used for the deposition of gold that had been brought into solution by the action of cyanide of potassium. In that case, as Major-Gen. Webber had pointed out, they were dealing with a clear solution containing gold, and that that was purely a case of electro deposition. But the processes which Major-Gen. Webber had dealt with, and the one that had been more particularly discussed—the Pelatan-Clerici process—aimed at doing something more than was done on such extensive lines in South Africa. It aimed not only at depositing the gold in solution, but also at assisting amalgamation, as the mercury in the vat was the cathode of an electrolytic system, and no doubt the gold in solution would be deposited through the electrolytic action. Another action was, of course, going on simultaneously, viz., the amalgamation of the gold which had not been brought into solution but had been brought into contact with the surface of the mercury kept fresh and clean by the action of the electric current. The subject dealt with had a larger scope than that of the electro-deposition of gold on a cathode, as described by Dr. Keith in the Paper he recently read before the Institution. The subject of the present Paper was an exceedingly important one, and they had had a very valuable discussion well worth the time bestowed on it.

A vote of thanks to Major-Gen. Webber for his Paper was carried unanimously.

THE "ALLAN" STORAGE BATTERY.

The demand for a hardy accumulator occasioned by the advent of the motor car has given a decided impetus to the development of a type of secondary battery suitable for traction purposes. It is a singularly fortunate thing that this should have occurred just when, in consequence both of the perfection of the trolley system and the discouraging results of a few misleading experiments in accumulator traction, the latter form of tramway traction was already being looked upon by engineers as "out of court." Now, however, it seems as if the electric motor-car were going to justify the use of the accumulator for tramway work no less than its own existence.



Lead Grid or Frame (without paste) of the "Allan" Storage Cell.

Recently, a new type of secondary cell—specially designed for traction work—has made a bid for notice, viz., the "Allan" accumulator, manufactured by Messrs. Allan and Adamson. This cell has been on the market for nearly three years already, but

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recent important modifications in its construction, by which its durability and safety under high discharge rates have been increased, give it now a claim to further notice. The plates of this cell are of the pasted form, the active material being supported inside and flush with the surface of a flat hollow frame or crate of lead (of which we give an illustration), both positive and negative elements being of similar construction. This crate or hollow frame is cast in one piece, otherwise it might be looked upon as a flat box, measuring outside (in one size) about 4¼in. by 9in. by ⅝in., with its two large sides pierced with lozenge-shaped perforations so as to leave a lattice-work extending from edge-to-edge on both sides of the frame. Until recently these lattices had bevelled edges on the outsides of the frame, so as to enable the latter to easily leave the mould after casting. This form of lattice was found defective, because, though it locked the paste at first, under the subsequent breathing action of the active material the latter could not contract or the lattices expand outwards without clipping off a flake of the paste. This difficulty was overcome by an ingenious method of casting the crate, so that the bevels of the lattices were inside the frame, which was still cast in one piece as before.

The composition of the paste used is said to be of such a nature as permits it to be made of almost any hardness during formation without lessening its power to discharge at very high rates with impunity. The following figures have been furnished by the makers respecting this accumulator. The discharge rate for three hours is 1·5 ampere per pound weight of complete cell; the average energy capacity at the above discharge rate is 9 watt-hours per pound weight, and the total capacity is given as 6 ampere-hours per pound weight of complete cell. The following figures supplied us also by the makers respecting their "R.S." type cell are of interest: Weight of one element, with box, connections and acid complete, 30lb.; discharge rate, 45 amperes per element, or 1·5 amperes per pound weight; total capacity of one element (complete), 135 ampere-hours or 270 watt-hours; the average pressure being 2 volts; the average energy capacity of one element complete is therefore 9 watt-hours per pound weight. These figures appear to be substantiated by the records of many tests made by the makers and by Mr. W. Peto, in which the final pressure of the cells was found not to fall below 1·81 volts, the tests indicating a decided reduction in weight and size relative to safe discharging rate and capacity—a feature of great value in traction work.

CORRESPONDENCE.

SYNCHRONISING ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am afraid Mr. Kensit's assumption that I have had no practical experience with actual parallel running of alternators, and have asked the question I did on purely theoretical grounds, is rather unfortunate; on the contrary, at one time, when inexperienced, I used to think it was possible to control the division of load between steam alternators, when in parallel, by merely altering excitation, in the same manner as can be done with continuous current sets. Finding that I could not persuade any load to go over, and having since met many station engineers who have had similar experience, led me to ask Mr. Kensit how it was done.

I am perfectly well aware that two or more steam alternators, when running in parallel on their governors, with the stop-valves wide open, will share any change of load between them all right, but this is quite a different matter to the question I asked, and one Mr. Kensit does not reply to. To make the matter clearer, as Mr. Kensit claims to having had an extended experience with steam alternators, I think he will agree with me that the best makes of governor will not keep the speed of an engine constant within 1 per cent. between no load and full load, and I doubt if he will find an engine that will govern within 2 per cent. Assuming the engines to govern within 1 per cent., and that two are running in parallel with their stop valves wide open, and also that one set is half loaded and the other has no load, does Mr. Kensit seriously mean to say that the load can be transferred from the half-loaded set to the other merely by altering their respective exciting currents, and not in any way interfering with the admission of steam to the engines?

It seems to me that for the lightly-loaded set to take up this load its speed will have to drop ½ per cent., since, with the governors in a fixed position, the engine will be having a definite amount of steam admitted to it, and will, therefore, be giving a constant torque to the crank shaft, and if the torque is to be increased the position of the governors will have to alter. If the other set is to give up its load its speed will have to rise ½ per cent.; and if they do this, how is it possible for the alternators to keep in step? Will Mr. Kensit kindly explain away this difficulty, or else admit that he has made a mistake?—Yours, &c.,

Feb. 21, 1898. H. H. N.

COMMUTATION OF CONTINUOUS-CURRENT DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your article on Mr. Reid's Paper on "Sparking: its Causes and Effects," as well as in the original Paper, it seems to be assumed that there are two distinct effects due to the current in the armature—(1) a distortion of the resultant field; and (2) an impedance E.M.F., and that it is the sum of these two effects which has to be balanced by the reversing E.M.F.; or, in other words, that as the impedance E.M.F. increases, the available reversing E.M.F. tends to diminish and become negative. Now these are not two separate effects, but merely different ways of stating the same fact. The diminution of the reversing E.M.F. is due to its being cancelled by the impedance E.M.F., and our observations give us the difference between the two, which is spent in driving current through the surface of contact between brush and commutator, or, if this is insufficient to absorb it, in sparking. We may consider the distortion of field due to the superposition of the armature field on that of the magnets, or the alteration of the curve of E.M.F. measured from section to section round the commutator by the inductance E.M.Fs. due to the self and mutual induction of the armature coils. The result is the same in both cases, and we have only to reckon with this once.

The consequence of this is that we may commutate at a point where the resultant field or E.M.F. is zero, since that is another way of stating that the reversing E.M.F. is equal to the impedance E.M.F., and there is no need for any additional reversing E.M.F. The inductances in this case would be measured by ballistic-galvanameter methods, for since the effects of rotation and uniform commutation balance each other externally, producing a stationary armature field, there is no need to consider the effect of closed secondary circuits in the pole-pieces, &c.

There is still to be considered the effects of non-uniform commutation due to a gradient in the reversing field. In the case of a dynamo the resultant reversing field is at first negative, and the current increases instead of diminishing; this produces a pulsation in the armature field which is screened off from the magnets by secondary currents in the pole-pieces, so that the impedance is relatively small, and therefore large fluctuations of current may be produced by small variations of reversing E.M.F.

It must be noticed that the so-called impedance E.M.F. for uniform commutation does not depend on the current in the short-circuited coil alone, but on a complicated system of varying mutual induction with the surrounding coils which is summed up by saying that the E.M.F. is produced by the coil within cutting the armature field. The inductance for currents superposed on the uniform variation is a small constant quantity, so that the fluctuations of current in the short-circuited coil depend on the resultant field only. If this resultant field is very far from zero on the average the current fluctuations are sufficient to fuse the brush tips and cause sparking. There are many experiments bearing on these points which must be reserved for another time.—Yours, &c., R. H. HOUSMAN.

Birmingham, Feb. 14, 1898.

LOCALISATION OF FAULTS IN SUBMARINE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. W. J. Murphy's criticism in your issue of Dec. 24, and his suggestion as to the possible correlation of the Kennelly laws with those I have recently published, and which would consequently give the function of the

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polarisation with respect to the current, my observation has convinced me that no such connection can be established. The two sets of laws are true only for the particular method of testing, Kennelly's being applicable to scale zero measurement under suitable conditions of the ratio of currents.

It seems to me obviously wrong to consider the polarisation as an extra resistance in *series* with the exposure; indeed, there seems every reason to believe that it acts as a *shunt* on it. In balancing by the false-zero method, at the moment the battery key is released the polarisation discharge produces a current in the reverse direction through the line circuit, but this is not incompatible with the idea that the current through the electrolyte, or rather the media between which the polarisation operates, may be in the same direction as before, and result merely in a lag of the testing current.

The truth of this deduction being admitted, it is clear that the resistance of the break during the brief interval elapsing before the false zero can be adjusted, has increased enormously and continues to do so at a decreasing rate, gradually approaching the limit infinity if left to discharge itself internally (*i.e.*, by freeing the accessible end of the cable) by which time the potential at the exposure would have fallen to that of the natural primary couple. That this is a property shared by all batteries seems most probable, since it would explain the reason why the potentials in an idle cell do not gradually equalise and thus discharge it.

It is at a moment when these complex disturbances are in progress that the inferred zero is selected, the measurement of f being effected by two distinctly different values and conditions, under which peculiar circumstances the Kennelly laws follow for the apparent resistance of the exposure.

Although it seems obvious to regard the polarisation as a function of the current, my experiments have shown that with currents such as are ordinarily used, the immediate discharge from the exposure on release of the battery key is practically constant within a wide range, and appears to be independent of the area. Thus if that were the correct value of the polarisation simultaneously with the "current on" period, its function as a spurious resistance would vary simply inversely as the current.

I reiterate my view, and think it more correct to regard the polarisation as a counter-current, the absolute value of which although undeterminable independently of the battery effect, can be compensated for by putting a mil-ammeter in circuit; the measured resistance by scale zero method when corrected for the E.C. yielding the true resistance for the current then flowing through the *cathode*. Some observations on the anodic resistance of small exposures showed it to be very small indeed, but irregularities occurred attributable no doubt to the formation of chlorides and the consequent erosion of the copper.

Mr. Murphy's remarks (Dec. 31st) concerning the relative merits of various tests I fully endorse, also the fact that under certain circumstances the Kennelly false zero method deserves preference. For instance, when the electrical distance to a break is great, and in consequence it is impracticable to use currents adequately strong to ensure the best conditions without raising the potential towards the home end of the cable to a degree that would prove dangerous to incipient faults, the localisation can be effected better by the false zero method. The latter is also less liable to introduce the heating error, which, with a bridge consisting of platinum-silver resistances, may result in a discrepancy of five or six ohms per thousand with currents not exceeding 30 milliamperes, corresponding to an increase in temperature of some 20°C.

Too much attention seems to have been directed to the reduction in weight and bulk of coils in bridges, which for purposes of fault and break localisation could advantageously be wound with a more liberal cross-section of manganin instead of the usual platinum-silver wire. For the simultaneous scale zero test, one of the higher resistance mil-ammeters of the Weston type, graduated to tenths of a milliampere, will be found delicate enough; but to satisfy the requirements of submarine cable electricians, a specially wound high resistance instrument, shunted by manganin coils, having as low a resistance as possible, and of known multiplying powers, would prove of invaluable and universal value.

I may suggest also that, in addition to the boat work equipment mentioned by Mr. Murphy, a milli-voltmeter, with compensating resistances adjusted for steps of one volt each, would fully complete the set, and eliminate the inherent defects of reproduction methods or, trusting to the constancy of the battery E.M.F., each calculation of $(x + f)$ being made in terms of $\frac{v}{c}$.—Yours, &c.,

C. W. SCHAEFER.

C.s. "Amber," Perim, Feb. 6th, 1898.

HIGH-PRESSURE MERCURY BREAKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The article on the construction of my automatic transformer switch apparatus in your issue of January 14th was accompanied by "Notes" which, in my opinion, do not quite put the properties of my apparatus in a true light. Although every reader of your valuable Paper can form his own opinion from the article itself and the accompanying illustrations, I do consider your "Notes" deserving of attention, and I ask you kindly to give space in your Paper for my comments.

You remark in one place: "Usually speaking, mercury contacts are not desirable for breaking high-pressure power circuits, and though such have been in use at Budapest for 18 months, and are said to have given satisfaction, we judge they must have been a source of anxiety. A high-pressure mercury break is in itself a phenomenon more dazzling than attractive, while the after-effect of minute globules of mercury copiously spread over the insulation does not tend to preserve the apparatus from disastrous breakdown." Here you are strongly opposed to mercury contacts, which point of view I think, upon the strength of my more than ten years' experience, is in *any* case not well founded.

Mercury is a material which can be of great service in electrotechnics, even when dealing with high-pressure systems, if due regard be taken of its known properties. For example, in coupling high-tension alternators in parallel, which must be done precisely and with the least observable effect on the light, when, so to say, everything depends upon one moment, I think the mercury switches are matchless. It is owing to this circumstance that Ganz and Co. supply such switches without the least "anxiety" to all their alternating-current plant, with a working pressure of 5,000 volts and downwards, as in Rome, Vienna, Budapest, and in many other large and small cities of the new and old world. After the quite reliable and satisfactory experience above-mentioned central station engineers do not feel induced to adopt any other construction, because mercury is the only material by which a *quick* contact is obtainable almost free of resistance.

Encouraged by this example, but not without due consideration of the different properties of this—now rehabilitated—material, I concluded to solve the problem of switching transformers in and out through mercury contacts, so much the more as I am convinced that "simplicity of construction, certainty and promptness of action," *i.e.*, the "imperative requirements" you correctly lay down, can be realised only with the greatest difficulty without the employment of mercury contacts. Now, as I was striving in my design to reach the *desiderata* you have set down, but was totally unhampered by "anxiety" with regard to the danger of mercury contacts, I constructed my experimental apparatus in this way, and "the after-effects of minute globules of mercury," mentioned by you, did not appear in the least. But care has been taken in the construction that, should they appear, a "disastrous breakdown" through the sprinkling of the mercury would not occur. The possibility of such an accident is totally excluded, as the break of the primary circuit is unipolar, and the interrupted surfaces are placed on a higher level, being mounted on a fairly high ebonite block.

The complication of the apparatus which you specially emphasise is really only "apparent," and my switch for a bank of transformers in Fig. 3 does not contain any more fixed or movable parts than the "Walton Transformer Substation Cut-in Gear," a description of which you published in the same issue, and whose simplicity you are right in praising; but our apparatus not only switches in but also switches

out. That the apparatus must be slightly more complicated than the above for automatically switching in a single transformer is evident to anybody who has tried to solve this problem. Such men will admit that the problem cannot be solved with fewer parts than I have used in the construction of my practical apparatus.

Finally, I would like to mention that the apparatus will be exhibited by the firm of Ganz and Co.—which hold the right of construction—at the Turin Exhibition this year, so that every expert can have a chance of convincing himself of the above claims.

Apologising for trespassing so much on your valuable space,—Yours, &c.,

ALFRED SCHLATTER.

Budapest, February 8, 1898.

LEGAL INTELLIGENCE.

Bedworth and Son v. National Telephone Company.

At Walsall last week the National Telephone Company were sued by Messrs. Bedworth and Son, of Great Bridge, for £37. 4s., the value of a horse, killed by electric shock. The South Staffordshire Tramway Company were joined as defendants, on the ground that they were jointly liable. A linesman in the National Company's employ was repairing one of the wires, when it fell across and short-circuited a trolley wire belonging to the Tramway Company. The wire fell, and plaintiff's horse became entangled in it and received a shock which proved fatal. The Judge held that the falling of the telephone wire on the tramway wire was a trespass, and that the Tramway Company could not be liable in any way. The Tramway Company were, therefore, dismissed from the action, with costs. An order was made against the National Company for the payment of £35. 4s. and costs.

New Zealand Electrical Syndicate (Limited).

An application was made in December last to Mr. Justice Stirling to allow a reduction in the capital of the New Zealand Electrical Syndicate (Limited), and was then adjourned for counsel to suggest terms of reference in order to bring the matter before a referee. These terms were submitted to his lordship this week. Mr. Carson said the main questions were: (1) what was the value of the Company's concession, which would include the goodwill of the business; and (2) what was the value of the Company's buildings, plant and machinery, taking into consideration the amount to be properly written off for depreciation? Mr. Clare said what was material for them to ascertain was the nature of the debenture debt. He should also like to know the net earnings of the Company for the half-years from June 30, 1895, to June 30, 1897. Another important question was the value of the Company's site. Lastly, he thought the valuation that had been made was too low. His Lordship decided that an expert electrician should be appointed as referee. Before making his report he would hear both sides.

Kaye v. Croydon Tramways Company.

The Master of the Rolls and Lord Justices Rigby and Vaughan Williams, in the Court of Appeal, delivered judgment this week in the action brought against the Directors of the Croydon Tramways Company, to restrain them from carrying into effect an agreement for the sale of the tramway undertaking to the British Electric Traction Company. The case has been before the Courts for some considerable time, and Mr. Buckley, Q.C., now stated that the position of the British Electric Traction Company was that they had agreed to pay £30,000 for the purchase of the undertaking, which they considered its full and ample value. They had originally proposed to retain the original Directors as Directors of their own tramway venture, but had reconsidered this suggestion, and under the scheme of purchase proposed to compensate the Directors in a measure for their disappointment by paying them a sum of money. Lord Justice Rigby expressed an opinion that this was an unbusinesslike arrangement. Mr. Buckley said the position had been clearly stated to the Directors, and his clients only desired to act in a perfectly honest and straightforward manner. It was for the shareholders of the Company to ultimately decide whether the agreement should be approved, and if not as a matter of course it fell through. For Major J. Kaye, who was suing for himself and co-shareholders, it was contended that the Directors had no right to enter into such an arrangement without the shareholders' consent. The Master of the Rolls, in delivering judgment, said the question raised was a very important one; but he was not prepared to say that the agreement in question was *ultra vires*, and he differed from the learned Judge in the Court below in thinking that the contract was one which could not be enforced. He was clearly of opinion that the agreement was one which could be lawfully entered into. Then came another question—whether the notice given to the shareholders was sufficiently explanatory and specified the purpose for which the meeting was called. It certainly concealed from the shareholders the important fact that a large portion of the purchase money was not to be paid to the vendors, but was to go into the pockets of the directors. He was alive to the danger of putting into a notice more than the Act of Parliament required; but he did not think that this notice, although it was correct by the card, was a notice disclosing sufficiently the purpose for which the meeting was called. It followed that, although in his judgment the contract was one which the Company could lawfully agree to, it was one which the Company had not yet adopted, and that the resolution which was passed was passed under the notice referred to, and was accordingly not binding upon absent or dissentient shareholders. The appeal therefore succeeded to a certain extent, and he thought the right course to adopt would be to discharge the order of Mr. Justice Kekewich, and to grant an injunction to restrain the defendant Company from carrying this agreement into effect until duly sanctioned by the shareholders of the Croydon Company at a meeting duly convened for that purpose. If they chose, upon proper notice and understanding what they were about, to ratify the contract, they were at liberty to do so, but it would not be right to allow this agreement to stand until that had been done.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J WADE. *In the Press.*

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

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"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshal. and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net 2s. 9d. post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is *now ready.* Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898, and contains about 150 additional pages over last year's book.

Tenders Invited.—The Council of the County Borough of West Ham invite tenders for wiring and fittings for the electric light of various public buildings in the Borough. Further particulars are given in an advertisement elsewhere, and plans, specifications, &c., can be obtained at the office of the Borough electrical engineer (Mr. John J. Steinitz), Pumping Station, Canning Town, E. Tenders must be sent to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, E., by 4 p.m. of Tuesday, March 8.

——— The Corporation of Glasgow, as will be seen in an advertisement elsewhere, invite tenders for the supply of (1) lead-covered cables and accessories (for twelve months), (2) accumulators, equalisers or balancing motors and transformers, motor-driven boosters and relative switching apparatus. Specifications, &c., can be obtained at the offices of Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow, and tenders must be sent in to Sir J. D. Marwick, town clerk, City-chambers, Glasgow, not later than Monday, the 28th inst.

———The Corporation of Glasgow also require tenders from makers of dynamos and engines for the hire of such plant as is described in an advertisement elsewhere. All further particulars can be obtained of Mr. W. A. Chamen, engineer to the Corporation, 75, Waterloo-street, Glasgow, and tenders must be sent in to Sir J. D. Marwick, town clerk, City-chambers, Glasgow, not later than Monday, the 28th inst.

——— The Plymouth Corporation invite tenders for the supply of alternating-current electricity meters for the twelve months ending March 31, 1899. Specification, &c., may be obtained by bona fide meter manufacturers or their authorised agents on application to the borough electrical engineer (Mr. John H. Rider), East-street, Plymouth, and tenders must be delivered to the town clerk (Mr. J. H. Ellis), Town Hall, Plymouth, not later than March 23. Further particulars are given in an advertisement elsewhere.

——— The Town Halls Committee of the County Borough of Salford invite tenders for the wiring of the Broughton Town Hall and the subways of the Salford Town Hall. Some additional information is given in an advertisement elsewhere, and specifications, &c., may be obtained from the borough electrical engineer (Mr. Chas. Turner), Walness-road, Broughton. Tenders, addressed to the Chairman of the Committee, must be delivered to the town clerk (Mr. Samuel Brown) by 9 a.m. on Thursday, March 3.

——— The Corporation of Blackpool invite tenders for the supply and erection of the following plant at their electricity works:—One tubular boiler with superheater; superheaters for five existing Lancashire boilers; surface condensers, pumps, pipes, and storage tanks; two 55-light rectifiers; ten 15-kilowatt boosters; high and low-tension lead-covered cables; ten 50-kilowatt transformers; 20 arc lamp pillars, and 100 arc lamps. An advertisement elsewhere gives further particulars, and specifications, &c. may be obtained from the borough electrical engineer, Mr. Robert C. Quin. Tenders must be sent to the town clerk (Mr. T. Loftos), Town Hall. Blackpool. by 10 a.m. on Tuesday. March 22.

Tenders Invited.—The Wallasey Urban District Council invite tenders for the supply of (*a*) engine, alternator and exciter; (*b*) two Lancashire boilers and one water tube boiler; and (*c*) condensing apparatus. Tenders to the office of the clerk to the Council (Mr. H. W. Cook), Church-street, Egremont, by 4 p.m., Thursday, March 17.

——— Tenders are required by the Edinburgh Municipal Council for the supply of electric lighting materials for Powderhall destructor, and for upholding the electric light installations for one year from May 15. Tenders to the Town Clerk, City Chambers, Edinburgh, by March 9.

——— The Watford Urban District Council require tenders for generating plant, switchboard and connections; overhead travelling crane; conduits and mains; transformer sub-stations, switch gear, electric lamps and posts, &c., &c. Tenders to Mr. H. Morton Turner, Council Offices, Watford, by noon of March 16.

——— The Electric Lighting Committee of the Coventry Corporation invite tenders for the supply of (*a*) 300-kilowatt steam alternator and exciter; (*b*) 25-kilowatt steam dynamo and accumulators; (*c*) condenser, air; pump, circulating pump, and footplates, &c.; (*d*) steam, exhaust, suction and discharge pipes, valves, oil separator, &c.; (*e*) main switchboard, &c., &c. Tenders to the Town Clerk (Mr. Lewis Beard), 10, Hay-lane, Coventry, by 4 p.m. of March 8.

——— The Shoreditch (London) Vestry require tenders for the supply of electric cables, engineers' stores, ironmongery, tools, &c., for the 12 months ending March 25, 1899. Tenders to Dr. H. Mansfield Robinson, Shoreditch Town Hall, Old-street, E.C., by 4 p.m. of March 8.

——— The West Derby Guardians invite tenders for work in connection with the electric lighting of the Mill Road Infirmary, and the wiring of infirmary administrative buildings, and Nurses' home, &c., &c. Tenders to Mr. Harris P. Cleaver, Broughamterrace, West Derby-road, Liverpool, by noon of March 8.

——— The Lighting Committee of the Pembroke Township Commissioners invite tenders for the supply and erection of Lancashire boilers and accessories, &c., high-speed steam dynamos and accessories, &c.; overhead travelling crane; switchboards and instruments; accumulators, &c., &c. Tenders to Mr. J. C. Manly, Town Hall, Balls Bridge, Co. Dublin, by March 5.

——— The Weaver Navigation Trustees invite tenders for the construction and erection of electric power plant for lighting and working the new swing bridges at Northwich. Tenders to the Clerk, Weaver Navigation Office, Northwich, by March 5.

——— A dispatch from Her Majesty's Consul-General at Warsaw states that the municipality of that town is inviting tenders for the erection of electricity works for the supply of current for lighting and traction purposes. Particulars can be obtained from the President of the town.

——— The municipal authorities of Cassino (Caserta), Italy, require tenders for the concession for the electric lighting of the streets for 30 years. Tenders (by March 1) to El Municipio de Cassino, from whom particulars may be obtained.

——— Tenders are invited until April 1 by the municipal authorities of Seraing, near Liège, for the concession for public and private electric lighting for 30 years from February, 1899. Tenders to the Collège des Bourgmestre et Echevins, Seraing, from whom particulars may be had for 2fr.

Tenders Accepted.—The Gas and Electricity Committee of the Bradford Corporation have accepted the tender of Messrs. Cole, Marchent and Morley for the supply of additional condensing apparatus at the new electricity works at £1,600.

——— The Shoreditch Vestry have placed an order with Messrs. Macfarlane and Co. for the supply of 70 new lamp columns at £9. 5s. per column. The tender of Messrs. Wall and Co. has been accepted for the construction of a sub-station at Clifton-street at £983.

——— The Electric Committee of the Belfast Corporation have accepted the tender of Messrs. Thomas Parker (Limited) for the supply of a 200-kilowatt steam dynamo, and arrangements have been made to make the new plant available for traction as well as lighting purposes.

——— The London County Council have accepted the tender of the National Free Wiring Company (Limited) for installing the electric light at the chief stations of the Metropolitan Fire Brigade for £992, "less the amount of wages of the Council's employés who will be engaged on part of the work."

——— The Aberdeen Town Council have accepted the tender of Messrs. P. C. Middleton and Co. for wiring the Corporation lodging-house for the electric light at £117. 13s. 5d.

——— The Glasgow Corporation have accepted the designs and tenders of Messrs. Walter Macfarlane and Co. for a number of split bases and brackets required in the extension of the electric lighting along the Springburn-Mitchell-street tramway route. The bases,

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including fitting, are to be supplied at £5. 16s. 6d. each, brackets £4. 10s. each.

Appointment Vacant.—A teacher of mathematics and physics is required for the Municipal Technical School, Blackburn. Salary £200 to £250 per annum. Applications to the secretary by March 10.

Dissolutions of Partnership.—Messrs. Frank Woolnough and Hermann Alfred Procter, electrical engineers, Surrey Grove, Norwich, have dissolved partnership. Debts by Mr. H. A. Procter.

——— Messrs. Burbey and Hutton, electrical engineers, Hatton-garden, London, have dissolved partnership. Debts by Mr. Burbey.

——— Messrs. Arthur John Fippard and Cecil James Cooper, electrical engineers, Albert-road, Bournemouth, trading as Fippard and Cooper, have dissolved partnership. Debts by Mr. Cooper.

Liquidations.—A meeting of the Universal Electrical Fittings Company (Limited) will be held at 18, Norfolk-row, Sheffield, on March 28, to receive an account of the winding-up. Mr. Geo. S. Greening is liquidator.

——— At a meeting on the 14th inst., of John Dewhurst and Sons, Sheffield (Limited), electrical and mechanical engineers, it was resolved to wind up the company voluntarily, and to appoint Mr. J. W. Best, 20, Bank-street, Sheffield, liquidator.

——— Messrs. Marsh and Yates, acting in the voluntary liquidation of William Banks and Co., electricians, Bolton, give notice that a meeting of the creditors will be held at 4, Wood-street, Bolton, on Wednesday next at three o'clock, to receive the liquidator's report, pass the accounts, and declare a second and final dividend. A first dividend of 5s. in the £ has already been paid, and a second and final dividend of 1s. 9d. is to be declared.

Bankruptcies.—Claims against John William Watson and John Arthur Clark, art metal workers, 23, Brooke-street, Holborn, London, W.C. (lately trading as J. W. Watson, Clark & Co.) are to be sent in by March 7. Mr. Wm. R. Taylor Carr, Monument House, London, is trustee.

——— The following list of creditors of the Ward Electrical Car Company (Limited) has been published :—

Greenfield and Accles (Limited), Birmingham	£380	0	0
R. Ward	195	0	0
Kearsley, Haines and Walsh	133	0	0
Rees and Frere	100	0	0
W. C. Russell	52	10	0

The total liabilities amount to £3,298. 18s. 6d., but no mention is made of assets.

——— The first meeting of creditors in the failure of John Dewhurst, electrician, &c., 52, North End-road, London, S.W., took place at Bankruptcy-buildings, London, last week, and the estate was left in the hands of the Receiver to be wound up in bankruptcy. Debtor started business about nine years ago in North Kensington. Insolvency was attributed to loss through the defalcation and misconduct of a former traveller. The accounts showed liabilities £315. 9s. 10d., assets £121. 5s. 8d. Public examination March 9.

Deeds of Arrangement.—John Thornton, 242, Stockport-road, Levenshulme, Manchester, trading as Francis B. Welch and Co., mechanical engineer, at 46A, Market-street, and as an electrical engineer at 5, Deansgate, Manchester, and 1, Albion-court, Wakefield, has executed a deed of arrangement to pay a composition of 7s. 6d., payable in four instalments. Mr. T. W. Handley, C.A., 4A, Booth-street, Manchester, is trustee. The liabilities are returned at £5,076. 6s. 10d., assets £1,500. The creditors include:—

Marshall, Sons and Co.	£338	J. Ashton and Sons	£26
Smedley Bros. (Limited)	275	Booth Bros.	26
General Electric Company	236	J. Holroyd and Co. (Limited)	25
Edison and Swan Company	165	Matthews and Yates	25
W. T. Glover and Co. (Limited)	165	J. Russell and Co.	23
Newton Electrical Works	134	J. W. Brooke and Co.	19
T. Sugden	120	Northern Electric Wire Co.	18
Jackson and Ogden	58	A. and R. Cochran	17
Crystal Electric Lamp Co.	52	Blackman Ventilating Company	16
Johnson and Phillips	47	Marr Electrical Company	16
Hudswell, Clarke and Co.	45	Electrical Power Storage Co.	12
N. G. Thompson	40	Schaffer and Budenberg	11
Merciers Patents	35	National Telephone Company	11
P. R. Jackson and Co.	32	H. G. Richardson and Sons	11
Dorman and Smith	31	Endolithic Ivory Company	10
Stewart Electrical Syndicate	28	S. H. Heywood	10
Brush Company	27		

——— Messrs. J. Dewhurst & Son, Ltd., of 656, Grimesthorpe-road, Sheffield, and George Longden, of 21, Binfield-road, Chesterfield-road, electrical and mechanical engineers and mill furnishers, late of 68, 70, 72, and 74, Attercliffe-road, Sheffield, have executed a deed of arrangement. Liabilities £2,082. 13s. 9d., and assets £100. Mr. J. W. Best, C.A., 20, Bank-street, Sheffield, has been appointed trustee. The liabilities against the separate estate of John H. Dewhurst is returned at £18. 17s., and the assets at £150; while the assets of the separate estate of George Longden are given at £15.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 16 to Feb. 22, with the ports of destination :—

Argentina—Buenos Ayres, £130; Rosario, £116 (including £61 telegraph material). *Australasia*—Albany, £42; Fremantle, £1,325; Perth, £330; Sydney, £99. *Austria*—Trieste, £2,050 (telegraph cable). *Burma*—Rangoon, £1,575. *Holland*—Amsterdam, £84; Flushing, £227; Rotterdam, £240. *India*—Bombay, £70.; Calcutta, £74. *Japan*—Yokohama, £10. *North Sea*—£5,843 (telegraph cable). *Russia*—St. Petersburg, £233 (telegraph material). *South Africa*—Cape Town, £183; Durban, £126; East London, £2,828 (including £2,747 telegraph material); Port Elizabeth, £1,185 (including £421 telegraph material). *Spain*—Barcelona, £10; Malaga, £158. *Straits Settlements*—Singapore, £45. *Sweden*—Gothenburg, £1,091 (including £216 telegraph material). *Uruguay*—Monte Video, £30. *Yahiti*—£6,000. *Zanzibar*—£24,480 (telegraph cable). Total, £48,584, against £7,372 in the corresponding week last year (Feb. 17 to Feb. 23).

Export Merchants Shippers' List.—An extremely useful and complete list of the export merchant shippers of Great Britain and Ireland, including their trading ports and the classes of goods shipped, is issued by Messrs. Dean and Son, of Fleet-street, London. This 1898 edition is the 33rd published. To those having or contemplating business relations with foreign houses the book will be found of great service. Nearly 1,300 pages of useful information is conveniently arranged. The published price is 17s. 6d.

Electrical Apparatus and Novelties.—Mr. A. J. Wright, of 318, Upper-street, London, N., forwards an excellent list of small electrical goods and novelties, including motors, batteries, bell sets, pocket galvanometers, pocket accumulators, scarf pins and brooches, parts for making electric jewellery, telephones, magnets, &c. A good list for retailers and others, and fully illustrated.

Track Tools.—Messrs. Laing, Wharton and Down have issued an illustrated list of track tools.

New and Second-hand Machinery List.—Mr. B. Mountain, of Leeds, issues a very complete list of new and second-hand machinery of all kinds.

Smoking Concert.—The staffs of the City of London, the Metropolitan, and the London Electric Lighting Companies gave a smoking concert at the Freemason's Tavern, London, on Friday last. A full and varied programme was much enjoyed by a large company.

Electro-Harmonic Society.—Members and their friends are reminded that a "Ladies' Night" entertainment of this Society takes place this (Friday) evening at St. James's Hall Restaurant, at eight o'clock.

Aberdeen.—The accounts of the electricity department for the year ended December show a total income of £5,707. 12s. 5d. After deducting expenses, there remains a balance of £3,111. 0s. 7d. to meet interest on mortgage and loans (£1,150), depreciation of plant (£1,024) and sinking fund (£767), leaving £169. 5s. 2d. to be carried to reserve fund. During the year a revised system of charging for current was introduced, viz., 6d. per unit for the first hour, and 3d. afterwards.

Ayr.—The Harbour Trustees have arranged with the electricity department of the Town Council for a supply of electric current to 10 arc lamps for lighting the North Quay and Dock, at £22 per lamp per annum, with £7 per lamp per annum for trimming and supply of carbons.

Belfast.—The question of the adoption of electric traction on the local tramways is being again considered by the Electric Committee, who have appointed a sub-committee to report.

Brighton.—At the meeting of the Town Council last Thursday the Lighting Committee's report (an abstract of which appeared in our last issue) recommending various alterations in the method of lighting some of the streets came up for discussion, and was referred back for further consideration.

Bristol.—About 800 employés of the Bristol Tramways and Carriage Company (Limited) were entertained by the Directors at a breakfast at Clifton last week, under the presidency of the Managing Director, Mr. George White. The gathering was in connection with the general meeting of the Men's Provident Society, and the speeches made referred to the excellent relations existing between the Company and its employés. In the course of his remarks the Chairman stated that he had been connected with tramway matters for 25 years, and the Bristol Company had been actually working for 22½ years. He referred to the many attempts to extinguish the Company that had been made by the local authority of the district, and concluded by notifying his intention of giving £1,000 towards a superannuation fund for the Company's employés, pointing out that the time might come when the local authority would take over the Company's undertaking, when many of the men who had worked in the service for a quarter of a century would be handed over to the tender mercies of a municipal body

who might have no regard to their claims for recognition. Mr. Samuel White, the secretary of the Company, announced his intention of giving a similar sum to that presented by his brother. Needless to say, this liberality, which is likely to be considerably augmented by the shareholders when the matter is put before them, was cordially appreciated by the large body of men present.

Buxton.—In a report on the electric lighting question just presented by Prof. Kennedy, the Town Council are recommended to establish electricity supply works, at a cost of £18,000.

Calcutta.—A Committee, consisting of Mr. A. J. Hughes (borough engineer), Mr. J. D. Berrington (chief telegraph superintendent), and Mr. J. B. Saunders (general manager of the Bengal Telephone Company), has been appointed to consider and settle the details of the Calcutta electric lighting scheme. The Bengal Government recommend the Corporation to extend the electric lighting licence to Messrs. Kilburn and Co. for a second period of 21 years.

Chelsea (London).—The minutes of the Works and General Purposes Committee of the Vestry, presented at the last meeting, stated that a proposal from the Chelsea Electricity Supply Company for the extension of their works in Flood-street would form an opportune occasion for the Vestry to approach the Company with a view to acquiring their electric lighting undertaking. A resolution in favour of appointing a small committee to negotiate with the Company upon the question of purchase, with power to consult electrical experts, was adopted.

Chester.—At the last meeting of the Electric Lighting Committee the appointment of resident engineer and manager of the electricity works was considered, and terms were arranged with Mr. F. Thursfield for undertaking the work. Mr. Thursfield has acted as resident engineer for Messrs. Thomas Parker since the inauguration of the works.

Dublin.—The Dalkey Town Commissioners on Wednesday decided to unreservedly approve the Bill now being promoted by the Dublin and Southern Districts Tramway Company, under which the Company will have the power to considerably accelerate the speed at which engines, carriages and trucks may proceed on the Company's tramways. It was also decided that the Commissioners should be represented before the Board of Trade in support of the Bill and "to give evidence that the residents in the townships considered the present speed at which the tramways are permitted to travel to be entirely too slow."

Edinburgh.—At Tuesday's meeting of the Town Council it was decided to lay a new feeder from Dewar-place, along Grove-street, to Merchiston at an estimated cost of £1,400. Various motions relating to the extension of public and private lighting were remitted to the Cleaning and Lighting Committee for consideration and report.

Electric Motor 'Buses.—Electricity as a motive power for the buses owned by the London General Omnibus Company had very few friends at the meeting of shareholders yesterday, and the chairman, while admitting that the directorate are watching very closely the development of motor vehicles, held out no promise of an early introduction of mechanical power as a means of propelling the omnibuses which now so nearly fill the London thoroughfares. One shareholder expressed his conviction that the day was very far off when buses would be propelled electrically, and to make matters worse, expressed himself as personally very glad this was likely to be the case.

Electric Welding.—At a conversazione held at Finsbury Technical College on Friday last the Electric Welding Company exhibited an automatic welding plant and a collection of samples welded by the Thomson process, including railway coupling links, &c.

Exeter.—The Electric Lighting Committee presented their accounts for the year 1897 at the meeting of the Town Council on Wednesday. The revenue account showed a credit balance of £1,222, the gross profit being £1,843. After allowing for sinking fund and interest, it was recommended that £750 be placed to a reserve fund, carrying forward £78. An increase in the salaries of the electrical staff was also recommended. The accounts and recommendation of the committee were approved.

Exhibition.—We are asked to state that the International Photographic Exhibition, to be held at the Crystal Palace, will be opened by H.R.H. the Prince of Wales, on Monday, April 25, and not on Wednesday, April 27, as originally announced. The latest date for the reception of exhibits is therefore two days earlier than that originally given.

Faversham.—Mr. H. E. McCreel, of Edenbridge, has notified the District Council that he proposes to apply for a Provisional Order for the district. The Council have refused to sanction the application on the ground that, "when the time arrives for Faversham to be lighted by electricity, the Council themselves ought to take the matter in hand."

Fire Prevention.—Mr. C. H. Wordingham has joined the working executive of the British Fire Prevention Committee, "with the particular view of representing the electrical interests on it."

Glasgow.—As a result of a conference between the Electricity Committee of the Corporation and a deputatian from the Clyde Trustees, the question of the electric lighting of Prince's Dock has been remitted to the engineers of the Trust and the borough electrical engineer (Mr. W. A. Chamen) for report.

At the last meeting of the City Council the electricity department was authorised to carry out the work of lighting the Springburn-Mitchell-street tramway route electrically. The cost of supplying and laying down the feeders and mains necessary for private lighting along the route would amount to £12,560, and if the cast-iron pipe and cables for the street lighting were laid down at the same time the extra cost would be £1,446. 12s., a total of £14,012. 12s. If feeders and mains large enough for the street lighting only were to be laid down, the cost would be £7,022, and the cost of subsequently re-opening the trench and laying down the mains and feeders for private supply would amount to £9,525. 15s., a total of £16,547. 16s. The former course, has therefore, been decided upon. The arc lamps are, with few exceptions, to be suspended from the poles to be erected on both sides of the route. Until the mains and network to be laid down for the street lighting are connected with the new works at Port-Dundas, current for the arc lamps will be supplied from the Waterloo-street station. In all, 104 arcs will be required. Of the columns to be put down by the Tramways Department, 91 can be made to suit for lighting purposes, so that 13 additional lamp pillars would require to be erected by the Watching and Lighting Department. The cost of electric energy for the whole of the lamps, at £18 per lamp per annum, will be £1,872. As set out under "Tenders Accepted," the designs and estimates of Messrs. Walter Macfarlane and Co., for such number of the split bases and brackets as may be required, has been accepted. Bailie Maclay took occasion, in moving the adoption of the report, to announce that Mr. W. A. Chamen, the City Electrical Engineer, had been installed in office and was now actively engaged in the discharge of his duties.

Hackney (London).—In reference to a paragraph under this heading in our last issue, it appears that the Vestry only decided to rescind the previous resolutions binding them to establish electricity works in the district, and the report of the Committee in favour of the adoption of the offer of the Electric Extension Company to provide electric lighting and refuse-destructor works was postponed for further consideration to March 7, when the matter will be discussed by the Vestry sitting in committee. This action was, we understand, taken in deference to a strong representation on the matter by Messrs. Laing, Wharton and Down, and another company who had submitted offers for taking over the Provisional Order. In addition to those already named, the following submitted terms: The County of London and Brush Provincial Company, Messrs. Siemens Bros. and Co., the Imperial Electric Lighting Company, Messrs. C. and A. Sax, and Mr. H. Bradley.

Lancaster.—The question of putting down additional plant at the electricity supply station occupied the attention of the Town Council on Wednesday. After discussion it was decided to apply to the Local Government Board for sanction to borrow £10,000 to enable the Electric Light Committee to double the present capacity of the station.

Leamington.—A report on the electric lighting question has been prepared for the Electric Lighting Committee by Mr. Robert Hammond. The report states that it would be in the interests of the Council to arrange that the present electricity works should continue operations until the whole of the present consumers are connected to the new mains of the Corporation. If customers for 15,000 lights could be obtained the cost of production would not be more than 2·4d. per unit, and if the charge to consumers were 6d. per unit there would be a profit on working account of £3,000 per annum, sufficient to provide for interest and sinking fund on a capital of £50,000.

Lectures.—The first of a series of lectures held under the auspices of the Worshipful Company of Carpenters was given at Carpenters' Hall, London-wall, E.C., on Monday last, by Prof. S. P. Thompson, on "Electric Motive Power," with experiments. The lecturer traced the progress of electrical science from the early part of the century, and said that now more than 60,000 persons were directly employed in the electrical industries, and this at a time when some of the more important applications of electricity to the public service were only in the early stages. The lecture proved of absorbing interest to a large audience, and the number and variety of the slides used to illustrate Prof. Thompson's remarks greatly helped his non-technical hearers to appreciate the points made during the lecture. These lectures are free, and will be given on the next four succeeding Mondays at 8 p.m. "Electric Motive Power" is the only electrical subject treated in the course.

Leeds and Bradford Light Railway.—Mr. Gerald J. R. Fitz-Gerald and Col. Boughey held an inquiry at Leeds last week into the application to construct a light (electric) railway between Bradford and Leeds. The Leeds and Bradford Corporations, the District Councils of Calverley and Farsley, the Midland Railway and Bradford Tramways and Omnibus Companies and the West Riding County Council were all represented. Mr. Addyman, in opening the case, said the promoters were a syndicate having a large financial connection in London. Neither the Leeds nor Bradford Corporations could say that they were taken by surprise as they had ample time and opportunity of doing what was required for the proper travelling accommodation of their respective districts. The proposed line would be constructed as a light railway, and electricity would be used as the motive power. The district through which the railway would pass was one of extraordinary traffic. It was practically, with short intervals, the seat of manufacturing industry along the whole length of the line. The Leeds Corporation had power to construct or work a portion of any light railway that was within their jurisdiction, and the promoters were prepared to employ the Corporation themselves, or their contractors to construct the line from Stanningley to Leeds, and to place the maintenance and the repair of that line absolutely in their hands. The work should, however, be done in reasonable concurrence with the promoters' engineer—that was to say, that they should have something to say as to the scheme of electric power which should be adopted—but the actual work of repairs and interference with the streets they left in the hands of the Corporation. With regard to Bradford, the Commissioners were aware that the gauge in that city was 4ft. If the gauge was not promptly altered Leeds would draw the traffic which Bradford ought to have a fair share of. The Leeds Corporation said they intended to construct tramways within the city whenever and wherever necessary, but nothing was said about when or how. About Dec. 1 two resolutions were passed by the Leeds Corporation, but before that time the light railway notice had appeared, and it had a wonderfully stimulating effect upon the Corporation. Petitions from the Farsley and Calverley District Councils in favour of the scheme were then put in, and also ratepayers' memorials. The contentions of both the Leeds and Bradford Corporations were that the application was not within the scope of the Light Railways Act, and that therefore the Commissioners had no jurisdiction. Mr. A. J. Hopkins, engineer to the promoters, said that the plans had been prepared under his direction. The gauge would be 4ft. 8½in. Mr. W. N. Stewart, manager of the promoting company (Power and Traction, Limited), stated that his experience comprised 13 years with Mr. Edison, and in his judgment the present railway service between Leeds and Bradford was inadequate. The intervals between the trains should not be greater than 7½ minutes. The promoters would charge 6d. from any part of Leeds to any part of Bradford, and the line would be divided into three equal parts, the Leeds and Bradford Corporations each taking 2d., and the Company the remaining 2d. For the Leeds Corporation Mr. Bairstow offered to withdraw opposition if the promoters abandoned the portion of the scheme which related to the construction of tramways within the city. His Corporation took over the tramway lines in 1894, and since that time had almost entirely relaid the whole of the 27 miles of original track, while 5 miles of new line had been laid. They had authority to construct another 29 miles, which was estimated to cost £172,800. Their policy was to make all proper extensions, and the reason why they did not resolve to make this extension before the present scheme was promoted was because, having regard to other demands, the time had not arrived when they could give preference to it. It was impossible for the Corporation to construct this tramway unless they neglected other work. Mr. FitzGerald said that they considered the utility and convenience to the public of the line had been established, but the objections of the two corporations to a company having the working and management within their respective boroughs required serious consideration. They would not, in the absence of Lord Jersey, make any further statement, but they trusted that the inquiry might result in the resumption of negotiations between the parties.

Lewisham (London).—Mr. George Offor, as secretary to the Great Western Electric Light and Power Company (Limited), has communicated to the *Kentish Mercury* some details of the proposals made to the Lewisham District Board of Works by "the Mutual Electric Trust (Limited), and Messrs. Madgen, Reason and Offor, individually," in connection with a dust destructor and electric lighting project for that district. The whole subject was to have been discussed at the meeting of the Board of Works on Wednesday.

Light Railways.—In reply to a question by Mr. Bainbridge in the House of Commons, on Monday, Mr. Ritchie said that up to the present time 16 Orders had been made by the Light Railway Commissioners, and submitted to the Board of Trade for confirmation. Of these, four have been confirmed by the Board after modification, and five others would shortly be ready for confirmation. One Order had been remitted to the Light Railway Commissioners for further consideration, and in the case of the remaining six the time for lodging objections had not yet expired. None of the undertakings authorised made any claim for financial assistance from the Treasury or local authorities.

Liverpool.—Owing to the rapidly extending use of electric current for lighting and power purposes, and in view of the electrical equipment of the tramways, the City Council are recommended to create a separate committee to manage and control the electricity undertaking of the Corporation. Hitherto the department has been under the control of the Lighting Committee.

At the last meeting of the Lighting Committee the electrical engineer (Mr. A. Bromley Holmes) reported that during January current had been supplied to the equivalent of 62,681 16 c.p. lamps for private lighting and 7,924 for street lighting, an increase of 2,944 for the month. 373,049 units of current were sold against 269,826 in Jan., 1897. It was decided to lay mains in Grove-street, South John-street and Brunswick-road.

London County Council.—At Tuesday's meeting a report was submitted by the Highways Committee with reference to the agreement with the National Telephone Company as to the placing of their wires underground. The Committee consider that additional conditions, not included in the Council's resolution, ought to be inserted to provide (*a*) that the Company should pay a rent in consideration of its user of the public streets, and (*b*) that the present charges to subscribers should be reduced to amounts which would, in the event of the Council establishing an independent telephone service for London, amply repay expenses, and as the system extended might possibly be reduced by 15 to 20 per cent. Clauses embodying these provisions had been inserted, and the amended draft agreement was submitted to the Company. The Company pointed out that they had also to obtain the consent of the road authority, who might impose conditions, and they could not be expected to pay rents both to the Council and the local authorities, and that such demands were inconsistent with the desire expressed for a cheaper service. As regarded the second proposal, they declined to discuss it, but was prepared to consent not to increase the present tariffs of charges. The Committee thought there was some force in the Company's representation as to the first demand, and had reluctantly decided not to press it. The second clause they considered more important, and recommended the Council to approve the insertion in the draft agreement a clause, under which the Company shall not, during the continuance of the agreement, charge metropolitan subscribers any larger annual amount than that set out below :—

On five years' agreement—First connection	£12	0	0
Second and additional connections	10	0	0
Private houses	8	0	0
On yearly agreement—First connection	15	0	0
Second and additional connections	12	10	0
Private houses	10	0	0

This tariff to include an area of 609 square miles (Dartford, Reigate, Redhill, Croydon, Epsom, Richmond, and Kingston on the south, and Tilbury, Woodford, Romford, Epping, West Ham, Harrow, Ealing, and Hampton Court on the north of the Thames). The subject is to come under the consideration of the new Council.

The Council declined to give their sanction to the London United Tramways Bill authorising the construction of 4¼ miles of tramways in Hammersmith on the overhead electric system.

Long-Distance Telephony.—The *Melbourne Leader* states that the Postmaster-General of New South Wales has decided to invite tenders for the erection of a long-distance telephone line from Sydney to Bathurst, the estimated cost of which will be between £5,000 and £6,000. This decision is due to the success of the Newcastle and Sydney line.

Loughborough.—The Town Council have appointed a committee to report upon the advisability of acquiring the gas works, and also to obtain information and report upon the question of establishing an electricity supply station.

Luton.—The report on the electric lighting question, recently prepared by Mr. Albion T. Snell, was discussed at the meeting of the Town Council last week. An abstract of Mr. Snell's report appeared in our issue of the 11th inst. Councillor Wilkinson, Chairman of the Electric Lighting Committee, moved its adoption, and stated that the Committee would probably visit two or three towns, similar in size to Luton, where electricity works had been established. Mr. Alderman Hucklesby seconded the motion, and said that "The longer they considered the electric lighting question the better they would understand it, and the wiser would be the resolution arrived at." He had that morning received an offer from a company to take over the Provisional Order. If a company were prepared to do this it was clear that the Corporation could do it more efficiently and economically. The motion was unanimously agreed to.

Morley.—Electric current was supplied from the Corporation's electricity works on the 14th inst. for the first time. All persons at present connected up to the mains are to have a free supply of current until the 1st prox.

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Mexico.—The Dresdener Bank announces that, according to telegraphic advices from Mexico, the electricity supply station of the Mexican Electric Works, Limited, has been so far advanced as to permit of the inauguration of the street lighting of the city on the 14th inst.

Newfoundland.—It is announced that the Government have entered into an agreement with Mr. Reid, a local railway contractor, to take over and operate the entire railway system of the Colony for 50 years on certain stated conditions. Mr. Reid also takes over the Government telegraph service, at a subsidy of $12,000 per annum, for seven years, and then to introduce a uniform tariff of 25 cents for ten words. The contractor, according to the particulars to hand, is also to build an electric railway in St. John's for $140,000.

Newington (London).—The Vestry have approved the plans and specifications submitted by Messrs. Kincaid, Waller and Manville for the erection of electricity supply station buildings in Penrose-street, Walworth-road, and tenders are to be invited for the execution of the work. The Vestry have also decided to apply to the London County Council for a loan of £40,000 to enable them to carry out their electric lighting project, the loan to be receivable in four instalments of £10,000 as the work progresses, and to be repaid within a period of 50 years.

Norwich.—Much to the disgust of many of the members of the Town Council, the Lighting Committee recommend the acceptance of the offer of the British Gas Lighting Company to light several of the principal thoroughfares by incandescent gas lamps for a period of five years. The Council have already before them an offer from the Norwich Electricity Company for erecting 22 arcs and supplying current for same at £20 per lamp per annum. The Committee should certainly reconsider their decision, and give to these Norwich thoroughfares the advantage of electric lighting.

Nottingham.—At a meeting of the Special Tramways Committee, on Tuesday evening, it was decided to recommend the Council to adopt the overhead trolley system of traction on the tramways recently acquired. The Committee have visited the electric tramways at Bristol and Dover and the cable tramways at Edinburgh, and, after considering the advantages of both systems, pronounce in favour of electric traction.

Poplar (London).—The District Board of Works have received from the Board of Trade a communication sent by the County of London and Brush Provincial Company relative to the position taken up by the District Board with regard to the Company's application for a Provisional Electric Lighting Order for Bethnal Green, Poplar and Whitechapel. After discussion the Board passed a resolution in favour of at once taking steps to put their Provisional Order into force, and a communication to this effect has been forwarded to the Board of Trade.

Private Bill Legislation.—The City and Brixton Electric Railway and the Corporation of London (Foreign Cattle Market, Deptford) Bills have been read a second time in the House of Commons, and the Brighton Underground Railway Bill has received a second reading in the House of Lords.

St. Pancras (London).—The Vestry have borrowed from the London County Council a further £22,445 for electric lighting purposes.

Shoreditch (London).—The Lighting Committee reported at the last meeting of the Vestry that applications for electric current to date exceeded the equivalent of 21,000 8-c.p. lamps. The salary of the wiring superintendent (Mr. Crombie) has been increased to £2. 5s. per week. The Vestry have also decided to appoint two additional clerks in the electricity department.

Stirling.—Prof. Kennedy has presented his report to the Town Council on the practicability of utilising the water power at Touch in generating electric current for lighting the town. He reports that the maximum theoretical horse-power of the water coming into Stirling from No. 3 reservoir is 26; from No. 4 reservoir, 7; and from the Touch compensation water, 7—in all, 40 H.P. The total horse-power provided in his steam-power estimates was 320, which would, after making all allowances, deliver at least 233 E.H.P. at the lamps. The total cost of this plant would be between £8,000 and £8,500. If they put down turbines and dynamos at Touch, they would have to spend about £1,600 at least for the sake of delivering about 15 H.P. at the lamps. The capital expenditure on this power would therefore be about £107 per horse-power at the lamps, against about £35 for the steam plant.

Sheffield.—There is, apparently, once more peace at Sheffield, and the troublesome Councillors have been duly admonished. The report of the chartered accountant appointed to examine the books of the Sheffield Electric Light and Power Company was submitted at last week's meeting of the Council. The amount expended by the Company to December 31, and chargeable to capital expenditure was £124,472. 7s. 5d., book debts £11,728. 5s. 4d., and value of stock-in-trade and stores £5,673. 16s. 1d. The dividend £10,562. 5s. 1d. to be retained for distribution by way of dividend, are in excess of a dividend of 5 per cent. per annum from the date of the Company's Provisional Order on the total of the capital expenditure to Jan. 1, 1898, and there was therefore nothing payable by the Corporation under this head. The following statement sets out the position of the Company on Dec. 31. The adoption of the Parliamentary Committee's report, embodying certain amendments of the terms of purchase, &c., was moved by Mr. Chambers, the Chairman of the Committee, and agreed to.

Electricity Department.

Land		£12,253	9 3
Buildings		14,410	14 9
Machinery and plant		35,981	7 2
Mains (new account)	£36,123 12 0		
Mains (old account)	1,903 3 1		
Mains (service)	2,829 15 8		
Mains (instruments)	23 0 4		
		40,879	11 1
Transformers, motors, &c.		6,462	12 6
Meters		4,001	16 0
Electrical instruments		617	16 1
Cost of licence		334	10 1
Office furniture		278	6 6½
Tools		121	17 3
Formation expenses		200	3 0
Depreciation written back—1892	153 15 9		
" " " 1894	202 7 2½		
" " " 1895	220 16 11		
" " " 1896	445 9 0		
		1,022	8 10½
Library		44	11 11
New office account		110	1 2
Construction stock		1.699	2 6
		£118,418	8 2

Wiring and Fittings Department.

Tools	£68 16 6		
Depreciation written back	19 11 7		
	88	8	1
Showroom	212 4 7		
Depreciation written back	115 17 10		
	328	2	5
		416	10 6

Factory.

Plant and tools	£1,516	10	1
Buildings	2,655	12	10
Office furniture	56	3	3
Patterns and models	353	18	0
Catalogues	326	1	6
Formation expenses	729	3	1
	5,637	8	9
Total	£124,472	7	5

Stoke-on-Trent.—The Town Council have decided to support the application of the New Mutual Telephone Syndicate to the Postmaster-General for a telephone licence. This decision has been come to notwithstanding the Huddersfield *contretemps*.

Telephone Municipalisation.—At the meeting of the County Council on Wednesday a communication was read from the Postmaster-General refusing to grant a telephone exchange licence for Bedford.

Transvaal Telegraphs.—The revenue derived from the Telegraph Department of the Transvaal in 1897 amounted to £69,495, compared with £78,678 in 1896. The Johannesburg and Pretoria telephone service realised £11,830, compared with £10,513 for 1896.

Weston-super-Mare.—The District Council are seeking the approval of the Board of Trade to the system of electric lighting proposed to be adopted for the district.

Winchester.—Mr. E. T. Ruthven Murray, the Council's consulting electrical engineer, has approved the plans and specifications of the Winchester Electric Light and Power Company. Mr. Murray reports that the electricity station buildings are in a forward state, and the Company propose to use water-tube boilers, Belliss engines, Parker dynamos and D.P. batteries.

BOOKS RECEIVED.

"La Teoria dei Raggi Roentgen." By Prof. Filippo Re. (Palermo: Alberto Reber.)

"Handbook on the Workmen's Compensation Act, 1897." By M. Roberts-Jones. (Cardiff: *Western Mail*, Limited.) Price 2s. 6d.

"The Official Gazette of the United States Patent Office." Nos. 7, 8, 9, 10, 11, 12. Vol. LXXXI. Published by authority of Congress. (Washington: Government Printing Office.)

"The Official Gazette of the United States Patent Office." No. 6, Vol. LXXXII. Published by authority of Congress.

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specifications accompanies application an aster isk is suffixed.*

January 3, 1898.

121. E. BATAULT. London. Improvements in electric meters.
122. D. F. SINCLAIR. London. Improvements for separating stable or other salts, and generating electricity.
124. K. BOWEN. London. Supporting electric accumulators for electric traction purposes and the like.
125. K. BOWEN. London. Speed-regulating switch for electric traction.*
143. W. J. DAVY and G. THOMAS-DAVIES. London. Improvements in electric arc lamps.
148. L. RIDOUT. London. An improved electrical terminal.
156. A. B. BLACKBURN and N. H. WHITE. London. Improvements in the method of fixing and suspending bare electric conductors.

January 4, 1898.

166. C. B. CRAWSHAW and C. W. HILL. Bradford. Improvements in dynamo electric machines.
192. S. S. BROMHEAD. London. Support for electric lamps or other fixtures. (O. C. White, United States.)*
235. R. BELFIELD. London. Improvements in or relating to dynamo-electric machines. (The Westinghouse Electric and Manufacturing Company, United States.)
242. F. R. and T. LENTZ. London. Improvements in electric time-pieces or clocks.*

January 5, 1898.

264. F. W. WHITTLE. Manchester. "Aurora" patent electric pipe, cigar, and cigarette lighter.
305. P. MEYERSFIELD. London. Device for preventing the displacement of the roller receiving the current from the cables of electric railways with overhead conductors.*
331. A. MÜLLER and H. TUDOR. London. Improvements in preventing sparking when making and breaking electric circuits.

January 6, 1898.

358. E. KOSEL and F. FRENTZEL. London. A new process for the preparation of electric paste accumulators.
373. G. WILKINSON. London. Improvements in insulated and protected conductors for the transmission of electrical currents.
383. J. G. STATTER and CHAMBERLAIN AND HOOKHAM (LIMITED). Improvements in switches for starting motors.
398. S. PREM. London. An improved electrically-propelled bicycle.
435. S. W. MAQUAY. London. Improvements in and connected with primary batteries.

January 7, 1898.

462. G. H. NISBETT. Liverpool. Improvements in or connected with electric mains.
468. P. ROSLING and H. W. APPLEBY. Bradford. Improvements relating to enclosed motors or dynamos.
494. A. EMRICH. London. Automatic rheostat for use in starting electromotors.*
525. S. P. THOMPSON. London. Improvements in electric signalling.

January 8, 1898.

533. A. J. HILLS. Guildford. Improvements in electric arc lamps.
571. W. BRIERLEY and R. FOSTER. Manchester. Improved means for making electrical connections upon railway trains.
584. E. S. CLARK. London. Improvements in underground conduits for electrical conductors.
586. P. R. JACKSON AND CO. (LIMITED) and J. S. LEWIS. London. Improvements relating to the mounting of dynamo electric machines
591. A. GRAHAM. London. Improvements in telephone transmitters.

January 10, 1898.

632. W. M. WALTERS. Liverpool. Improvements connected with electric lamps and switches.
665. J. L. HINDS and H. B. CROUSE. London. Improvements in electric switches.*
678. C. A. JENSEN. London. Method of diminishing the affinity of electrolytically-produced chlorine. (Alf. Linding-Larsen, Norway.)
698. BRONISLAW DE SZWANTOWSKI. London. Improvements in or relating to the electric illumination of railway trains.

January 11, 1898.

729. F. GARDNER and W. J. SMITH. Glasgow. Electric rotary cutters.
735. H. TAFFS and J. HILL. Manchester. Improvements in switches for use in electric light installations.
756. R. W. GAY. Birmingham. An improved electrical apparatus for railway signalling during fogs.
773. J. DAVIDSON. London. Improvements in portable electric alarms and bell-sets.
809. W. P. THOMPSON. Liverpool. Improvements in automatic calling devices for telephone exchanges. (The Strowger Automatic Telephone Exchange, United States.)*
812. P. R. JACKSON AND CO. (LIMITED) and J. S. LEWIS. London. Improvements in or relating to dynamo electric machinery.
814. J. T. GENT. Birmingham. Improvements in the means for controlling the lighting and extinguishing of electrically illuminated signs and other advertising and show tablets.
817. R. F. THOMPSON and E. J. SULLIVAN. Liverpool. Improvements in electric railway conduit systems.*
831. H. W. LIBBEY. London. A system of conducting electricity for propelling heating, lighting and telephoning from railway vehicles.
834. L. B. ATKINSON. London. Improvements in single-phase induction motors.
835. L. B. ATKINSON. London. Improvements in single-phase and multiphase alternate-current motors.
848. J. VON DER POPPENBERG. Manchester. An improved galvanic battery.

January 12, 1898.

885. G. LANGBEIN. London. Apparatus for electro-plating articles in bulk and in large quantities.*
913. A. F. MCGAW and W. A. WOODFORD. London. An improved electropathic sock for boots and shoes.
932. C. POLLAK. London. Improvements in the manufacture or production of electrodes for secondary batteries.
933. C. POLLAK. London. Improvements in electrolytical condensers and electric current-directing devices.
935. C. W. DAWSON. London. Improvements in or connected with pole-pieces of dynamo-electric machines.
936. C. A. BAKER. London. A new or improved power-transmitting device.*

January 13, 1898.

953. G. LAY. London. An improved telephone line switch.
1,002. A. A. VOYSEY and R. P. WILSON. Improvements in electricity-measuring instruments.
1,011. R. J. BOTT. London. Improvements in electric incandescent lamp sockets or holders.
1,017. A. GINISTY. London. Improved method of and apparatus for signalling or advertising by electricity.*
1,021. C. H. STEARN. London. Improvements in the manufacture of filaments for incandescence electric lamps.

January 14, 1898.

1,046. R. C. QUIN. Blackpool. An improved method and electro-magnetic cut-out for automatically disconnecting charged conductors in the event of breaking or short circuit applicable to overhead systems of electric traction and the like.
1,073. R. HURLEY. Liverpool. Improvements relating to graphic or writing telegraphy.
1,114. J. O. O'BRIEN (of the firm of W. P. Thomson and Co.). Manchester. Improvements in telephone exchanges. (G. Ritter, Germany.)
1,127. H. M. SALMONY. London. Improvements in electrical safety devices.
1,140. H. H. LEIGH. London. Improvements in electro-magnets for electric traction. (The Gesellschaft zur Verwerthung Elektrischer und Magnetischer Stromkraft (System Schiemann and Kleinschmidt) (Ad. Wilde and Co., Germany.)

January 15, 1898.

1,145. G. C. ALLINGHAM and W. FENNELL. London. Improvements in electric cables.
1,166. A. WILKINSON. Bradford. Improvements in phonographs.
1,184. T. HARDEN. Balham. Improvements in safety devices for electrical circuits.
1,194. G. PHILIPPART. Liverpool. Improvements in secondary batteries.*
1,213. Sir C. S. FORBES, Bart. London. Improved apparatus for the electro-decomposition of water.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

24,091. ROCHATTE. Electric batteries. (Date applied for under International Convention, April 21, 1896.)
29,576. HUGHES. Electric furnaces.
29,087. HUGHES. Electrical low water alarm or indicator for steam boilers.
29,868. BHISE. Electrical appliances for the handles of cycles, pedals of sewing machines, harmoniums and the like.
29,933. BROUGHAM and BERSEY. Controlling apparatus for electrically-propelled vehicles.
30,061. MCEVOY. Electrical connecting cords.
30,123. BROWN. Means for telegraphing through long uninsulated or badly insulated submarine or other submerged cables, and maintaining communication notwithstanding a break in the continuity of the conductor.
24,574. HOWELL. Microphones.

1897.

1,830. STOCKALL. Electric clock movements to record the time by electricity.
4,753. SEGUY. Portable Röntgen ray apparatus.
6,073. LIORET. System of mounting acoustic trumpets to phonographic apparatus.
6,178. MESSING. Device for deadening the noise in telephone conductors and the like.
6,181. SMITH and GRANVILLE. Electric cables and their manufacture.
6,292. STOWELL. Electric Incandescent lamps.
10,994. WORSLEY. Electric arc lamps.
10,995. WORSLEY. Carbon holders for electric arc lamps.
14,247. THOMPSON. (La Société Italiana dei Forni Elettrici). Electric furnaces.

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14,253. RAAB. Alternating-current meter.
14,708. NASH. Apparatus for coating metal articles by electro-deposition.
16,388. CASLER. Cinematographs and like machines. (Date applied for under International Convention, December 10, 1896.)
17,081. PATTEN. Electrical furnaces.
17,597. WISE (KROTZ ALLEN and KELLY). Conductors for electric railways.
19,745. FAIRWEATHER (Klein). Electromagnetic picking mechanism for looms.
20,394. VON LEON. Arrangement for strengthening electric currents.
20,996. DORMAN AND SMITH. Electrical cut-outs.
20,500. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED (Parker). Surface contact electric railways.
20,501. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). (Potter.) Surface contact or closed conduit electric railways.
21,462. WILKINSON. Street boxes of electricity, mains, tramway, cables or analogous road receptacles.
21,818. ADAMS. Electric arc lamps.
22,250. THOMPSON (von Zweigbergk). Controllers for electric motors.
21,704. HART. Secondary electric batteries or accumulators.
21,705. HART. Secondary electric batteries or accumulators.
22,203. BOULT (Soden). Process of and apparatus for electrically treating ore.
22,206. POTTER. Machine for making storage battery plugs.
22,216. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Electric recording watt meters.
22,218. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) (Thomson). Electric measuring instruments.
22,240. BROCKIE. Electrical arc lamps.
22,772. THOMPSON. Dynamo electric machines.
22,800. DOW. Electrical apparatus for use in dental surgery and other electro-surgical treatments.
23,033. GOVER, BLAIR and PROCTOR. Electric plug contacts.
23,057. CROCKER and HOWE. Electric railways on a sectional conductor system.
24,131. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). (Reist). Electric controllers.
24,150. LLOYD. Electrodes for storage batteries.
25,307. FYNN. Drum armatures for dynamo-electric generators and motors.
25,703. HANSCOM and HOUGH. Electrical batteries.
26,656. RIBBE. Electric accumulator plates.
26,682. WEBB. Electro medical and exercising apparatus. (Date applied for under International Convention June 2, 1897.)
27,345. JAEGER and BENDER. Holders for incandescent electric lamps.
27,346. JAEGER and BENDER. Holders for incandescent electric lamps.
27,495. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED (Foster). Starting devices for alternating-current motors.
27,496. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED). (Steinmetz.) Dynamo electric machines of the inductor type.
27,765. SPENCER. Electric arc lamps.
27,995. FYNN. Devices for protecting electric circuits and apparatus from injury by excessive electrical potential due to lightning or other cause.
28,246. GOVER and MÜLLER. Safety electric fuses.
28,225. BROWN. Electric railways on a road contact system.
28,268. TIMAR. Current collectors for electric railways with overhead wires.
28,895. ANDERSON. Insulating supports for the third rail or electric conductor of electric railways.
28,956. KELMAN. Electric cables.
29,024. WEBSTER and REYNOLDS. Reflectors and supports for electric glow lamps.

COMPANIES' MEETINGS AND REPORTS.

Charing Cross and Strand Electricity Supply Corporation, Limited.

The annual ordinary general meeting of the shareholders in this Corporation took place on Monday at the offices, 15, Maiden-lane, Covent-garden, under the presidency of Mr. G. H. Brougham Glasier.

The SECRETARY (Mr. E. Wilmot Seale) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, the first duty which falls upon me is to express the very sincere regret of the Directors, which I am sure will be participated in by the shareholders, at the loss we have sustained in the death of our estimable colleague, the late Mr. Isaac Percy Mendoza, who was one of our Directors almost from the inception of the Company, and who always acted most cordially with us. My next duty is one which gives me great pleasure—it is to introduce to you our new Director, Mr. William Francis Fladgate. His qualifications are most probably known to many of you. He has been intimately connected with the Corporation from the commencement, and comes to us with a full knowledge not only of our affairs, but of affairs generally. He is a Director of the Law Life Assurance Society and a Member of the Council of the Incorporated Law Society, and will bring to our deliberations, in addition to business qualifications of a high order, a special knowledge of the legal aspect of matters which we believe will prove of the highest service to the Corporation. If you will be good enough to turn to para. 1 of our report you will note that we are able to congratulate you on a satisfactory increase in the business of the Corporation. This increase is really even more satisfactory than at first glance it would appear. In the electric lighting business, as in most other businesses, an increase in the number of customers is just as desirable in its way as an increase in the amount of business done. Each customer forms the nucleus for a further extension of business, provided of course that an efficient and reliable supply be given, and that such a supply is given by this Company the fact that the loss of customers during the past eight years has been infinitesimal amply testifies. Since 1896 we have increased our *clientèle* 55 per cent., and the units of electricity sold are about 33½ per cent. above those of the preceding year. The addition of lamps connected to our mains being an increase of 53·7 per cent. over those in 1896, can only be described as extremely satisfactory; it is a large increase, and compares favourably with the published results of other companies in the Metropolis. Rather more than one-half of this increase is derived from our acquisition last year of the Strand district, but it is also gratifying to find that a substantial proportion is contributed by our old area, the St. Martin's parish. The rate of increase was considerably greater during the latter part of 1897, consequently a large proportion of the lamps only earned revenue during that period. In para. 4 you will note that we have laid down 6½ miles of mains during the past year. You will remember last year we reported that during 1896 no less than 41 miles of mains had been laid in the Strand district alone (our total mileage is now about 83). Not only are our mains laid in both our areas of supply in the 30 streets in which it was compulsory to lay them under our Provisional Order, but as to St. Martin's in 49 streets, and as to the Strand district in 36 streets besides. Our mains in the combined areas are of sufficient capacity for a large increase of business. I propose commenting later on upon para. 6 when dealing with certain items in the Revenue account; suffice it at this moment to say that when completed we believe our station building will be found a thoroughly satisfactory, well-designed, and suitable structure. I now come to para. 7. We are, I think, justifiably satisfied with the results of the extension of area of supply in the Strand district, and believe that similar good results will accrue in Holborn and St. Giles. The Holborn District Board of Works and the St. Giles District Board of Works assented to our applications for Provisional Orders, and in the case of the St. Giles District our application to the Board of Trade is supported by upwards of 800 important property owners and ratepayers. It is only right to say, however, that consent has also been given by these District Boards to the application of another company, and that our respective claims will be considered and dealt with in due course by the Board of Trade. If you will refer to the map you will find the St. Giles District coloured green, the area we are seeking in the Holborn District yellow, and our present districts brown. You will now have a good geographical idea of our present and proposed areas, and will be able to form an accurate estimate of their extent and possibilities. For some time past we have been aware that a very strong desire for competitive supply existed within the City of London, and we have on several occasions been requested to give such a supply, but, of course, in the absence of powers, we have been compelled to decline. If you will again glance at the map you see that our present and proposed boundaries adjoin for a considerable distance those of the City, coloured blue, and that we are very favourably situated for giving such a supply. After careful consideration we gave notice in December last to the City Commissioners of Sewers of our intention to apply for a Provisional Order at an early date, and asked the consent of that body to our application. The application has been acknowledged, and we have been informed that the same will receive consideration in due course. There the matter at present stands. I now come to our accounts, para. 8. Our net revenue for 1897 is £18,907. 2s. 11d., as against £15,238. 15s. 1d. for 1896, or an increase of £3,618. 7s. 10d. Referring to our revenue account, para. 8, you will note that we have paid the sum of £3,648. 10s. 4d. in respect of debentures and temporary loans. We are glad to be able to tell you that we have made satisfactory arrangements with our bankers to advance money on loan as may be required on unissued debentures. I would draw your attention also to the fact that we have carried forward the substantial sum of £3,014. 18s. 4d. to our next account, and that this provision is larger than is made in the generality of electric lighting companies. Passing to the revenue, No. 4 account, the only item on which I wish to dwell is the question of coal. We are not quite satisfied with this. We have had to face considerable difficulties, and to work under conditions at our Lambeth station anything but conducive to economy. We had hoped to derive a far greater benefit from our wharf side premises this year than we have been able to obtain. For some time past it has been found quite impossible, owing to the extensive building operations on the wharf front, and its comparatively limited extent, to land our sea-borne coal from barges, and thus secure the substantial saving of about 3s. per ton or more, according to the coal used, and a large proportion of our coal has, in consequence, had to be rail- and land-borne at this relatively higher cost. As we have stated in our report, our building operations on the wharf front will shortly be completed. These operations comprise an extension of our engine and boiler rooms, and the erection of a large coal bunker capable of storing over 1,000 tons of coal—a by no means unnecessary provision in these days of strikes—with all the suitable appliances in the way of cranes and so forth, from the utilisation of which we hope to effect a considerable saving in the future in the unloading and handling of our coal. Then as regards the amount of the coal consumed, we are very disappointed with the results obtained from some of the boilers installed at Lambeth; but we feel sure when we tell you that this matter is receiving our best consideration, and that it is at present the subject of negotiations which may or may not result in an amicable arrangement being come to, you will see it is unadvisable to discuss the matter. I will only say that if our efforts are successful, the question of coal consumption from this cause will not trouble us further; if, on the other hand, they should prove unsuccessful, then the remedy, although drastic, will be none the less effectual. You will note further that we have expended £1,713 in

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repairs and maintenance of our buildings, plant, &c. It has been, and always will be, our object to keep our buildings in a good state of repair, and our plant in high state of order and efficiency and thoroughly well maintained. I next pass to the depreciation account, to which we have added the sum of £5,427, making, with the amount already set aside for the depreciation fund, a total balance of £13,000, and it may be interesting to state what has from the first been written off for depreciation and paid for repairs and maintenance. In 1892 the Company having only just been formed, nothing was required to be written off, and the only charge was for repairs, maintenance, &c. (£1,032. 19s. 8d.) In 1893 the amount under these headings and for depreciation was £2,575. 10s. 7d. ; in 1894 the amount was £3,394. 1s. 6d.; in 1895 it was £4,961. 7s. 10d.; in 1896 it was £6,939. 10s. 5d., and this past year you will see that the total sum written off, including the cost of repairs and maintenance, is £7,555 4s. 3d. In each case these amounts have been written off revenue. In No. 3 account, on the creditor side, you will note a balance of £33,770. 0s. 1d. ; this amount is made up of the following items :—£13,000, the Depreciation fund ; £9,608. 3s. 2d., Revenue Fund (*vide* general balance sheet, No. 7 account, Share Premium account), derived from the £1 premium shares ; and £11,161. 13s. 10d., the difference between liabilities and assets on the general balance sheet. We have thought it to the best advantage of the Company to at present utilise the Depreciation fund and the Reserve fund in the business of the Corporation. I do not think that there is anything further with which I need trouble you. We have thought the progress of the business of the Company sufficiently good to recommend an increased dividend, and we look forward with every hope of making your undertaking one of the most successful of its class. I now beg to move—

"*That the report and accounts be received and adopted.*"

Mr. FLADGATE seconded the motion.

A discussion followed, in which Mr. R. A. Bush, Mr. M. N. Adler and other shareholders took part.

Mr. FLADGATE, in reply, said : With respect to the debentures the directors will carefully consider the method of dealing with them ; but if they were paid off at the present time it would have to be at a premium of 5. It would hardly be good policy for us to pay them off at 5 premium when they only have two years to run, for it would mean a loss to the Company of 3 per cent. during the term. Our bankers have agreed to lend us money at 3 per cent., or ½ per cent. above the Bank rate, on our unissued debentures. That is a policy not wholly unfavourable to the Company. The whole of our installation here and this house are freehold. Two questions have been asked as regards the ashes. At the Lambeth station there will be a considerable decrease in those expenses when we can practically use our frontage there ; but the building operations have been so considerable that we have not been able to use the river frontage as we had hoped. That also applies to coal. The question of the acquisition of these undertakings by the vestries is a matter which the directors of every electric lighting company have to consider. Without giving the shareholders any actual or special information with respect to the form in which it will be carried out, practically the one important point is that the vestries are not bound to pay for goodwill. It is therefore important to write off your accounts as much as will represent the goodwill, and to keep that item down. The depreciation we make is after consultation with, and, to a certain extent, by direction from, the Board of Trade, to whom we have to submit our accounts every year. I do not think we should be justified in giving you the names of the makers of the boilers of which we are complaining. As a matter of fact, I hope that we shall not come to litigation with the makers, but the Directors have taken up a firm attitude in this matter. With respect to the powers that we have, in order that there may be no possible mistake, I may tell you that the present powers we have extend over the Strand and the St. Martin's district, which are coloured brown on the map. In the whole of that district we have competition. In the areas we are seeking there will be competition also. As to the area marked blue, we have not yet obtained the consent of the City authorities. We have received consent from the St. Giles's district and that portion of Holborn for which we have applied. Judging from our experience of the Strand district, we think it would be wise to go for larger districts, if we can get them. We were told by several persons when we went for the Strand district that there was no opening there for us, that there was another company there already, and that what we were doing was very unwise : but the results of that proceeding have been most satisfactory, and we do not in the least regret—in fact, we very much rejoice—at having taken the step we did. I think we shall be well advised in going forward as far as possible, if we can get the districts. Our engineer reports that our present well is very satisfactory. There is a very great saving in it from what the result would be if we had to pay for the water for our supply ; and the Directors have under serious consideration the advisability of sinking a well at our Lambeth station, and they think it would be at any rate worth consideration. The remuneration of the Directors has to be proposed each year. I think I have now dealt with all the questions which have been put, and I have very much pleasure in seconding the adoption of the report and accounts.

The CHAIRMAN then put the resolution, and it was carried unanimously. He afterwards proposed the payment of the dividend on the Cumulative Preference shares at the rate of 4½ per cent. per annum, and of a dividend at the rate of 8 per cent. for the half-year ended December 31st last on the Ordinary shares, making, with the interim dividend paid on these shares last August, 7 per cent. for the whole year.

Mr. JOHN M. GATTI seconded the resolution, which was carried unanimously.

The retiring Directors, Mr. Glasier and Mr. Fladgate, were re-elected, as were also the Auditors, Messrs. O. R. Johnson & Son ; and a resolution was also passed fixing the remuneration of the Directors at £700 per annum, as in the former year.

A vote of thanks to the Chairman and Directors terminated the proceedings.

India-Rubber, Gutta-Percha and Telegraph Works Company (Limited).

The thirty-fourth ordinary general meeting of this Company was held at the Cannon-street Hotel, London, on Wednesday, under the presidency of the Hon. Henry Marsham.

The SECRETARY (Mr. T. J. Lloyd) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said : Before moving the resolution that the report and accounts be adopted, I shall offer, as usual, a few explanatory remarks. Turning to the accounts, you will notice on the debtor side that the statement of profit and loss account has been expanded in accordance with the suggestion made by one of the shareholders, and which the Directors thought would be an improvement. Lower down on the same side you will see that "contingent liability—bills receivable discounted," £9,774. 8s. 11d., is set forth. This, of course, is a very important matter in the case of a discount company, but in our case the amounts are always small, and represent trade bills accepted by customers and discounted by us. However, we have shown the item separately, as the auditor thought it desirable to do so. Also, on his suggestion, in the profit and loss account, the mortgage and debenture interest has been shown under a distinct head. Our turnover in general business during last year was greater than that of any previous year, and the first six weeks of the present year show a still further increase. On every side, however, we meet with very keen competition, and the desire to keep up the quality of our goods renders our task an arduous one. The price of raw india-rubber was continually rising during the past year, and as the article showed at the beginning of this year a tendency to rise rather than recede in price, the principal manufacturers, including ourselves, have been compelled to notify an advance in the prices of rubber goods. In this connection I may mention, as a sign of the times, that companies are being formed for acquiring tracts of land in countries suitable for the cultivation of rubber trees, which may have an important bearing on the market of the future. Our steamers, the "Silvertown" and the "Dacia," have been employed on cable work in the North Atlantic, and the "Buccaneer" has also been at work. Our Silvertown and Persan works are kept highly efficient, and are well able to cope with any work that may be forthcoming. In the recent strike in the engineering trades our Silvertown works were amongst the few selected for attack. On representation being made to us by the Unions we went carefully into the whole question of the eight-hour day, and we found that the real object of the agitation was not the declared object. The desire of the Union was to force an increase of wages of about 15 per cent., and to gain further control in the working of the shops. We informed a deputation of the affected workpeople employed by us that we could not agree to their demands. The Unions then called out their members on strike and picketed our works. The strike has, however, terminated, and the normal condition of things is now restored. You will notice in the Directors' report that the great fire which took place in Melbourne on November 21st last destroyed our agency there, and that our stock of goods was consumed. I may mention that we are insured in eight responsible offices, and expect our claim to be met in full shortly. We have secured other suitable premises. With these remarks, I beg to move—

"*That the report and accounts now presented be received and adopted, and that a dividend of 7½ per cent., or 15s. per share, free of income tax, payable on the 24th inst., be now declared.*"

Mr. S. W. SILVER seconded the motion.

Gen. TREVOR said that before the motion was put he desired to ask whether the Directors were quite satisfied with the form of the auditors' certificate. He was not sure whether they did consider the form satisfactory—probably not. He was told that it was a form which had been used before. If so, he confessed that he had not noticed it, or he should have spoken about it before. There were two very large items on the credit side of the balance-sheet to which he desired to draw attention. One of these items was "debts owing to the Company," £175,519, and the other was their "debentures and shares in other companies," £216,236, aggregating together nearly £392,000. These items were only certified by the auditors as probably correct. What the auditors said was that these figures were correct "subject to the correctness of the value placed" on them. As to that correctness, the auditors said that they were "unable to certify." The auditors' certificate, in other words, said that if these figures were correct the shareholders were all right, but that they were not able to certify that they were correct ; and if they were not correct, then the shareholders were not all right. The shareholders could not, of course, expect auditors to go round to creditors and demand to see their books, and thus ascertain whether the £175.000 odd were really good debts, or whether some of them were not bad. Again, as to their debentures and shares in other companies, a great many of them were not quoted in the London market. How was an auditor to ascertain whether the amount at which the Directors took their present value, £216,000 odd, was their saleable value that day? They did not know whether all these companies were paying dividends, but they hoped most of them were. If, however, they were shares held, as all businesses must hold shares, in other companies for business purposes—if such shares were held, and were not paying any dividend, then their cash value at the present moment must be *nil*. Before sitting down he would like to know whether the Directors themselves were perfectly satisfied that the debts owing to the Company were all realisable, if necessary, or whether any of them were bad ; and, further, whether the debentures and shares held by them in other companies were all in dividend-paying concerns, or mostly so, or if any of them were paying nothing, and whether the £216,000 odd was really their present value if it were, unfortunately, necessary to sell them. He made these remarks because the two items added together amounted to little short of £400,000. Their whole reserve fund, which was employed in the business of the Company was only £450,000, so that if the two large items to which

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he had called attention was really over-valued, then to that extent their reserve fund, which they fondly believed was employed in the business, had already disappeared. He hoped that this was not the case. The home trading capital in the past year had been £1,250,000—share capital, debenture capital, and the reserve fund. The trading on that amount had only produced 4¼ per cent. In these days of competition this was probably considered by the Directors (he did not actually know that it was) a fair return; but unless they did better than this, they could not expect very much longer to get a dividend of 10 per cent.

The CHAIRMAN: The Directors are inclined to agree with General Trevor as to the certificate that is given by the auditors, and we should be quite content if it were not so worded. With regard to the two items to which he has called attention, they are valued on the responsibility of the Board. The debts owing to the Company are, in the main, trading debts, which we look upon as realisable, and we hope to see the money in due course finding its way into the Company's till. With reference to the debentures and shares held by us in other companies, there, again, the valuation is that of the Board, who value them on their own responsibility, with, however, a knowledge of the circumstances. That they are all of equal value we do not pretend to say. That everyone of them is a dividend-paying security we do not say, and it is not the case; but that they are necessarily valueless on that account I am not inclined to agree. Although they may not be at the moment a dividend-paying security, there is no saying what may happen in the future. We know what the securities are, and the valuation we put on them we hold to be reasonable and proper. Gen. Trevor said that he hoped there were no bad debts among the debts which are owing to the Company. There are an immense number of people who owe money to us in the way of trade, and it may be possible that we have taken too sanguine a view as to one or more of these people, but we have no reason to believe that we have any bad debts in this item.

The motion was then carried, and Major Leonard Darwin was re-elected a Director.

Messrs. Turquand, Youngs, Bishop and Clarke were reappointed auditors.

Gen. TREVOR said he hoped the auditors would be instructed to give a better form of certificate next year.

The CHAIRMAN: We shall intimate to the auditors that this form does not meet with the approbation of the shareholders or of the Directors.

Mr. LAMONT said he thought the auditors were acting within the line of their duties in making the remarks which they did in their certificate.

A vote of thanks was passed to the Chairman, Directors and staff for their devotion to the business of the Company, reference being especially made to the demands upon their services during the engineers' strike.

The CHAIRMAN, in reply, thanked the shareholders for their vote, and said he was very glad the permanent staff had been included in the vote, as they had always given the most faithful, devoted and loyal services to the Company, and the Directors were greatly indebted to them for their assistance.

The proceedings then terminated.

City of London Electric Lighting Company (Limited).

The report of the Directors of this Company for the year to Dec. 31 last will be presented to the shareholders at the meeting to be held at Winchester House, London, E.C., on Wednesday, March 2, and is as follows:—

Capital.—The expenditure on capital account during the year amounted to £82,085. 17s.

Revenue.—The total revenue for the year was £190,573. 12s. 11d., from which must be deducted expenses of generation and distribution (£42,923. 10s. 8d.); rents, rates, taxes, general charges (£23,980. 19s. 6d.); allowances to consumers (£14,780. 19s. 9d.); transfer to depreciation fund, No. 1 (£17,000); transfer to reserve fund (£3,528); written off suspense account (£1,338. 0s. 8d.)—£103,551. 10s. 7d.—leaving £87,022. 2s. 4d., to which must be added £1,415. 3s. 1d. brought forward, together £88,437. 5s. 5d. Of this sum interest has been paid on debenture stock for year ended Dec. 31 (£20,000), and an interim dividend on £400,000 Six per Cent. Preference shares for half-year to June 30 last (£12,000), together £32,000, leaving for further distribution £56,437. 5s. 5d. The Directors now recommend the payment (less income tax) of 6s. per share for the six months on the Preference shares; £1 per share on Ordinary shares (40,001 to 80,000), being at the rate of 10 per cent. per annum; and 10s. 7d. per share on Ordinary shares (80,001 to 90,000), being at the rate of 10 per cent. per annum, calculated from dates of respective instalments to Dec. 31. This will absorb £55,381. 18s. 10d., and leave £1,055. 6s. 7d. to be carried forward. The respective dividends will be paid on and after March 3. £20,528 has been set aside out of revenue for depreciation and reserve funds.

Generation and distribution expenses for the year, including repairs and renewals, were 31·3 per cent. of earnings, compared with 34 per cent. in 1896, 36·87 for 1895, 46 for 1894, and 54·2 for 1893. The progress made by the Company is shown by the following statement:—

Number of Customers and Lamps Connected at Dec. 31.

	1892.	1893.	1894.	1895.	1896.	1897.
No. of customers	242...	1,080...	2,740...	4,230...	5,303...	6,322
Equivalent 8-c.p. lamps connected	20,241...	65,341...	135,460...	195,317...	247,785...	296,012

On Feb. 9, 1898, there were 316,705 8-c.p. lamps (equivalent) applied for, out of which 302,871 were connected.

Statement of Income for the Full Yearly Periods to Dec. 31.

	1893.	1894.	1895.	1896.	1897.
Gross revenue	£39,663...	£63,864...	£107,000...	£146,947...	£175,793
Net revenue available for depreciation, reserve, interest and dividends.....	16,941...	34,865...	59,100...	85,701...	107,550

Notting Hill Electric Lighting Company (Limited).

The Directors of this Company have issued the following report of the year to Dec. 31 last:—

The expenditure during the year has been £14,079. 7s. 10d., of which £11,769. 13s. 11d. has been devoted to mains. The total capital expenditure to date is £113,184. 5s. 4d., or £3,184. 5s. 4d. in excess of the capital issued. The balance due at the beginning of 1897 on the Preference shares, £3,160, was called up and duly paid during the year, making the whole share capital of £100,000 fully paid up.

As announced in the last report, £10,000 was raised by the issue of Four per Cent. First Mortgage debentures maturing in 1931, and redeemable in 1907, at the option of the Company, at a bonus of 5 per cent. These debentures were issued at 106 per cent., and the applications were considerably in excess of the amount required. In accordance with the debenture trust deed, the amount of these First Mortgage debentures is limited to 50 per cent. of the share capital actually issued and paid up. At present, therefore, there are £40,000 of debentures available for additional expenditure. The capital expenditure during the current year is estimated at £7,000, for which further debentures will be issued. The following shows the progress of the Company:—

Year.	Lamps.		£.	s.	d.
1891	6,056	*Loss*	554	18	6
1892	9,438	*Profit*	112	6	1
1893	12,153	„	1,481	7	1
1894	15,669	„	2,101	17	8
1895	20,307	„	3,227	14	10
1896	25,716	„	4,736	9	8
1897	33,000	„	6,854	1	2

The Directors have set aside £1,000 for depreciation and reserve, and have paid a dividend of 6 per cent. on the Ordinary Preference shares for the year to Dec. 31, requiring £1,767. 14s. 4d. After payment of interest and leasehold redemption there is a balance of £3,884. 18s. 1d., out of which the Directors propose a dividend on the Ordinary shares at the rate of 6 per cent., less income tax, absorbing £3,871. 4s. The £401. 16s. 2d., premiums on the issue of £10,000 First Mortgage debentures (after deduction of the legal and other expenses), has been written off the preliminary expenses account.

The Company had hitherto supplied current at the standard pressure of 100 volts at 8d. per unit. In March last it was decided to supply current at 200 volts at 6d. per unit, less the usual rebates for long hours.

A contract has been entered into with the National Electric Free Wiring Company (Limited) which enables intending customers to obtain current without initial outlay for wiring or fittings. This arrangement came into force at the end of 1897, and already 17 connections have been made.

Very considerable inconvenience has been caused to the engineering staff by the non-delivery of the new and additional machinery ordered in the early part of last year, owing to the labour troubles in the engineering trade. Fortunately, the Company were able to meet all demands on them without any accident or breakdown. Great credit is given to the manager and staff generally for their care and energy during this very anxious time.

Kensington and Knightsbridge Electric Lighting Company (Limited).

The eleventh annual report of the Directors will be presented to the shareholders on Thursday next, and covers the financial year 1897. During the year the number of houses and shops connected with the Company's system has increased from 1,325 to 1,620, and the number of 8-c.p. lamps from 119,955 to 137,953. Additional capital required by the Company has been raised by the issue of £1,160 4 per Cent. Debenture stock, producing £1,240 and 2,000 Second Preference shares, offered to shareholders at a minimum price of £6 per £5 share, were subscribed for, producing £12,219. 12s. 6d. The renewal account has been strengthened by transferring to it £8,061. 7s. 1d., making the total £20,497. 13s. 10d.

After providing for the above amount, and paying dividends on the 6 per Cent. First Preference shares to June 30, on the 5 per Cent. Second Preference shares to September 30, and an interim dividend at the rate of 8 per cent. per annum on the Ordinary shares for the first half of the year, the balance net revenue is £7,263. 11s. Of this sum £1,450 has been appropriated to the payment of the First Preference dividend, and £300 has to be set aside to meet the portion of the dividend on the Second Preference shares accrued, leaving £5,513. 11s., out of which it is proposed to pay a further dividend on the Ordinary shares at the rate of 12 per cent. per annum for the past half-year, making, with the interim dividend, 10 per cent. for the year. £1,163. 11s. is carried forward.

W. T. Henley's Telegraph Works Company (Limited).

The report of the Directors of this Company for the year 1897 states that, of the £50,000 additional capital duly authorised, the Directors limited the issue to £25,000, reserving the remainder for future needs. The whole of the £25,000 was taken up by the shareholders or their nominees at 60 per cent. premium, increasing the reserve by £15,000. After negotiations with the local authorities (protracted for several years), Victoria-road, which intersected the Company's works at North Woolwich from east to west, has been legally closed, and its site added to the Company's property—which now lies within a ring fence. This great advantage entailed a payment of £2,000 to the Woolwich Local Board of Health, to be applied to some purpose of public utility.

The accounts show a net profit of £29,584. 19s. 7d. After payment of Debenture interest and income tax, and making ample allowance for depreciation of buildings, plant, machinery, &c., there remains £23,936. 5s. 7d., making, with £14,294. 6s. 7d. brought forward, a total of £38,230. 12s. 2d.

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From this sum has to be deducted the £500 voted to the Directors at the last general meeting, leaving £37,730. 12s. 2d. available for distribution. The Directors have transferred £7,500 to reserve (in addition to the £15,000 premiums above-mentioned), and recommend the payment of the following dividends, viz.: On the Preference shares, 7 per cent. (including the interim dividend of 3½ per cent. paid in September last); on the Ordinary shares, at the rate of 12 per cent. per annum (including the interim dividend of 3 per cent.). These payments amount to £22,941. 0s. 7d., leaving £14,789. 11s. 7d. to be carried forward.

Telegraph Construction and Maintenance Company (Limited).

The report of the Directors of this Company for the past year will be submitted to the thirty-fourth annual ordinary meeting to be held on Tuesday next. The accounts for the year show a net profit of £61,131. 7s. 10d., after charging interest on debentures. Adding £39,940. 2s. 1d. brought forward, there is a total of £101,071. 9s. 11d. From this amount is deducted the interim dividend of 5 per cent. (paid in July), amounting to £22,410, leaving £78,661. 9s. 11d. to be now dealt with. The Directors propose to distribute a dividend of £1. 4s. per share (absorbing £44,820), being at the rate of 10 per cent., and making a total dividend of £1. 16s. per share, or 15 per cent., free of income tax, leaving £33,841. 9s. 11d. to be carried forward.

The Company's works have been actively employed in the manufacture of various lengths of submarine telegraph cable and insulated wire for land lines; and the steamships have been engaged in sundry repairing operations. The factories at Greenwich and Wharf-road are in a thoroughly efficient condition, important improvements in the buildings as well as in the plant having been carried out. The Company's steamships have been efficiently maintained, and are in good repair.

NEW COMPANIES, STATUTORY RETURNS, &c

ELECTRIC INSTALLATION COMPANY (LIMITED).—This Company was registered on Feb. 19, with a capital of £100,000, in £1 shares, to carry on the business of an electric light, telephone and telegraph company in all its branches, to construct, lay down, establish and fix all necessary cables, lines, accumulators, lamps and works, and to carry on the business of electricians, electrical and mechanical engineers and contractors, suppliers of electricity, and manufacturers of and dealers in electrical apparatus of all kinds. The first subscribers are: W. Coffey, J. Boydell, T. Currie, H. T. Johnson (engineer), R. A. Beaver, R. V. Critchley, and F. F. Bennett (engineer). The first Directors are: R. A. Beaver, J. Boydell, W. Coffey, T. Currie, and H. T. Johnson.

W. T. GLOVER AND COMPANY (LIMITED).—This Company was registered on February 16, with a capital of £200,000 in £1 shares (of which 100,000 are £5 per Cent. Cumulative Preference), to acquire and take over as a going concern the business now carried on by Messrs. Henry Edmunds and Godfrey B. Samuelson, at Springfield Works, Salford, Manchester, under the style of W. T. Glover and Company, and to carry on the business of manufacturers of and dealers in wires, cables and lines for electrical purposes, electrical engineers and contractors, electricians, manufacturers of electrical apparatus and suppliers of electricity. The subscribers are: Henry Edmunds (electrical engineer), Godfrey B. Samuelson (electrical engineer), W. P. James Fawcus (engineer), James Morton, John W. Moore, Robert Taylor (electrical cable maker), and Samuel Hartford. The first Directors are: Henry Edmunds, Godfrey B. Samuelson, W. P. James Fawcus, and Henry P. Holt.

INTERNATIONAL ENGINE PATENTS DEVELOPMENT COMPANY (LIMITED).—This Company was registered on February 17, with a capital of £3,750 in 1s. shares, to acquire and undertake all or any of the assets and liabilities of New and Mayne (Limited), pursuant to a scheme of arrangement sanctioned by order of the High Court of Justice on January 12, and to carry on the business of mechanical, electrical and general engineers, engine builders, and manufacturers of electrical oil or steam motors. The first Directors are: Reuben Hunt, William Shrimpton, and Anthony G. New.

CRYSTAL ELECTRIC LAMP COMPANY (LIMITED).—The statutory return to Dec. 16 has been filed. The nominal capital is £10,000 in £1 shares, and 6,667 have been taken up. 1,667 of these have been issued as fully paid, and £5,000 has been called and paid on the remainder.

MUNICIPAL ELECTRIC LIGHT AND POWER SYNDICATE (LIMITED).—The annual return to Jan. 14 has been filed. The nominal capital is £25,000 divided into 2,490 Ordinary shares of £10 each, and 100 Founders' shares of £1 each. 37 of the former and 30 of the latter have been taken up, and the full amount called, resulting in the total receipt of £400.

MORLEY ELECTRICAL ENGINEERING COMPANY (LIMITED).—The statutory return to Jan. 15 gives the nominal capital as £5,000 in £1 shares, of which 1,024 have been taken up. £1 per share has been called, and £1,024 has been received.

EASTERN TELEGRAPH COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company will be held at Winchester House, Old Broad street, London, on Thursday next, at 2.30 p.m., for the purpose of confirming, as a special resolution, the resolution passed at the extraordinary general meeting on Tuesday, the 15th inst.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 25 1/16d. per oz. (Feb. 24). Consols (2¾ per cent.) 112⅞—112¾ for money, 112 1/16—112 3/16 for account; 2½ per cent. 105⅝—106¼ (Feb. 24). Stock Exchange Settling Days: Consols, March 1; Stocks and Shares Continuation Days, March 9 and 28; Ticket Days, March 10 and 29; Pay Days, March 11 and 30; Mining Share Carry-over Days, March 8 and 26.

CAPE ELECTRIC TRAMWAYS (LIMITED).—The statutory general meeting of the shareholders of this Company was held on Wednesday. The Chairman (Col. Sir C. Evan-Smith) stated that the Company was formed in July last with a share capital of £400,000 fully-paid and debentures amounting to £430,000, for the purpose of acquiring the various tramway companies in the Cape of Good Hope and Port Elizabeth. These included the City Tramways Company of Cape Town, with a capital of £158,500; the Metropolitan Tramways Company, of Cape Town, with a capital of £130,000; the Southern Suburbs of Cape Town Tramways, with a capital of £45,000; and the Port Elizabeth Tramways Company, with a capital of £120,000. Since taking over the Cape Town tramways various extensions and improvements had been carried out, and the whole system was now worked by electric power. From July 1 until December 31 last the Cape tramways carried 3,300,000 passengers, which aggregated about 30 times the total population of Cape Town and its suburbs. The gross receipts were £40,909. On the Cape Town system they had about 22 miles of track running through 18 miles of streets, and 42 cars of the latest pattern. The Port Elizabeth tramways were now also worked by electric power, but they were only beginning to reap the full benefits of the improved service. For the six months ended Dec. 31 last 869,550 passengers were carried and the receipts amounted to £11,985. At Port Elizabeth they owned about 11 miles of track, running through six miles of streets, the equipment, &c., being in a high state of efficiency. The directors were able to declare an interim dividend of 2½ per cent. for the past six months' working.

ELMORE'S FRENCH PATENT COPPER DEPOSITING COMPANY (LIMITED).—At a meeting of the first mortgage debenture-holders held on Wednesday at Winchester House, the Chairman (Mr. J. H. Duncan) said the Directors had received an acceptable offer for the Founders' shares of the Société Française d'Electro-Metallurgie, which was the main asset of this Company. The offer was £12,000, less £1,000 commission. This amount, together with some miscellaneous assets of the Company, brought up the sum now available for distribution to about £12,900. This would enable a payment to be made to the debenture-holders of 7s. 4d. in the pound. He moved a resolution that the sale be effected. This was carried, the Chairman being authorised to deduct 5 per cent. from such composition, *pro rata*, for his services in the matter.

LUCAN STEAM TRAMWAY COMPANY.—At a meeting of this Company, on Friday last, it was decided to issue fresh capital to provide for the electrical equipment of the line.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED). The annual general meeting of this Company was held on Tuesday. The Chairman (Mr. J. D. Milburn), said that they would be glad to see that they were paying an increased dividend this year, and this had principally been attained on account of economy in coal. There was one circumstance about the Company that they were not quite satisfied with, and that was the lack of work in the daytime. They hoped, however, that circumstances would soon allow them to apply their energy to meeting the requirements of day work. In 1891 their output was 206,000 units; 1892, 290,500; 1893, 388,500; 1894, 431,000; 1895, 472,000; 1896, 541,000, and 1897, 643,000 units, showing a steady increase year by year since the Company commenced operations. They had recently, in view of certain possibilities, thought it well to apply to the Board of Trade for permission to lay cables for the supply of continuous current. They had now eleven generators at their works, and there was another of large capacity nearly ready.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The report of the Directors to be presented to the shareholders at the ordinary general meeting of the Company, to be held at Moorgate-court, London, E.C., on Thursday next, at 2 p.m., states that the capital expended during the year amounted to £3,828. 17s. 1d., making the total expenditure at December 31 last, £44,793. 11s. 9d. Of the amount expended during the year, the principal items were in respect of mains and accumulators, the latter having been increased to more than double their previous capacity. The balance to credit of revenue account, including amount brought forward, and after payment of interest, depreciation and reduction of suspense account, is £1,072. 18s., against £33. 14s. 9d. in 1896. Out of this sum the Directors recommend the payment of a dividend on the Ordinary shares at the rate of 3 per cent. for the year, which will leave a balance of £133 to be carried forward. The total number of lamps connected on December 31 last was equivalent to 9,512 8-c.p., an increase for the year of 2,387. In order to meet the growing demand for current, additional plant will be installed in time for next winter's lighting, and further extensions of mains have already been decided upon.

SALT UNION (LIMITED).—In the report of the Directors of this Company for the year ended Dec. 31 it is stated that the recent engineering strike retarded the trial which was being made with their electrolytic process for the production of caustic soda and bleach

SANITAS COMPANY (LIMITED).—Mr. C. T. Kingzett, who presided at the meeting of the Sanitas Company on Wednesday, congratulated the shareholders on the continued and increasing prosperity of the Company. A balance dividend was declared, making the total distribution for the year 13¾ per cent. on the fully-paid shares. The Directors have before them a proposal to divide the shares of the Company.

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BARCELONA TRAMWAYS COMPANY.—The report of the Directors, to be presented at the ordinary general meeting of the Company on the 2nd prox. at Winchester House, London, E.C., states that the sanction of the municipal authorities to the adoption of electric traction on the Company's system was obtained last summer, and the work of transformation was making rapid progress. During the year 5,072 unissued shares, as well as £100,000 in Four and a Half per Cent. Redeemable Debenture Stock, were issued for providing funds for the conversion of the line and other purposes.

BLACKPOOL AND FLEETWOOD TRAMROAD COMPANY (LIMITED).—The half-yearly meeting of this Company was held in Manchester on Friday. The chairman (Mr. G. Robertson) said the balance-sheet showed an expenditure on capital account of £82,000 to Jan. 17, and he hoped that at the next annual meeting they would be able to present a satisfactory revenue account. The progress of the works had been satisfactory, and they had every expectation that the line would be ready in time for a portion of the summer traffic. The line from Talbot-road station to Fleetwood would be ready for opening by June. It was decided to make an issue of debentures to the amount of £40,000.

G. R. BLOT AND COMPANY (LIMITED).—At the recent statutory meeting of this Company, the Chairman (Mr. Thomas Parker) said that the future of the Company was well secured owing to the fact that they had orders in hand and in view. The capital of the Company had been largely subscribed by English and French shareholders. The parent Company (Compagnie des Accumulateurs Electriques Blot) had been very successful and had just received an order from the Compagnie d'Eclairage Electrique du Secteur des Champs Elysées for a battery having a capacity of 10,000 ampere hours, discharging at the rate of 2.000 amperes per hour. This was, he said, one of the largest batteries, if not the largest, in the world. The Company had 15 tons of plates to handle per week, so that they had every reason to hope that they would do quite as much at their factory at Wednesfield. They were proceeding as quickly as possible with the erection and fitting out of the new works, and in a few weeks they would be able to commence delivery of accumulators on a large scale. For his own part, he had been connected with accumulators since 1881. There was a notice of his first effort in this respect in *The Electrician*, of February 7, 1882. He was managing director of Elwell Parker (Limited), which did a large accumulator business in Wolverhampton until 1889, when the manufacture ceased. The Company had everything in its favour: works admirably situated, with every facility for cheap transport by canal, railway, &c.; and freights being so reduced and rent so cheap, it was more than probable that handsome dividends would soon be paid. Situated as their works were right in the very heart of the electrical world, there was every reason to hope for a favourable result.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY (LIMITED).—The half-yearly meeting of this Company was held on Thursday last at Bristol. The Chairman (Mr. William Butler), in moving the adoption of the report, stated that the receipts from the tramways department showed an increase of £9,494, which was largely made up of receipts from additional lines opened during the half-year. General expenses had increased owing to additional business, and there had been a heavier expenditure on renewals. The net revenue was £16,859, against £12,378 in the corresponding half-year, an increase of about £4,500. The Chairman referred at considerable length to the dispute with the Corporation on the question of the introduction of electric traction.

BRITISH ELECTRIC TRACTION COMPANY (LIMITED).—Letters of allotment and regret for the recent issue of 10,000 Six per Cent. Cumulative Preference shares in this Company have been posted.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY (LIMITED).—The transfer books and register of members of this Company will be closed from the 1st to the 14th prox. inclusive, preparatory to the payment of the dividend on the Preference shares for the six months ended Dec. 31. The fourth ordinary general meeting of the Company will be held at 2 p.m., on the 14th prox., at Winchester House, Old Broad-street, E.C.

LEGAL NOTICE.—An advertisement in another column gives particulars of the order made on the 5th inst. in the High Court of Justice by Mr. Justice Romer in the matter of the House-to-House Electric Light Supply Company (Limited), and the reduction of the capital of the Company from £200,000 to £199,500, consequent upon the extinguishment of the Founders' shares.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The half-yearly coupons, which fall due on the 1st prox., of the £100,000 Six per Cent. Debentures of this Company will be paid by Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, London, E.C., on and after that date. Coupons must be left three clear days for examination.

MANCHESTER CARRIAGE AND TRAMWAYS COMPANY.—A special meeting of the shareholders of this Company was held at Manchester on Friday to consider the Bill now before Parliament to enable the Company to work their tramways by mechanical power, &c. Sir John Harwood, in seconding the approval of the Bill, said this was a measure to put the Company in a position to use mechanical or electrical power in the working of their tramways, either on their own account or by mutual arrangement with the local authorities. Outside Manchester and Salford there were, he said, local authorities who in one way or another were interested in tramways, and if they should hereafter determine that the tramways passing through their districts should be worked by electricity, somebody would have to find the necessary electric power. The local authorities would probably not do it. If they did, it would be agreeable to those who were intending to work the tramways. The Manchester Carriage and Tramways Company had a very large interest in tramways outside the city of Manchester and the borough of Salford, and if it should be found necessary for them to erect electricity works, the Bill would enable them to go to these outside authorities and enter into a mutual arrangement. On the other hand, if the authority generated the current, the Company would try to arrange to work it on terms agreeable to both parties. The Bill was unanimously approved.

SCARBOROUGH ELECTRIC LIGHT COMPANY (LIMITED).—The sixth ordinary general meeting of this Company was held at Scarborough on Thursday last. The Chairman (Mr. G. Alderson-Smith, J.P.) stated that the Directors' report, an abstract of which appeared in our last issue, fairly set out the result of their operations during the past year. They had spent more money, and the result had been that they had had increased receipts. They were rather handicapped by the cost of coal. He noticed that in Leeds the current sold brought in £17,000, and their coal bill was £875. In Scarborough the current brought in £5,300, and their fuel cost £1,138. The Directors were giving their attention to the matter to see if they could not do something to economise. They had already got a patent forced draught, and they hoped to be able to burn coke during some part of the day. There was also the question of the erection of a destructor, a matter which was being much discussed in the town. Perhaps a small one might be fixed on the premises of the Company, and that might supply them with steam. He had no doubt it was only a matter of time before the Corporation purchased the undertaking, and if they put a destructor on the premises they would be doing something towards the future. The report and balance-sheet were, after a brief discussion, adopted, the Chairman stating that since the report was drawn up application had been made for between 600 and 700 more lights. A dividend of 5 per cent., less income tax, was then declared; and the retiring Directors and auditors were re-elected.

SOUTHAMPTON TRAMWAYS COMPANY.—At the half-yearly general meeting of this Company on Monday, the chairman (Col. E. Bance) said that the Corporation had notified them of their desire to purchase the Company's undertaking, and had made an offer of £40,000. This amount the Directors considered inadequate, and the matter would therefore go to arbitration.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee has appointed Wednesday, March 2, a special settling day for £110,100 Four per Cent. Perpetual First Mortgage Debenture stock of the Electric Construction Company (Limited), and have ordered the same to be quoted in the official list.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Feb. 18 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,819.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half-month ended Feb. 15 is £1,804, against £2,239 in the corresponding period of 1897. The October receipts (estimated at £3,719) realised £3,751.

YORK TRAMWAYS COMPANY.—At the half-yearly meeting of this Company at York, on Thursday last, the chairman (Mr. Joseph Kincaid) said that they anticipated being in the near future able to introduce electric traction on their tramways, and that they hoped that the Corporation would meet them fairly in the matter.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Feb. 19	3,526	+203	...	...	...
Bristol Trams & Carriage	,, 18	2,399	+311	7	16,524	+ 3,020
City & South London Ry.	,, 20	1,051	+ 7	8	8,565	- 152
Dover Tramways	,, 19	104	...	24	2,679	...
Dublin United (Southern)	,, 18	385	- 99	8	2,864	- 84
Liverpool Overhead Rly.	,, 20	1,320	...	8	10,830	+ 689
Sheffield Tramways	,, 20	941	+ 51	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Feb. 16.	Price Wednesday, Feb. 23.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 19. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	3/0	Central London Ordinary	10¼ 11	10¼ 11	2 14 1	June and December	10⅛	10¼
143,106	10	1/9⅔	Do. (46 paid)	6½ 7	6½ 7	2 11 6	,, ,,	6⅝	6⅝
£800,000	Stock	1¾	City and South London Railway Con. Ordy.	58 70	66 68	2 15 2	January and July	69	68½
8,419	£10	5%	Do. 5% Perpetual Preference	15 16	15 16	3 2 6	,, ,,	..	..
£135,701	Stock	4%	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	..	..
54,000	10	2/8⅓	Waterloo and City Ordinary	13⅞ 14½	13⅞ 14½	2 2 1	June and December	14½	13⅞
37,500	10	8%	Liverpool Overhead Railway Ordinary	10⅝ 11⅛	10⅝ 10⅝	2 14 10	February & August	..	..
10,000	10	5%	Do. 5% Preference	15½ 16½	15½ 16½	3 1 6	,, ,,	..	..
125,000	Stock	4%	Do. 4% Debenture	108 110	108 110	3 11 5	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price Feb. 16.		Price Wednesday, Feb. 23.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 19.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£923,060	Stock	19/6	Anglo-American	61	63	58	60	5 0 0	Feb., May, Aug., Nov.	61½	61
£3,038,020	Stock	39 0	Do. Preferred	111	112	107	104	5 11 1	" "	111½	109
£3,038,020	Stock	5/0	Do. Deferred	12¾	13½	11½	12	—	—	13⅜	12½
£137,400	£100	4%	*African Direct Telegraph (Red)	100	104	100	104	3 16 11	January and July	—	..
£225,000	10	..	Amazon Telegraph	6	7	6	7	..	—	..	..
130,000	10	3/0	Brazilian Submarine	16¾	17½	16¾	17½	4 1 2	Mar., June, Oct., Dec.	17½	16¹⁵⁄₁₆
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	112	116	4 6 2	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	187	192	187	192	4 3 6	Jan., Apr., July, Oct.	..	..
£633,586	Stock	4%	Do. 4 per Cent. Debenture Stock	106	108	106	108	3 14 1	" "	107½	106¾
16,000	10	8/0	Cuba Submarine	8	9	7½	8½	9 8 3	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	17½	18½	16	17	5 17 8	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10¾	11½	10¾	11½	5 15 7	Jan., Apr., July, Oct.	11½	10¾
400,000	£10	2/6	Eastern	18	18⅛	18	18⅛	3 10 3	" "	18⁷⁄₁₆	18⅛
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	19	20	19	20	3 0	" "	19½	19½
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131	134	131	134	2 19 11	May and November	..	..
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension	18¾	19½	18¾	19½	3 13 8	Jan., Apr., July, Oct.	19⅛	19
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	130	133	130	133	3 0 2	February & August	..	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99	103	99	103	4 17 3	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99	103	99	103	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 16 2	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞	111⅞	108⅞	111⅞	3 12 1	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	12½	13½	12	12½	3 16 0	Jan., Apr., July, Oct.	..	..
180,042	10	6%	Do. 6 per Cent. Preference	18	18½	17⅞	18½	3 5 9	" "	..	..
159,000	10	5/0	Great Northern of Copenhagen	27½	28½	27½	28½	3 10 3	January, April, July	27⅞	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	101	104	101	104	4 17 7	March & September	..	
17,000	25	12/6	Indo-European	52	55	52	55	4 10 11	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	108	111	108	111	5 10 1	March & September	—	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105	108	105	108	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	8	9	8	9	4 8 11	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	140	145	139	144	4 4 3	" "	..	—
15,609	10	6/0	West African Telegraph	4½	4¾	4½	4¾	5 0 0	.. ..	—	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 14 4	March & September	..	..
30,000	10	..	West Coast of America	¾	1½	½	1	..	..	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	107	105	107	3 14 9	June and December	..	..
88,321	10	1/0	West India and Panama	½	¾	½	¾	..	May and November	..	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	8	8½	8	8½	7 1 2	" "	8½	8⁵⁄₁₆
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	—	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	10½	11	10½	10¾	2 15 10	May and November	10⅞	10⅝
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	8	7½	8	3 15 2	" "	7⅞	7¼
33,129	7½	1/6	Do. Deferred Ordinary	3½	4	3½	3¾	..	" "	3⅝	3½
£382,230	..	4%	Do. 4 per Cent. Debenture Stock	105	107	105	107	3 14 1	June and December	..	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	—	—
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	—	..
			TELEPHONES.								
44 000	£5	4/0	Chili Telephone (fully paid)	3	3½	3	3½	5 14 4	August	—	—
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	⅛	¼	⅛	¼	..	July	⅛	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	..	..
484,597	5	3/0	National	6¾	7⅛	6¾	7⅛	4 4 3	February & August	7⅛	6⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	15	17	16	18	3 6 8	" "	17	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	14	16	15	17	3 10 7	" "	16	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	6	6½	6	6½	3 16 11	" "	6⁵⁄₁₆	..
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104	109	104	109	3 4 0	June and December	105	..
171,504	1	0/4	Oriental	⅝	¾	⅝	¾	6 13 4	April and October	..	—
58,000	5	5/0	United River Plate	4	4½	4	4½	5 11 1	July	4½	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	106	101	106	4 14 6	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
£200,000	5	4½%	Birmingham Electric Supply (fully paid)	10¾		10⅝	10⅞	—	March	..	—
50,000	£10	16/0	City of London Electric Lighting (fully paid)	28½	29½	28½	29½	2 7 5	February & August	29½	28⅝
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17½	18½	17½	18½	3 4 10	January and July	17⅝	..
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	132	129
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	14	15	14	15	2 3 6	February & August	14½	14
20,000	5		Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	6⅝	6½
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	—	—	January and July	—	—
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	11¾	12½	11¾	12½	3 1 3	March	12½	11⅞
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	115	117	3 17 5	June and December	..	..
£30,000	£10		County of London & Brush Prov. Ord. (fully paid)	15½	16½	15½	16	..	..	15⅞	15½
20,000	£10	6/0	Do. 6% Cumulative Preference	15½	16½	15½	16½	3 13 10	March & September	16	15⅝
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	10½	11½	10½	11½	..	..	11⁷⁄₁₆	11
10,000	£5	7%	Do. 7 per Cent. Preference	11½	12	11½	12	2 18 4	March & September	11⅝	..
111,000	£5	..	London Electric Supply Ordinary	4⅜	4¾	4¼	4⅜	..	—	..	..
48,050	£5	..	Do. Preference	6¼	7¼	6¾	7½	..	..	..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	20	21	20	21	2 12 4	April and October	20⅞	20½
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	19½	20½	19½	20½	..	" "	..	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	..	..
8,452	10	8/0	Notting Hill Electric Ordinary	18½	19½	19	20	2 0 0	March	19½	19
275,000	1	..	Rand Electric	1⅛	1⅜	1⅛	1⅜	—	—	—	—
£125,000	Stock		River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90	95	90	95	5 5 3	..	..	..
150,000	$100	$2	Royal Electric Company of Montreal Shares	145	147	145	147	..	..	..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 4 1	April and October	..	..
19,980	5	11/0	St. James and Pall Mall Electric Ordinary	18½	19½	18½	19½	3 14 4	February & August	19½	19½
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	10⅜	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	104	107	107	110	3 13 1	June and December	..	..
67,900	5	4/0	Westminster Electric Supply (fully paid)	18	19	18	19	3 3 2	March & September	18½	18
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	5%	Brush Electrical Engineering	2	2½	2	2¼	..	—	..	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2½	2⅝	2½	2⅝	4 16 0	..	2⅛	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109	113	109	113	4 0 9	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 6 2	June and December	—	—
10,000	£10	..	British Aluminium Ordinary	..	..	—	—	—	—	..	—
20,000	10	..	Do. 7% Cumulative Preference	..	..	—	—	—	—	..	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	9	10	9	10	5 0 0	June and December	9½	9⅛
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	109	112	110	113	4 0 0	" "	..	..
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1	1½	1	1½	—	—	..	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	2½	2¾	2½	2¾	—	—	..	—
£82,850	100		* Do. 5% First Mortgage Debentures (red.)	86	91	86	91	5 6 5	January and July	..	—
99,261	5	1/6	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3	5 10 0	February & August	2⅛	—
17,139	5	2/0	Do. (£5 paid)	4	5	4	5	5 10 0	" "	..	—
£200,000	Stock	3/0	Do. 4% Mortgage Debenture Stock (red.)	103	105	103	105	3 16 2	June and December	..	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅝	2⅞	2⅝	2¾	3 13 1	February & August	2⅞	..
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3⅝	3½	3⅝	4 3 4	August	..	..
91,116	1	10/0	Elmore's Patent Copper Depositing	½	⅝	½	⅝	..	..	..	..
10,000	10	6/0	Henley's Telegraph Works Ordinary	22½	23½	22½	23½	4 5 1	February & August	23⅜	22¾
3,000	10	7/0	Do. 7 per Cent. Preference	19	20	19	20	3 10 0	" "	—	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	112	117	112	117	3 18 5	" "	..	—
80,000	£10	5/0	India Rubber, Gutta Percha, &c., Works	22	23	22	23	4 6 11	" "	22⅞	22½
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	103	107	3 14 9	March & September	..	..
37,856	10	12/0	Telegraph Construction and Maintenance	39	42	39	42	4 2 5	March and July	40½	—
£180,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	106	102	105	4 15 3	January and July	—	—
£22,850	£5	3 6	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	8⅞	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	6¾	7¼	6¾	7½	4 2 9	" "	—	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	106	108	106	108	3 18 6	May and November	107¾	107

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THE ELECTRICIAN:

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NOTES.

THE plethora of reports of electric supply companies and of companies meetings, in our issue this week, is not without its encouraging aspect, in view of the overwhelming evidence it affords of the splendid success of the supply business, both in the metropolis and up and down the land. Everywhere there are brighter and more hopeful signs; concerns that have been semi-failures in the past having not only effaced in a single year all trace of their misfortunes, but also paid substantial dividends; while others, which Fortune favoured more kindly in the past, have been able to raise their dividends to a pitch scarcely looked for in business undertakings of the class to which they belong. Indeed, the outlook indicates that electric supply may be regarded as one of the most lucrative of commercial undertakings.

JUDGMENT has been reserved in regard to an important action, heard at the County Court at Leicester last week, concerning the legality of trading in the sale of lamps and other electrical apparatus on the part of a municipality owning electricity supply works. As is well known, many municipal authorities carry on an important branch of their electrical department in the sale or hire of electrical apparatus; and it was contended at Leicester in support of this practice that in the model form of accounts issued by the Board of Trade, such items as "sale and repair of lamps" and "sale and repair of other apparatus" are inserted, and are a tacit recognition of the legality of such procedure. The issue of this action, further particulars of which are given under "Legal Intelligence," is of considerable importance, and judgment will be awaited with interest by more than one section of the electrical engineering industry.

THE Rev. T. C. PORTER entertained the Physical Society last Saturday afternoon, at Eton College, when he described his recent researches in optics and other branches of physics, and exhibited in action several ingenious pieces of apparatus. A large number of Fellows were present, many remaining after the meeting to view the quaintly-built chemical laboratory, in which Mr. PORTER gives the Eton boy an insight into the properties of elements and compounds. Although nothing of direct interest electrically came before the meeting, we allude to this outing of the Physical Society as it affords a successful and pleasing example of what might more frequently occur if those engaged in interesting research in physical laboratories and teaching institutions were to follow Mr. PORTER's example. Naturally, Papers likely to lead to much discussion, or those not involving elaborate experimental apparatus, are better dealt with at headquarters at Burlington House; but the leaders of physical science in and around London are frequently engaged upon important work, the apparatus for which could not be transferred from their laboratories; and such would do well to arrange for a visit of the Physical Society to the scene of their labours. On occasions of this kind it would be well to follow the practice adopted last Saturday, and to postpone discussion until all the Papers had been read, or, preferably, until the next meeting at Burlington House.

IT is now over two years since the supply of electrical energy at a minimum house-terminal pressure of 230 and 220 volts was inaugurated by Mr. BAYNES in Bradford and St. Pancras, and the crowded attendance at the meeting of the Institution of Electrical Engineers last week, when Mr. BYNG read his Paper "On the Manufacture of Lamps and Other Apparatus for 200-volt Circuits," showed that the interest in the question of the expediency of adopting this higher pressure has by no means diminished. We know that Mr. BYNG himself would be the first to allow that the majority of his audience were probably mainly attracted by the anticipation of a discussion on this *question d'actualité* by the general body of lamp-makers, central station engineers, contractors and consultants; but at all events, so far as the proceedings last week were concerned, the discussion itself brought out very little new. The Paper deserves better treatment at next Thursday's meeting, for not only did it suggest many points for consideration, as any Paper on a comparatively new departure is bound to do, but

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it also offered evidently well thought out opinions on some of them, and detailed the results of practical work. We hope on Thursday to hear the experiences of other lamp-makers and lamp users, especially as regards those lamps with sinuous filaments, which would appear to solve the difficulty of the size of the bulbs and caps, and also that something interesting will be contributed on the standardisation of fittings and on arc lamps. Perhaps some consumers who have looked at the question from a broad point of view, and have realised that a diminution in the outlay for mains means an eventual reduction in the price per unit, might also be tempted to state their views on the subject.

Obituary.—We regret to record the death, on Saturday last, of Signor Emilio Sineo, the Italian Minister of Posts and Telegraphs.

Opening of a Central Station.—The Mardy Electric Light Company's station in Mardy (South Wales) was formally started yesterday evening.

Röntgen Rays in Medical Work.—In a letter to *The Times* the treasurer of St. Thomas's Hospital states that during last year 416 patients passed through the X-ray department of that hospital.

A New Material for Fluorescent Screens.—MM. Ducretet and Roger have observed, says *l'Industrie Electrique*, that celluloid rendered opaque with zinc white, as used for collars, cuffs, &c., fluoresces when exposed to Röntgen rays.

Cable Interruptions and Repairs.—

	Date of Interruption.		Date of Repair.
Latakia—Cyprus	Feb. 10, 1898	...	—
Bolama—Bissao	Feb. 19, 1898	...	Feb. 28, 1898.
Aden—Zanzibar	Feb. 28, 1898	...	—
Saigon—Hong Kong	Feb. 28, 1898	...	—

Electrical Engineers Royal Engineers Volunteers.—The headquarters of the Corps, at 18, Victoria-street, Westminster, are now open during the week, Saturdays excepted, from eleven to four, between which hours general information in reference to the Corps can be given to inquirers On Monday and Thursday evenings at 8 p.m. some of the officers are in attendance for the purpose of considering applications and enrolling recruits.

Arc Lamp Carbons.—A New York firm is bringing out a grooved carbon, which, it is claimed, considerably increases the candle-power of arc lamps. It differs from the ordinary carbon by having a longitudinal groove running from one end to the other parallel to its length. The manufacturers state that the gyration of the arc is checked by this groove, so that the crater is held stationary at the apex of the pencil. It is further claimed that the lower carbon maintains a better shape, and that the size of the white light crater is greatly increased, but we fail to see how the latter effect could be caused.

Electric Lighting of Mail Carriages in Germany.—According to an article in the *Volkszeitung*, of Cologne, 64 per cent. or 1,108 out of 1,728 mail carriages on the North German railways are now provided with electric light, whereby a saving of £3,500 per annum has been effected. In consequence of this, all the new carriages now being built (numbering 73) will be furnished with this form of illumination. The success which has attended these experiments being so great the Bavarian and Austrian postal authorities are now taking steps in the same direction.

The Nernst Incandescent Lamp.—It has been currently reported that Prof. Nernst, of Göttingen, has invented an incandescent lamp having an efficiency of about 1·1 watts per candle. Up to the present no particulars of the construction of the lamp in question have been published, but short articles in the German technical papers tell us on what lines the Professor has been working. Magnesium oxide when heated to incandescence becomes an electrolyte. A hollow rod of fused magnesia is used as the incandescent body in the lamp. It is first heated to incandescence by an outside source, and an electric current is then passed through it to supply the heat lost in radiation, conduction, and convection. An alternating current must be used so as not to decompose the magnesia. It is stated that a cylindrical rod 7mm. long, 4·5mm. outer diameter and 1·5mm. inner diameter, glowing in air, gave 26 c.p. with an alternating current of 0·23 amperes at 118 volts, *i.e.*, 27 watts. The *Zeitschrift für Elektrotechnik*, after stating that Nernst proposes to use the spark of an induction coil to bring the body to incandescence initially, makes the practical suggestion that for this a carbon filament, embedded in the magnesium oxide and heated by an electric current, would be preferable.

Electrically-caused Fires.—The *Elektrotechnischer Anzeiger* has received from the Union of Private Fire Insurance Companies of Germany a list of no less than 17 electrically-caused fires which have occurred during 1897. The following are brief particulars abstracted from our contemporary:—(1) In a shipping office a stock of sugar was burnt, probably due to a piece of glowing carbon from a badly-fitting arc-lamp ash tray. (2) Stock in a shop window burnt through the breaking of a glow lamp. (3) Glowing carbon fell from an arc lamp in a shop while electrician was attending to it and burnt some decorating material. (4) Fire occurred in the Hamburg electricity works through short-circuit. (5) Flag became entangled in a conductor, established a short circuit, and was burnt. (6) Fire in auditorium of a theatre, caused by short-circuit. (7) Fire in battery room at Messrs. Schuckert's works, supposed to be due to earth contact from a leaky accumulator box. In four cases damage was done to stock in shop windows through short circuits or faulty conductors, and finally six fires, most of them doing but slight damage, are reported to have occurred in private houses through short-circuits. We believe that, with the exception of the fire at the Hamburg supply station, none of these 17 cases were serious. In connection with the fire No. 7 in the above list experiments were made with an old wooden battery tray saturated with acid and moistened with acid on the surface. Nails were stuck in this about 2ft. apart, and on applying 110 volts between them a piece of cotton-waste moistened with acid and placed on the wood caught fire; with 40 volts considerable heat and smoke was generated, but no actual fire was produced.

Protection of Electric Power Transmissions from Lightning.—At a recent meeting of Students of the Institution of Civil Engineers, Mr. John T. Morris read a Paper on the above subject. After demonstrating in a curve the relation between the sparking distance and voltage, the author stated that the discharges from which the line must be protected were of three kinds:—(1) Those due to lightning actually striking the line; (2) the rush and surgings of electricity induced in the line; and (3) those due to slow accumulation of the charge. Discharges of the first kind were extremely rare, those of the third were occasional, while those of the second were, he said, the most frequent. The methods of preventing discharges from entering the circuit were described, including that used at Niagara and Grünberg, where an earthed wire is stretched along the circuit a short distance above the conductors, and the means were detailed of providing opportunities for the discharge, after it had entered the circuit, to pass to earth. Lightning arresters were divided into two classes: those in which the line is permanently connected to earth through a high resistance, and those consisting of a short spark-gap, one terminal being connected to earth and the other to the line. Examples of both types were explained, and the various methods of extinguishing the arc were cited. After dealing with the non-arcing properties of some metals, such as zinc, cadmium, antimony, bismuth, &c., the author proceeded to detail arrangements for good earths, and the methods, such as by choking-coils, of preventing discharges passing along the line to the power-house. The best positions of arresters in power-transmission and tramway work were considered, and a description given of a 15,000-volt 3-phase arrester and choking-coil rack. The author concluded with the statement that recent experience had shown that one per mile in sheltered places, and as many as twelve in exposed positions were

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necessary to ensure a reasonable degree of safety. Numerous specimens of different arresters used in power transmission work were exhibited.

Phosphorescence Produced by Electrification—An article by Prof. John Trowbridge and John E. Burbank in the January number of the *American Journal of Science* contains an account of an investigation, by means of the phenomena of phosphorescence, of the question whether X-rays can communicate an electrical charge to bodies. When fluorite, in the state of a comparatively coarse powder, is heated to a low red heat for about an hour it loses completely its power of phosphorescing under the effect of a low red heat; if it is then electrified by means of the brush discharge of an electrical machine, and then submitted to a low red heat, it suddenly phosphoresces. E. Bequerel in his book "La Lumière: ses Causes et ses Effets" (Paris, 1897, p. 55) attributes the phenomenon merely to the light of the discharge. E. Wiedemann and G. C. Schmidt (*Wied. Ann.*, LVI., 1895, p. 237) conclude that the phosphorescence is not due to the violet rays of the electrical discharge but to peculiar discharge rays analogous to cathode rays, and this view is confirmed by M. W. Hoffmann (*Wied. Ann.*, No. 2, 1897, p. 273). The present investigators submitted the coarsely-powdered fluorite to the light of the electric discharge of the electric arc and of burning magnesium without producing phosphorescence either directly or with subsequent heating. After having been electrified by the brush discharge, however, the material phosphoresced on being heated. The action of X-rays on the mineral was found to be exactly similar, the fluorite being enclosed in an earthed brass box fitted with an aluminium window, and subjected to the action of the rays. After considering the effect of heat in increasing the glow of most phosphorescent substances which have been submitted to sunlight or daylight, and in decreasing its duration, the authors conclude that the phosphorescence in such cases might also be due to an electrical condition which can be dissipated by heat. They point out that such a supposition does not seem inconsistent with the electromagnetic theory of light, and they suggest that phosphorescence may be an evidence of the electrical stresses which produce the phenomena of ultra-violet light.

Prof. Ayrton on Technical Education.—Those present at the annual distribution of prizes at the Coventry Technical Institute, on Feb. 4th, had the good fortune to hear a most interesting and characteristic address by Prof. Ayrton. The ideal school, said the Professor, would be one attached to the factory, but the main duty of a factory was to turn out the best goods in largest quantities at lowest price, so that there was little opportunity for the turning out of good men. Hence to manufacture goods and men in different establishments was only an example of the modern division of labour. Many, however, will disagree with Prof. Ayrton as to the distinction between education and training. He says:

I am aware that a sharp distinction between education and training has been drawn by some authorities, and that they have pronounced it a misnomer to apply the name education to what is often called the training of the hand and eye. This appears to me, however, to be a mistake, for there is no radical difference in the method of trial and error which has to be followed in learning to perform any useful operation really well, whether it be making a first-rate fit between two pieces of material, skilfully fingering the violin, or adroitly solving problems in Euclid. Determination, application, the appreciation of the importance of accuracy and continued practice are necessary in each case; and the bodily, as well as the mental, improvement which is effected in the individual during the acquisition of any such form of dexterity is of the nature of education, but does not by itself, of course, constitute an entire education.

This led the Professor to some remarks as to the danger of the teaching becoming too academic and stereotyped, and we cordially agree with the following passage:—

So far from there being a risk of the instruction in a technical school becoming too practical, there is a much greater one of it becoming too purely theoretical. For when a technical teacher has to spend the greater part of his time giving out information he has but little left to take any in, and he thereby runs the risk of losing touch with his trade or profession, especially if it be one in a state of rapid development, like electrical engineering. His so-called practical teaching may then easily become unpractical and untechnical, academic, stereotyped, and only distantly related to industry. Hence we technical teachers ought to welcome any suggestions from manufacturers as to what should be taught in technical schools, and indeed even how it should be taught. Further, I would urge on my teaching brethren that not only should we keep in close touch with the trades we represent, not only should our aim be to avoid imparting antiquated or unpractical knowledge, but we should make an effort to keep our teaching to some extent even in advance of the industry it deals with.

And an excellent little lecture on the elementary political economics of the "machine question" followed. A passage comparing the methods of English and American manufactures also deserves to be quoted:—

One of the most important duties of a manufacturer is to create wants on the part of the public, and not merely to supply existing demands. . . . The American believes in the proverb, "L'appétit vient en mangeant," and so he manufactures and supplies "notions" before the public is aware it is in need of them, whereas the Englishman, with some brilliant exceptions, does not take up a novelty until it ceases to be one, and until he is no longer able to resist the clamour of a public hungering after some innovation of recognised utility.

The usual comparisons between the American elevated railways and the London "Underground" and between the tramway statistics of the two countries are not forgotten, and, finally, Prof. Ayrton could not forbear poking fun at the abuse of the examination system.

It should, however, be a consolation to those who do not shine in the examination room, but who yet feel that they have got something in them, to remember that success in life is not attained by supplying written answers to a series of questions. Some there may be who can point to their having made a small steady income, for a short period, by regularly sending in the missing word, or by supplying answers to a series of questions, set pictorially on one of the weekly collection of snips, regarding the names of 50 famous authors or a like number of cricketers. But it can be scarcely maintained that this class of competitive written examination constitutes a lucrative profession, or can be relied on to produce an income not distinctly precarious.

But evidently remembering the nature of the function at which he was assisting, the Professor added that of course the examinations at the Institute were of a totally different character, and that even he himself was by no means confident that the system he employed for "marking" students really placed them in the order of value they will be to the world.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 4th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "An Outline of Patent Law and Practice," by Arthur H. Stanley.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Some Recent Results of Physico-Chemical Inquiry," by Prof. J. E. Thorpe, F.R.S.

TUESDAY, March 8th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be further discussed: (1) "The Theory, Design and Practical Working of Alternate-Current Motors" by Llewelyn B. Atkinson; (2) "Dublin Electric Tramway," by H. F. Parshall. Paper to be read: "Calcium Carbide and Acetylene," by H. Fowler.

WEDNESDAY, March 9th.

SOCIETY OF ARTS.

8 p.m. Thirteenth Ordinary Meeting. Paper to be read: "Linde's Method of Producing Extreme Cold and Liquefying Air," by Prof. J. A. Ewing, F.R.S.

THURSDAY, March 10th.

ROYAL INSTITUTION.

3 p.m. Afternoon Tyndall Lecture II., "Magnetism and Diamagnetism," by Prof. J. A. Fleming, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Continuation of Discussion on Mr. G. Binswanger-Byng's Paper "On the Manufacture of Lamps and other Apparatus for 200 Volt Circuits."

FRIDAY, March 11th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On Dynamical Illustrations of Certain Optical Phenomena," by Prof. J. D. Everett, F.R.S.; (2) "On Properties of Liquid Mixtures," by R. A. Lehfeldt.

SATURDAY, March 12th.

INSTITUTION OF ELECTRICAL ENGINEERS.

10:30 a.m. Students' visit to the stations of the Metropolitan Electric Supply Company. Applications to join the party should be made at once to the Students' Hon. Sec.

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday noon.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Canal Rays.—E. Goldstein's complete dissertation on the kind of radiation, provisionally termed by him "canal rays," appears in *Wiedemann's Annalen*. These rays form the yellow layer next the cathode, and have not been closely studied before. The layer is very thin, as a rule, but when flat cathodes are used it may attain a thickness of some 2cm. at suitable pressures. Closer investigation shows that the yellow light may be obtained without admixture of blue cathode light by dividing the vacuum into two parts by means of a perforated cathode. The shape of tube most frequently used is that of a flask, with a stopper in the form of a sieve, and a wire introduced through the bottom. The wire is the anode, and the sieve is the cathode. The sieve is surrounded by another vessel, and the whole is exhausted. The usual blue cathode light appears in the interior of the flask, but outside the sieve the vessel is filled with yellow fire columns, consisting of canal rays, so called after the manner of their production. These rays travel in straight lines. From each perforation a feebly divergent bundle of rays emerges, surrounded by a slight mist. The most striking difference from cathode rays consists in the fact that whereas the separate cathode ray bundles diverge more and more as exhaustion proceeds, the canal ray bundles converge more and more towards the axis of the tube. They form in fact the prolongations of the cathode rays backward, and their direction is quite independent of the curvature of the back surface and the direction in which the perforations are bored. Their origin must therefore be sought on the front surface of the cathode. The canal rays produce no phosphorescence, and are not deflected by a magnet.

[Goldstein, *Wied. Ann.*, No. 1, 1898.]

Potential Gradients in Vacuum Tubes.—W. P. Graham has made some interesting and instructive determinations of the fall of potential along the path of the vacuum discharge, partly by means of fixed probes, and partly by a couple of movable electrodes, mounted a small fixed distance apart, and moved to and fro in the tube by means of the mercury-column arrangement adopted by Wood for his measurements of the temperature of the discharge. He found that in the positive part of the discharge the potential gradient is smaller for the dark strata than for the bright ones. In the dark space the gradient is not constant, but, as a rule, it decreases near the cathode. Curiously enough, maxima and minima are often observed in the dark space itself, just as in the stratified positive light. In the negative glow light the gradient becomes even slighter than in the dark space, and it reaches a minimum at the boundary of Crookes's dark space. It may therefore be said that, as far as the gradient is concerned, the glow light belongs to the dark space. At pressures higher than the usual a somewhat modified distribution of potential sets in. Part of the dark space then shows a fairly constant steep gradient, such as is always associated with the unstratified positive light. This is accompanied by a phosphorescence of the adjoining glass. A matter of great theoretical interest is the presence of free charges at various points along the path. Taking each stratum separately, a positive charge is found on the side next the anode, and a negative charge on the side next the cathode. But in every case the positive exceeds the negative charge. This observation sheds some light on Goldstein's supposition that each stratum represents a partial discharge, such as must necessarily occur if different regions of the tube have different inductive capacities. Just in front of the cathode the gradient shows a minimum value, and another minimum, somewhat less pronounced, is found in front of the anode. It is evident that the layers next the electrodes possess a considerable conductivity.

[Graham, *Wied. Ann.*, No. 1, 1898.]

Coloured Alkaline Haloids.—That alkaline salts acquire a coloration under the influence of electric discharges was first proved by Becquerel for cathode rays and sodium chloride. Goldstein based his explanation on the assumption of a physical modification of the salts. Wiedemann and Schmidt sought the cause in the formation of sub-chlorides; Elster and Geitel inclined to the hypothesis of a solution of the metallic base in the chlorides; and Abegg and others denied the alleged alkaline reaction of the coloured products, and supported the physical change idea. E. Wiedemann and G. C. Schmidt have now overhauled the whole question, and have apparently succeeded in vindicating their chemical theory. To begin with, they eliminated Kreutz's objection concerning traces of iron by digestion with carbon bisulphide, three-fold crystallisation, and the most searching qualitative analysis. Besides, they actually tried salts containing iron, side by side with the purified salts, and found no difference in their behaviour. But the most important question to deal with was the alkaline reaction and the liberation of chlorine, which, taken together, prove the formation of sub-chlorides. The salt was placed in a tube provided with an external cathode, which could be moved along the tube. The coloration of the salt was either carried out in the cold, shaking it up after each exposure, or the salt was repeatedly coloured by the rays and discoloured by heat. In both cases the alkaline reaction could be placed in evidence by pouring the salt into water containing a little phenol-phthalein. Wherever this reagent touched the surface of the salt, a distinct red coloration was produced. The formation of free chlorine was proved by drawing out the vacuum tube into a capillary leading into a tube containing a little mercury. Mercurous chloride was formed. This was converted into mercurous oxide by the addition of caustic potash, and the liberated chlorine was separated out by the addition of silver nitrate. That the alkaline reaction was actually due to a modification of the salt, and not to a disintegration of the glass, was brilliantly shown by substituting barium sulphate for the alkaline salts. This did away with the alkaline reaction altogether. The amount of salt converted is excessively small. The authors had originally assumed that the salt is only affected to a depth of 0·001mm. But according to Goldstein, a layer of collodium 10^{-5}mm. thick, is quite opaque to cathode rays. This accounts for the fact that the reactions described could not be observed unless the exposure and stirring were carried on for several days, and that the reactions were obtained at all must be regarded as a distinct triumph.

[Wiedemann and Schmidt, *Wied. Ann.*, No. 1, 1898.]

Glow-Worm Rays.—It will be remembered that in December last the electric world was somewhat startled by a discovery made in Japan that, glow-worms, when shut up for some days, with a sensitive plate, emitted something like Röntgen rays, which impressed the plate through the usual brown-paper covering. It was rather tantalising to be told at the time that no further studies could be made till the next glow-worm season, and that unless European expeditions were organised to that favoured spot, Kyoto, our Japanese colleagues would have the monopoly of a virgin field of discovery. H. Muraoka and M. Kasuya now still further complicate matters by announcing, as a result of further experiments, that the effect described is not solely due to radiation, but partly, at least, to some quasi-chemical influence of moisture or volatile substances upon the sensitive salt. They found that moist brown paper produced the same effect as moist glow-worms. The latter have to be periodically moistened to keep them aglow. Moisture by itself does not, however, produce the effect observed. Organic substances like resin and coffee produce a decided blackening of the plate, even when not in contact with it. Further, zinc, cadmium, and magnesium exert a similar influence, which may either be due to phosphorescence, or to Le Bon's "dark light," or to metallic vapour. Phosphorescence is ruled out by the fact that no difference of behaviour exists between metallic plates exposed to sunlight and the same plates kept in the dark. Mica or glass stop the effect. Metallic vapour does not yield a perfectly satisfactory explanation, since only the portions of the plate next the outline of the metal are blackened. Zinc oxide shows a similar effect. An interesting but somewhat puzzling experiment was made with cadmium oxide. A small square was cut out of a sheet of stout cardboard. The square

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was filled with powdered cadmium oxide. Another piece of cardboard was laid upon the first. It had a larger square cut out of it. A sensitive plate surmounted the whole. It was found that the area blackened was only the smaller square. This blackening could be intercepted by a copper rod. Was it due to vapour or to radiation?

[MURAOKA AND KASUYA, *Wied. Ann.*, No. 1, 1898.]

THE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

BY F. CHARLES RAPHAEL.

VII.—THE MANCHESTER EXCHANGE SYSTEM.

(*Continued from page 492*).

THE UNDERGROUND SYSTEM.

The so-called underground system adopted by the National Telephone Company is in reality a practical combination of underground and overhead wiring. The lines are led in large lead-covered cables, each containing 153 pairs, to distributing centres, where they are connected to short overhead wires leading to the subscribers' instruments and their call-wire circuits. The city was laid out in 36 areas, and in the centre of each of these is a distributing point. The work has only been completed a year. The whole of the trenching and pipe-laying was executed by contract, and, in addition, 350 men were employed on the special reconstruction work. Eight and a-quarter miles of street were opened out, and 48 miles of 3in. cast-iron pipes laid for the cable. The number of circuits in these cables, including spare wires, is 6,120, making a mileage of 7,500 miles of underground wire, and including 146,880 joints. The pipes laid can accommodate 15,320 circuits. There are in all 182 manholes on the system. The transformation to the new system also entailed a great deal of overhead work, 1,500 miles of wire being actually taken down within the city, and 3,100 miles were used in putting up the new overhead system. This latter figure includes the reconstruction of over 30 miles of pole route.

The pipes are 3in. cast-iron spigot-pipes coated with Angus Smith composition, and laid chiefly in 9ft. lengths. The cables used are of the Fowler-Waring "dry-core" type. The wires are of No. 20 S.W.G., and each is surrounded with a loose longitudinal covering of paper They are laid up in pairs, and there are in all 153 pairs in the cable. It is specified that the average capacity of the conductors in any length of cable shall not exceed 0·08 microfarad per mile, the measurement being made on each conductor, with all other conductors connected to earth. The capacity of any one wire is not to exceed 0·085 microfarad per mile. The thickness of the lead covering is $\frac{1}{8}$in. A 408-wire cable is being used for extensions. Its conductors are of the same size as those of the 306 wire cable, but its outer diameter is almost identical, viz., $2\frac{1}{2}$in. For this to be so a slightly higher capacity has to be permitted.

As is well known, extreme precautions must be taken to prevent any access of moisture to cables of this type, and that it is even necessary to protect the ends of the cables from the ordinary damp atmosphere. To effect this the ends are all fitted with "cable heads"—cast-iron boxes provided with a terminal for each wire of the cable. Fig. 59 shows the design of these cable heads. The box is cast in two portions, A and B, which are screwed together. The partition C carries the terminals, one of which is shown in detail in the bottom right-hand corner of the figure. The compartment A contains the ends of the wires from the lead-covered cable, while the six rubber cables of distributing wires are led into the compartment B. The opening in the lower side of A for the underground cable is merely a brass tube D screwed into a hole in the box drilled and tapped to receive it. The cable is passed through this brass sleeve, and the lead is soldered to it by means of a plumber's "wiped" joint. Rubber-canvas insertion is placed between the cover and flange of this part, so that it closes absolutely air-tight. The rubber cables are led through ordinary screw glands, one of which is shown in section, and the lid of this compartment is hinged and bolts on to box. The construction of the terminals is also very simple. A brass screw, F F, is screwed through an ebonite sleeve G, part of which has a screw-thread. The ebonite is screwed through a hole drilled and tapped through the partition C of the box, a disc of mica M being placed between. L is a strip of brass bent into a U, and almost touching the mica. This arrangement serves as lightning arrestor The wires on either side of the terminal are clamped under ordinary hexagonal nuts. In some cases the portion B of the cable head is not used, and the terminals are left exposed, the paper cable-end remaining hermetically sealed in the box A.

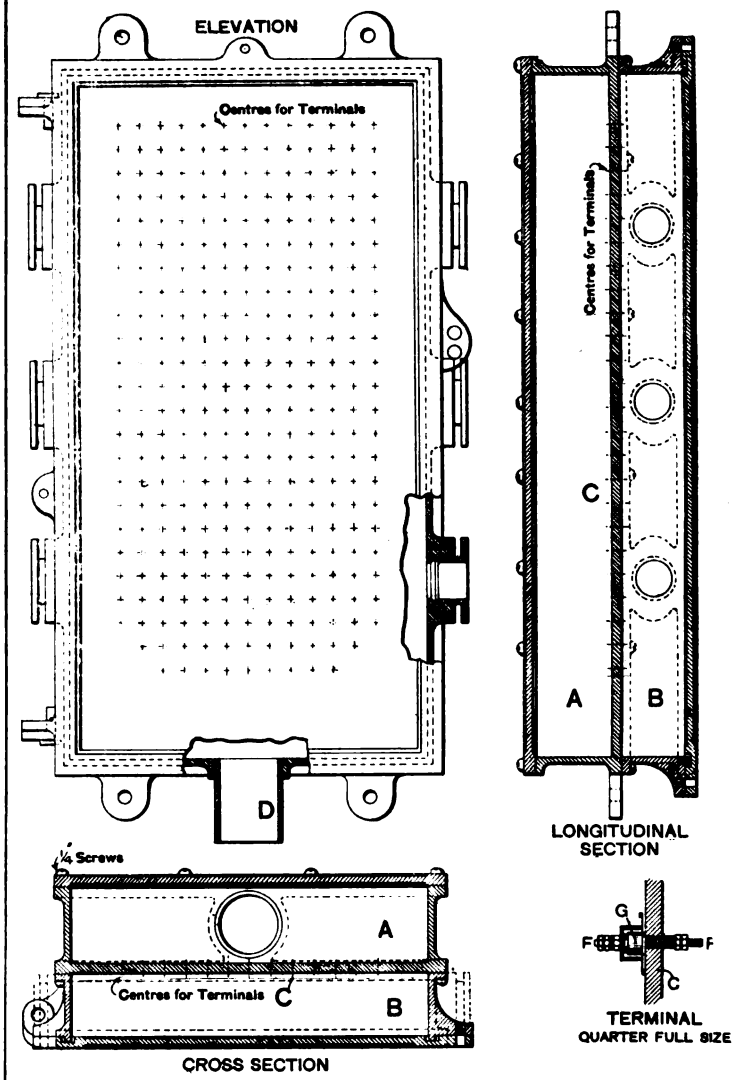

FIG. 59.—Cable-head for 153 Circuits. Scale, $1\frac{1}{2}$in. = 1 foot.

There are in all 86 pipes concentrating at the central exchange in Manchester. Thirty-seven of these carry cable at present. Fig. 60 shows one of the manholes through which the cables are led into the basement of the exchange building. The cables are led up a disused hoist-way, where they are supported by cross-bars every 4ft. to the test-room, ending here in cable-heads.

In the basement is an equipment for pumping dry air through any cables which may have developed faults through dampness. This method of drying cables by means of dry air was originally adopted by the French Administration of Posts and Telegraphs in connection with their dry-core cables some four or five years ago. It is found that not only is a fault or inadequately dried joint very quickly restored to normal insulation resistance by this means, but, in the case of a hole in the lead of the cable, its position is indicated by the hiss of the escaping air. In Manchester a brass screw plug

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is soldered to the lead of each cable and the compressed air tube is led directly to it. The hole is about ¾in. diameter, and it is found that a pressure of 15lb. per sq. in. above atmospheric pressure suffices to send air through any of the mains at present in use. The air is pumped by a Bailey air-pump, and passes first through four U tubes containing fused

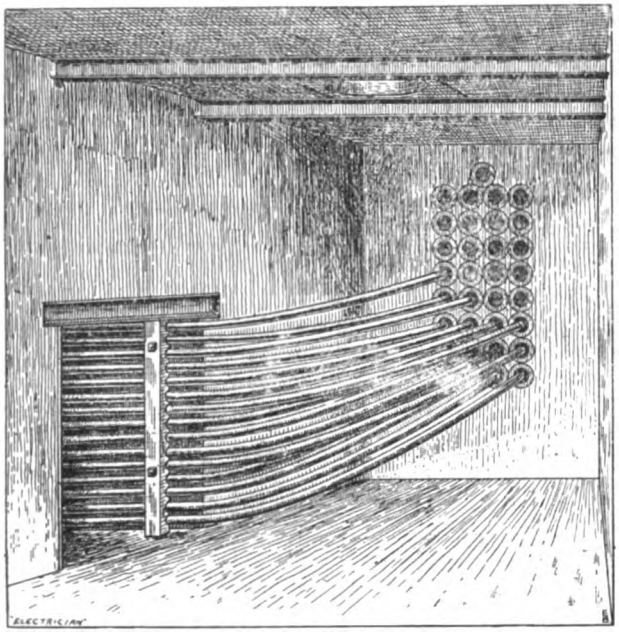

Fig. 60.—Exchange Box. Faulkner-street, Manchester.

calcium chloride, for the purpose of drying. One of these tubes is shown in section in Fig. 61. The tubes are of lead, and are 4½in. diameter. The rod in each of them, holding circular trays for the calcium chloride, can be withdrawn. The

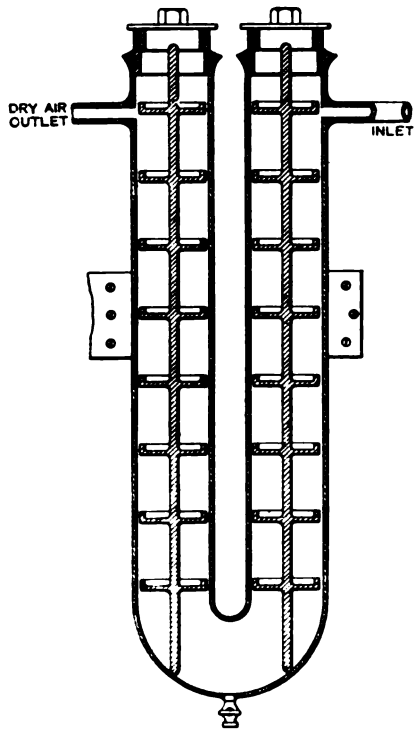

Fig. 61.—Drying Tube.

trays are perforated so that all the moisture collected drops to the bottom of the U tube and is removed through the cock at its lowest point. After passing through the four drying tubes, the air is led through a copper cylinder about 1ft. diameter and 4ft. high, filled with wadding. The air enters at the top and leaves at the bottom of this tube. This effectually removes all solid matter—such as particles of calcium chloride that may have come over from the other tubes. It is intended to connect a hygrometer "in parallel" with this cylinder, so that the state of dryness of the air passing into cables may be ascertained at any time.

The manner in which these large multiple cables are jointed may be referred to briefly here. The ends of the cables are always sealed with lead caps until required for use. Before the joint is made the exterior of the cables is wiped clean and dry, and a lead sleeve passed over one end. The ends are then opened and corresponding wires of corresponding layers are jointed together, the copper ends being scraped clean and then twisted, but not soldered. Before each copper joint is actually made, a small paper sleeve is passed over the end of the wire, and this is afterwards pulled over to cover the bare copper joint and squeezed down with the fingers to hold it in place.

The wires of each layer after being jointed and insulated in this manner are tied down with a few turns of well-dried cotton tape. After all the wires have been jointed, the whole joint is placed for a short time in a trough containing heated lime, and this effectually removes all moisture. The lead sleeve is then drawn over and soldered to the lead on either side of the joint by a plumber's "wiped" joint.

THE MECHANICAL FEATURES OF ELECTRIC TRACTION.

The following is an abstract of the discussion which took place at the Institution of Mechanical Engineers on November 4th and February 10th, in connection with Mr. Philip Dawson's Paper on the above subject:—

DISCUSSION.

Mr. R. E. CROMPTON did not agree that for electric traction a widely different kind of engine was required from that used for electric lighting; nor that the consequences of a breakdown in an electric traction station were more serious than in an electric lighting. It was the English system of applying accumulators in parallel with the generating plant, which had first given America really steady electric lighting. Although that country had had such a long start in electric traction, yet in the engines he thought the American practice would not be followed here. The substitution of slow-speed engines of American design with heavy fly-wheels, in place of high-speed engines of the kind used in England, he considered a retrograde step. For electric traction he believed this country could design and manufacture both better engines and better dynamos. In the construction of the trucks it seemed to him a great achievement to have succeeded in carrying cars of 32 to 35ft. length on a wheel-base of only 7ft.

Prof. W. E. AYRTON had recently visited in the United States an electric traction motor works turning out over 200 car motors complete per week, of about 25 H.P. each, and in some weeks 500. On an electric railway he had travelled 35 miles out of Boston at 12 miles an hour, and as fast up hill as a horse could gallop down hill. Though electric tramways in Boston had only been started in 1888-9, the original central station, with 50 100-H.P. dynamos, had after a year or two been replaced by a new station, with units of 400 H.P.; and now a third station was running, with 10 2,000-H.P. dynamos, each coupled direct to a separate steam engine. In some towns, when summer ended, the open car bodies were taken off the trucks, and winter cars, warmed electrically, were put on them. In large traction stations, with an output of 10,000 amperes at 560 volts, he had seen no such fluctuations at short intervals as those observed on an English tramway; the ammeter needle hardly moved during the time he watched it.

Mr. JOHN S. RAWORTH gathered that American developments were progressing by a system of trial and error. In the working of electric-traction stations he was satisfied there were no such shocks as would necessitate engines of a different kind from those for electric lighting; and no more flywheel power should be provided than was necessary to make the engine work smoothly; the heavier the flywheel, the more would the difficulties and dangers of working be increased, as exemplified by the trouble experienced from the bursting of flywheels in the United States. Governing the engines within 1½ per cent. of uniform speed was not asked for in electric lighting, and he did not understand its importance for electric traction. Nor was it consistent with so small a fluctuation of speed to expect that the flywheel could be drawn upon for power to get over sudden increments of stress. In this country it had been recognised that in electric lighting some fluctuation must be allowed in the speed of the engines; this had been met by over-compounding the dynamos, not only for the losses in the dynamos and in the leads, but also for the loss in the engines. In this way the light was now successfully kept steady, notwithstanding irregular driving; and for electric traction exactly the same plan could be carried out. Ordinary electric-lighting engines with which he

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was concerned had on each side of the crank a bearing whose length was two and a-half times its diameter, instead of only twice its diameter, as recommended for electric-traction engines; consequently the total length of bearing to carry the crank was five diameters. The electric-lighting engines made on these lines were perfectly good for any traction work.

Mr. E. J. CHAMBERS said tubular poles for carrying overhead wires could be produced in this country in a single length from the cast-iron base, and taper, which would be far better and would cost less than jointed poles. If jointed poles were preferred, he considered it rather a mistake to make the joints solid, swaged, and sweated; it was better for them to be taper, turned, and tight, so that the poles could be taken apart for transport.

Mr. H. GRAHAM HARRIS pointed out that, under the conditions of the test to which the solid, swaged, and sweated poles were subjected, it was possible that a number even exceeding 20 per cent. of the entire lot might be unable to stand the test, and yet the whole might have to be accepted.

Mr. MARK ROBINSON said that even if the Americans had had more experience than we had had over here—which he admitted—they should remember that there were examples even in England which were not to be despised. He, for one, had no hesitation in saying that English engine builders would be utterly wrong to go to America for any experience in any portion of their dynamo-driving business. One seemed to be reading an American Paper rather than an English one when one saw the grave discussion (on page 483) of particular kinds of coupling and then the statement that direct coupling was steadily gaining ground. For electric traction, the flywheel might be very heavy when there were great variations of load. The small flywheels on high-speed engines appeared to have given an idea that high-speed engines were unsuitable for electric traction work. But it was just as easy to give ample flywheel power to a high-speed engine as it was to a slow-speed engine. In England the small diameter disc flywheel was practically exempt from any danger of bursting, and this advantage was directly due to the use of high speed engines. The author stated that a guarantee should be required that the annular velocity during one revolution should not vary by more than $\frac{3}{4}$ per cent. No doubt in a slow-speed engine this was a good performance, but with the ordinary engines in Engish stations this velocity did not vary $\frac{1}{4}$ per cent. The idea prevailed that the variations of load which were always taking place in electric traction were injurious. If the engine had a governor worthy of the name, there should be no fear of this. For instance, every high-speed engine that had been coupled to a dynamo, so far as he knew, could be exposed absolutely with impunity to the test of throwing the whole load on and off again as fast as the hand could move the switch. There were numerous cases of such engines being pulled up in a very short time indeed by a short circuit, but no one ever heard of that engine being any the worse for it. In electric lighting engines the reciprocating parts were built to withstand 600 to 900 variations per minute, and nothing whatever happened. What additional harm could be done by the engine being pulled up once more than this number? The Liverpool Corporation had bought a 1,500 H.P. high-speed electric traction engine for their tramways, and the Bradford Corporation two 700 H.P. engines, and the only drawback to the demand for such engines appeared to be the capacity of the works of the various makers to make them.

Mr. JEREMIAH HEAD thought the discussion rather had a tendency to be a little too severe, and even bordering on irrelevancy. For instance, Mr. Crompton at the last meeting had stated that electric traction work could be done just as well by English engineers as by American. He had no doubt that the Americans would all agree with that themselves. Mr. Crompton had then said that as regards the question of engines, American practice would not be followed here. But if the American practice in engines was wrong, it was not only a question of its not being followed out here, but anywhere where electric traction was employed. Mr. Crompton had further stated that this country could design both better engines and better dynamos. On that point, perhaps, they might expect their American friends to differ from them. They might give the Americans credit—remembering also that they had been at it for ten years, and several years before they had begun to touch it here—for knowing something about the matter.

Mr. W. WORBY BEAUMONT said that English engineers were accustomed to making engines to drive rolling mills, and they could easily make them for electric lighting purposes; and English engineers had their own opinions as to what was necessary for English electric tramways. Mr. Head had sat down asking why it was that there were so many hundreds of miles of electric tramways in the United States and so very few here. To a very great extent English people could answer that it was because they knew better. In the first place, we had not wanted these tramways; we had roads that did not exist in the States; secondly, there was not the necessity for adopting mechanical means of developing road traffic outside cities that there was in the United States. With regard to flywheel accidents in America, he thought the fact that they were very frequently happening was proved by the ingenuity displayed by the Americans in designing wooden flywheels and wire-wound flywheels, and yet they were told in the Paper that over 90ft. per second was frequently allowed, as seen from some of tables, whereas in English practice it was not considered safe to go beyond 80ft. This might be due to the better quality of cast iron in America. If the fact of flywheels going to pieces was proof of their superiority, then American flywheels were certainly the best.

Sir FREDERICK BRAMWELL said that, with reference to the question as to why we were so much behind the United States and the Continent in the matter of electric railways, it should be remembered that in the States and most of the countries in Europe private enterprise was not checked by Acts of Parliament which compelled persons at the end of 25 years to give up the fruits of their industry and enterprise to City corporations and other bodies, who in every way restricted them from the honest exercise of their industry and capital.

Prof. UNWIN thought that they had had practically no experience in this country of the trolley system of tramway traction. There were one or two tramways, and these were American built. The Americans had a very large experience, and when anyone gave them, in a very interesting way, the benefits of his experience, they might have met him in a little more grateful manner than the author of this Paper had been met on more than one point in the discussion. The Americans might be wrong, but at any rate they were working, with a very remarkable degree of success, a system of traction of which we had no experience. With regard to the steam engine, he thought no one who had studied the matter would doubt that the flywheel question was the principal one. He had had some time ago to look into the question of electric traction engines, and had found that the apparently light flywheels of a Willans engine suited very well the conditions under which they worked. It was in the long-stroke engine that they must put these very heavy flywheels which were spoken of in the Paper. But he entirely took the view that in such engines as the Americans were using it would not be right to use lighter flywheels than they did. It certainly did not follow that because a flywheel was heavy it was dangerous. A heavy flywheel had exactly the same proportion of strength as a light one, provided the rim velocity was the same.

Prof. A. B. W. KENNEDY said he had not found it any more agreeable or disagreeable when riding on a tramcar in America than riding on one in England, and he thought it only right to say that so far as he could see engineers were bound to treat electric traction as a piece of mechanical engineering. There was no difficulty whatever in running electric tramways with high-speed engines any more than there was with slow-speed engines.

Mr. ARCHIBALD SHARP said they had heard a good deal about the flywheel accidents in America, but were not told of those that happened in this country. Three of them which he remembered had been the cause of great destruction to property. One was at Glasgow, one at Barrow-in-Furness; and, only a few months ago, one in a cotton mill in Lancashire. Unfortunately, for the purposes of discussion, there had been no lives lost! When a flywheel was set in motion the rim tended to expand, owing to the action of the centrifugal forces and the stresses on the rim. There were two ideal methods of constraining the rim of a flywheel. One was the method of joining the rim by a continuous disc, and the other to give the rim no support at all. This last method, of course, would not be practicable. In a free rotating rim, with a linear speed of 100ft. per second, which was about the safe limit, the whole tension produced was only 0·47 tons per square inch diameter. In the large flywheel of the usual type, with six or eight arms, the stresses on the rims were due principally to the straining of the arms. He had designed a flywheel on the following principles: Firstly, it had numerous spokes, so that the unsupported length of rim was small; secondly, the nuts at the end of the spokes were all screwed up tightly in completing the wheel, which put an initial tension on each spoke and an initial circumferential compression on the rim; thirdly, the spokes, being thin, were tangent, otherwise the wheel would not have a circumferential rigidity. With a flywheel so designed for a gas engine running at 180 revolutions per minute, or a linear speed of 91ft. per second, they got an initial tension on the rim of about a third of a ton. The average circumferential stress on the spokes was very nearly zero, while the direct stress due to the bending on the rim was only half a ton per square inch.

Mr. M. HOLROYD SMITH thought that there was one feature which had hardly been emphasised sufficiently, viz., the abominable condition of the ordinary roads in the United States. In the principal streets of Philadelphia he had seen the tram lines for lengths of 10 or more yards at a stretch standing fully 6in. above the ordinary street level. Neither were they obliged to use grooved rails, and the rails used there would not be permitted here for one moment.

Mr. C. H. GADSDY thought that the real reason of the slow progress made in this country in the matter of electric traction was the 43rd section of the Tramway Act of 1870, allowing the local authority to step in at the end of 21 years and take possession of a system for just a nominal sum.

Mr. Dawson's reply to the discussion will be communicated to the Institution in the *Proceedings*.

The Wire-Rope Tramway on the way to Klondike.—A few particulars of the electrical equipment of the wire-rope tramway which is being built across the Chilkoot Pass, on the way to Klondike, are given in the *Electrical Engineer* of New York. The plant, which has been built by the Westinghouse Company and has already been shipped, comprises onr 45 kilowatt two-phase alternator, with the accompanying exciters and switchboard, one 30 H.P. Westinghouse motor, one 15 H.P. motor, two 25 kilowatt step-up transformers, and four 10 kilowatt step-down transformers. Owing to the ice-bound nature of the region, steam will be the prime power, but as there is plenty of coal on the coast, the cost of operation should not be high. The distance of transmission is 13 miles. The line potential will be 5,000 volts, three-phase. One of the two tramways will be driven by the 30 H.P. motor, 12 miles from the generator, and the other, one mile further, by the 15 H.P. motor.

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ELECTRICITY WORKS ACCOUNTS.

We present our readers this week with statements and analyses of the accounts of the Liverpool Overhead Railway and of the electric supply works at Bedford and Richmond.

Liverpool Overhead Railway Company.

The report and accounts for the last half of 1897 of the Liverpool Overhead Railway Company indicate there has been no falling-off in the improvement steadily maintained since its inauguration in 1893. The Share Capital consists in 45,000 Ordinary shares at £10, upon which a dividend of 8½ per cent. per annum has been declared; and 12,000 Preference shares at £10, the dividend declared being 5 per cent. per annum. The Loan Capital of £170,000 was raised by Four per Cent. Terminable Mortgage Debentures, with available borrowing powers of £20,000.

By comparison with the previous half-year, the accounts for which are also shown and analysed, improvement is shown in many important respects; notably, in the train mileage and number of passengers carried, in the revenue per train-mile, and last, but not least, in the balance available for dividend and in the dividend actually declared. On the other hand, there is a slight decline in the revenue per passenger, though this need not be an unhealthy sign, but is a healthy one if it shows a greater tendency on the part of the public to take short journeys rather than walk. An increase is noticeable in the percentage of revenue actually expended, apart from sums set aside for depreciation, &c., the expenditure for fuel and maintenance of way, works and stations being the chief items that have increased. The provision of only £2,600 per annum for depreciation, in respect of boilers, machinery at power station, permanent way, &c., seems inadequate, being at the low rate of about 0·36 per cent. on the total capital expended. At present the "Renewal Fund" stands at £9,600, and there is a "Contingent Fund" of £500.

Bedford Municipal Electricity Supply Works.

The accounts for the year 1897 of the electric supply works owned by the Bedford Urban Sanitary Authority are set forth in the annexed table. At the present time this concern labours under the disadvantage of being unable to pay its way, a deficit of £1,200 being shown on the year's working, and a sum of £914 having been contributed from local rates. This state of affairs, however, is not a true indication of the financial condition and future prospects of the undertaking, which are brighter than would seem to be indicated by these figures; for a considerable portion of the new capital expended has not yet had an opportunity to produce its *quantum* of revenue, and must be regarded as a temporary dead load on the concern which will be rectified when the new plant has had a full year in which to contribute to the returns. We may therefore expect a happier state of affairs when the 1898 accounts are published. The substantial increase from 9,000 to 13,000 in the lamp-connections is a most hopeful sign; and it should also be noted that the working profit for the year has increased both in actual amount and in its percentage ratio to the capital expended, and that the revenue per 8 c.p. lamp or per kilowatt capacity has increased as much as 43·2 per cent. in the year. The decrease in the expenditure, more especially in the works-costs per unit sold, is a healthy sign, and one that shows that, from an engineering point of view, the concern is being worked with improved economy; but the heavy capital charges have overbalanced this advantage, leaving a deficit of 2·83 per cent. on the mean capital expended.

Richmond (Surrey) Electric Light and Power Company (Ltd.)

By comparison with the accounts of the Bedford high-pressure alternate-current municipal supply works, those of the continuous-current low-pressure battery system of the Richmond Company are of interest. This latter concern is in the happy condition of being able to pay a dividend of 8 per cent. on the Ordinary shares, whereas in the previous year the net profit amounted to only £34. It has also started an independent "Depreciation Fund," which, with the sum set aside at the end of 1896, now amounts to £500—a fairly good beginning, which we hope to see improved upon, for the 0·7 per cent. on the mean capital set aside for this purpose is a trifle small. Among other hopeful signs are a decided increase in the lamp connections, 2,387 lamps having been added during the year, and a substantial reduction in the total costs and works-costs per unit sold, and in the charges for management. Sundry little economies, have helped to swell the working profit for the year, which has grown from 2·91 per cent. to 5·2 per cent. of the mean capital expended.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

Date of Commencement of Working Railway. March 6, 1893.
System ..... Third-rail surface conductor at 600 volts.
Chief Engineer ..... S. B. Cottrell.

Half-year ended.....	June 30, 1897.		December 31, 1897.	
QUANTITIES.				
Train mileage.....	*363,399*		*371,773*	
Passengers Carried	4,269,260		4,467,490	
Miles of railway authorised ...	7 ml. 5 ch.		7 ml. 5 ch.	
Miles of railway constructed...	6 ml. 57 ch.		6 ml. 57 ch.	
Miles of Railway Worked.....	6 ml. 57 ch.		6 ml. 57 ch.	
Miles of railway under construction	nil		nil	
Rolling stock, number of cars	47		51	
CAPITAL.				
Authorised (Total).....	£760,000		£760,000	
Authorised (share).....	570,000		570,000	
Authorised (loan)	190,000		190,000	
Received (Total)	737,608		740,000	
Received (share).....	567,608		570,000	
Received (loan)	170,000		170,000	
	Total.	**Per mile of working railway.**	**Total.**	**Per mile of working railway.**
Expended (Total)	£729,931	£108,700	£737,304	£109,850
On line open for traffic	619,622	92,325	623,280	92,885
On working stock, including power station	110,309	16,430	114,024	16,985
Balance of Capital Account...	+ 12,148	—	+ 7,168	—
Renewal Fund	8,300	—	9,600	—
Contingent Fund	400	—	500	—
REVENUE.	**Total.**	**Per train mile.**	**Total.**	**Per train mile.**
Total	£36,026	23·800d.	£37,583	24·20d.
Passenger traffic.....	35,424	23·385d.	36,995	23·87d.
Parcels, rents, transfer fees, &c.	602	—	588	—
EXPENDITURE.				
Total	£21,459	14·175d.	£22,940	14·80d.
Maintenance of way, works, & stations (less depreciation)	*2,720*	*1·796d.*	*3,345*	*2·160d.*
Maintenance of way	909	0·600d.	909	0·587d.
Repairs of structure, stations, &c.....	1,811	1·196d.	2,436	1·570d.
Locomotive power	*5,178*	*3·420d.*	*5,747*	*3·710d.*
Coal and coke.....	871	0·576d.	950	0·614d.
Wages at power station... ..	2,848	1·881d.	2,979	1·920d.
Oil and stores.....	378	0·250d.	512	0·331d.
Repairs and renewals.....	1,081	0·714d.	1,306	0·843d.
Repairs and renewals of cars...	*433*	*0·286d.*	*587*	*0·379d.*
Traffic expenses	*8,190*	*5·415d.*	*7,937*	*5·120d.*
Salaries and wages.....	5,616	3·710d.	5,787	3·740d.
Other charges.....	2,574	—	2,150	—
General charges	*2,399*	*1·585d.*	*3,237*	*2·090d.*
Liverpool Tramways and Omnibus Company ...	500	0·331d.	1,500	0·969d.
Other charges.....	1,899	—	1,737	—
Rent, rates, taxes, &c.....	*1,826*	*1·206d.*	*1,749*	*1·129d.*
Miscellaneous items.....	*713*	*0·472d.*	*338*	*0·218d.*
FINANCIAL RESULTS.	**Total.**	**Per cent. to mean capital expended.**	**Total.**	**Per cent. to mean capital expended.**
Working Profit for Half-year	£14,567	2·027%	£14,618	1·993%
Sum carried to depreciation fund.....	1,300	0·181%	1,300	0·1773%
Net interest on loans	2,921	0·4065%	3,400	0·4640%
Balance from last half-year's account.....	3,065	—	3,810	—
Balance Available for Div. ...	£13,410	1·865%	£13,753	1·873%
Ordinary Dividend paid at per cent. per annum	3%	—	3½%	—
Percentage of total expenditure to revenue	59·5	—	61%	—
Revenue per Mile of Working Railway	£5,410	—	£5,600	—
Expenditure per mile of working railway.....	£3,200	—	£3,420	—
Revenue per Passenger	2·026d.	—	2·019d.	—

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	BEDFORD.		RICHMOND (SURREY).	
Undertaking Worked by	Bedford Urban Sanitary Authority.		Richmond (Surrey) Elec. Light & Power Co. (Ld.)	
Date of Commencement of Supply	1894.		1893.	
System of Supply	Alternate current transformer sub-stations.		Continuous current 3-wire battery system.	
Chief Engineer	W. J. Hope Johnstone.		Malcolm C. Flemyng.	
YEAR ENDED DECEMBER 31st.	**1896.**	**1897.**	**1896.**	**1897.**
QUANTITIES—				
Units generated	208,106	342,351	105,771	152,052
,, **SOLD (TOTAL)**	158,238	255,990	97,044	138,916
,, sold to consumers	85,956	129,508	97,044	138,916
,, sold for public lighting, &c.	72,282	126,482	nil	nil
,, used on works	11,040	20,400	1,891	2,071
UNITS SOLD PER 8 C.P. LAMP CAPACITY	11·3	18·300	10·2	14·6
Maximum supply demanded	200 kilowatts	270 kilowatts	135 kilowatts	185 kilowatts
Number of public lamps	201 (glow)	352 (glow)	nil	nil
Connections to mains in 8-c.p. lamps	9,000	13,000	7,125	9,512
CAPACITY OF PLANT IN 8-C.P. LAMPS	14,000	14,000	9,540	9,540
CAPACITY OF PLANT IN KILOWATTS	420	420	290	290
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£39,000 / £92·9	£58,650 / £140	£75,000 / £259·0	£75,000 / £259·0
Share	— / —	— / —	50,000 / 173·0	50,000 / 173·0
Loan (including Debenture charges)	39,000 / 92·9	58,650 / 140	25,000 / 86·0	25,000 / 86·0
RECEIVED (TOTAL)	39,000 / 92·9	39,000 / 92·9	43,080 / 149·0	46,080 / 159·0
Share	— / —	— / —	31,330 / 108·0	31,330 / 108·0
Loan (including Debenture charges)	39,000 / 92·9	39,000 / 92·9	11,750 / 40·6	14,750 / 51·0
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil / —	19,650 / 46·8	31,920 / 110·0	28,920 / 99·7
Share (unissued)	— / —	— / —	18,670 / 64·4	18,670 / 64·3
Share (uncalled)	— / —	— / —	nil / —	nil / —
Loan (including Debentures)	nil / —	19,650 / 46·8	13,250 / 45·8	10,250 / 35·4
REPAID (TOTAL)	1,360 / 3·24	2,920 / 6·95	— / —	— / —
RESERVE OR SINKING FUND	nil† / —	nil† / —	1,500* / 5·18	1,250* / 4·32
DEPRECIATION FUND	nil† / —	nil† / —		500 / 1·73
EXPENDED (TOTAL)	38,676 / 92·1	46,390 / 110·0	40,965 / 141·0	44,794 / 155·0
Lands and buildings	4,347 / 10·3	4,496 / 10·7	10,403 / 36·0	10,454 / 36·1
Plant	9,836 / 23·4	12,293 / 29·3	12,382† / 42·8	14,188†† / 49·0
Mains	18,270 / 43·5	21,654 / 51·6	14,844 / 51·2	16,673 / 57·5
Miscellaneous	6,223 / —	7,947 / —	3,336 / —	3,479 / —
BALANCE OF CAPITAL ACCOUNT	344 / —	7,214‡ / —	2,115 / —	1,286 / —
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£3,007 / 4·56d.	£4,718 / 4·42d.	£3,194 / 7·89d.	£4,469 / 7·72d.
Revenue from supply	2,138‖ / 3·24d.	3,214§ / 3·02d.	2,812 / 6·95d.	3,929 / 6·79d.
,, meters, &c.	67 / 0·102d.	110 / 0·103d.	136 / 0·336d.	182 / 0·314d.
,, public lighting	801 / 1·21d.	1,392 / 1·30d.	nil / —	nil / —
,, sale of lamps, &c.	10s. / —	2 / —	nil / —	nil / —
,, miscellaneous sources	1 / —	1 / —	246 / 0·608d.	359 / 0·62d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,164 / 3·28d.	£3,125 / 2·93d.	£2,032 / 5·02d.	£2,235 / 3·86d.
WORKS COSTS	1,779 / 2·70d.	2,550 / 2·39d.	1,228 / 3·04d.	1,493 / 2·58d.
Generation of electricity	*1,632 / 2·48d.*	*2,279 / 2·14d.*	*1,071 / 2·65d.*	*1,344 / 2·32d.*
Fuel (including cartage, &c.)	888 / 1·35d.	1,322 / 1·24d.	452 / 1·12d.	627 / 1·08d.
Oil, waste, water, stores	104 / 0·158d.	135 / 0·127d.	46 / 0·114d.	100 / 0·173d.
Wages at station	562 / 0·853d.	642 / 0·602d.	389 / 0·962d.	378 / 0·653d.
Repairs and maintenance at station	78 / 0·118d.	180 / 0·169d.	184 / 0·455d.	239 / 0·413d.
Distribution of electricity	*48 / 0·073d.*	*118 / 0·110d.*	*157 / 0·388d.*	*149 / 0·258d.*
Wages, &c.	48 / 0·073d.	78 / 0·073d.	133 / 0·329d.	114 / 0·197d.
Repairs, renewals of mains, &c.	nil / —	40 / 0·037d.	24 / 0·059d.	35 / 0·061d.
Public lighting	*99 / 0·150d.*	*153 / 0·143d.*	*nil / —*	*nil / —*
Attendance	47 / 0·071d.	52 / 0·049d.	— / —	— / —
Renewals	52 / 0·079d.	101 / 0·095d.	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	323 / 0·495d.	485 / 0·455d.	804 / 1·99d.	742 / 1·28d.
Royalties	*nil / —*	*nil / —*	*52 / 0·129d.*	*nil / —*
Rent, rates, taxes	*122 / 0·190d.*	*142 / 0·133d.*	*338 / 0·836d.*	*366 / 0·632d.*
Management	*201 / 0·305d.*	*343 / 0·322d.*	*414§ / 1·025d.*	*376¶ / 0·65d.*
Salaries	173 / 0·261d.	285 / 0·267d.	116 / 0·287d.	116 / 0·20d.
Stationery, &c.	18 / 0·027d.	32 / 0·030d.	45 / 0·111d.	39 / 0·0674d.
Establishment charges	11 / 0·017d.	27 / 0·025d.	82 / 0·203d.	74 / 0·128d.
Law charges, &c.	nil / —	nil / —	114‡ / 0·282d.	108** / 0·187d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£843 / 3·01%	£1,593 / 3·75%	£1,163 / 2·91%	£2,233 / 5·2%
Sum carried to Depreciation Fund	nil / —	nil / —	200 / 0·50%	300 / 0·70%
Sum carried to Reserve or Sinking Fund	880 / 3·14%	1,560 / 3·67%	211‖ / 0·53%	250‖ / 0·58%
Net interest on loans (incl. Debenture charges)	877 / 3·13%	1,558 / 3·67%	579 / 1·45%	643 / 1·50%
BALANCE FROM LAST ACCOUNT	780* / 2·79%	−914* / 2·15%	— / —	34 / 0·08%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	34 / 0·085%	1,073 / 2·5%
Deficit	*914 / 3·26%*	*1,200 / 2·83%*	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	nil / —	3% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	72%	66·3%	63·7%	50%
Expenditure per kilowatt capacity	£5·16	£7·44	£7·0	£7·72
REVENUE PER KILOWATT CAPACITY	£7·15	£11·2	£11·0	£15·4
Expenditure per 8-c. lamp capacity	3s. 1d.	4s. 5½d.	4s. 3d.	4s. 8d.
REVENUE PER 8-C.P. LAMP CAPACITY	4s. 3½d.	6s. 9d.	6s. 8½d.	9s. 4d.
Price charged for lighting, per unit	6d.	6d.	7d.	7d.
Price charged for power, per unit	6d.	6d.	7d.	7d.
Price charged for public lighting, per lamp	£3·98	£3·96	—	—

BEDFORD.—REMARKS—* Received from local rates. † No separate fund is accounted for. ‡ Represents expenditure on capital account in excess of capital received, overdrawn at bank. § £20 in bad debts has been deducted. ‖ £11 in bad debts has been deducted.

RICHMOND.—REMARKS—* Suspense account. † Includes £1,401 for batteries. ‡ Includes £81 for insurance. § Includes £36 for auditing and £21 for bad debts written off. ‖ Allocated to reduction of suspense account. ¶ Includes £26 for auditing and £13 for bad debts written off. ** Includes £99 for insurance. †† Includes £3,037 for batteries.

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The Electrician.

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ELECTRICITY WORKS ACCOUNTS.

Electricity works in the United Kingdom are of varied character, and, fortunately, are steadily on the increase both in the number of varieties and of individual specimens. Those which partake of a public character, and are worked either by the Government, by the local authorities, or by companies on which statutory powers have been conferred, comprise the system of inland telegraphs and telephone trunk lines, the telephone system worked by the National Telephone Company, call-wire and alarm systems licensed by the Post Office, electric lighting and power supply systems, and electric railways and tramways. Others there are which partake of a less obtrusively public character, though their operations are of scarcely less interest to electrical engineers, and are of no small benefit to mankind in general. Among these may be included works for the carrying on of chemical and metallurgical processes, engineering and other workshops for the manufacture of electrical plant and apparatus, and general engineering works and factories operated by electric power.

Satisfactory and rapid progress in any branch of material civilisation, or, to speak more particularly, in any variety of electricity works, is possible only when those interested in and capable of contributing to that progress are intelligently informed as to what has been done in the past and what is being done in the present. This is true, whether in regard to the commercial or simply to the technical development of the industry; but inasmuch as the commercial success of an engineering undertaking is, as a rule, regarded as the ultimate *desideratum*, it is of prime importance to the electrical industry that systematised information be forthcoming concerning electricity works accounts. *The Electrician* has from the first recognised the importance of a systematic comparative analysis of the published accounts of electrical undertakings; and,

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from time to time, such comparisons have been supplied to our readers through the medium of our well-known Supplements. It has been both gratifying to ourselves, and an index of the importance attached by electrical engineers to these comparative analyses, that they have met with such a welcome from our readers. It is of interest to notice that the Tables published in our issue of July 8, 1892, were the first in which the capital and revenue accounts of electric supply concerns were conjointly set forth and comparatively analysed. We have now to announce a modification, which also is in the nature of an extension, of our former practice in the compilation of these analyses. Hitherto, so far as the Supplements are concerned, we have restricted our comparisons to works for the supply of electric power and lighting; and the number of these which in the past have possessed special interest has been so limited that every useful purpose has been served by tabulating all the analyses on a single sheet. Now, however, we are face to face with an altered condition of affairs—firstly, in the increase in the number of electric supply concerns which call for detailed notice; and secondly, in the growing importance of electricity works dealing not with lighting and public supply, but with railways and tramways operated by electric power. To meet these new conditions we have decided to adopt a system of publishing our analyses of accounts which we have already made use of, from time to time, when dealing with the accounts of the more important electric traction accounts in this country, viz., to embody a tabulated statement and analysis of the accounts in our ordinary pages, accompanying the table with such comments and criticisms as may serve to elucidate it or to show in what direction progress has been made. On another page will be found the accounts of the Liverpool Overhead Railway Company, and of two electric supply concerns—one owned by a municipality, the other by a company; and it is our intention to present our analyses of electricity works of various kinds substantially in this form in future, but with such modifications as the particular circumstances of the case may call for.

Owing to the preponderance in the number of electric supply works over other varieties of electricity works, it will naturally happen that, for some time to come, the majority of accounts we shall deal with will relate to this class of undertaking. Thanks to the insistence of the Board of Trade in regard to the form in which the accounts of electric supply concerns are annually returned, it is possible to analyse these accounts fairly completely, and to compare in a really instructive manner the results of one concern with those of another. We wish an equally systematised form of accounts were enforced in regard to electric traction concerns, the variety in the systems of bookkeeping of which makes analysis difficult, and close comparison often an impossibility. Having in view the superiority, in the point of numbers, of electric supply undertakings, some few words explanatory of the schedule we have compiled for the presentment of the accounts of these concerns will probably be of service to our readers. We have, in the first place, arranged the schedule with a view to its adaptation both to municipal and company undertakings; and one or two items may be referred to in this connection. The items "Loans (including debenture charges)" and "Net interest on Loans (including debenture charges)" refer, in the case of a municipal undertaking, simply to sums borrowed for capital, and in the case of a company to all debentures, debenture stock, mortgages and temporary loans. Our motive in adopting this classification, as regards a company, has been to sift the share capital and sum distributable therefor from all temporary and permanent fixed charges. In the item "Balance available for distribution, &c.," therefore, this deduction of fixed charges having been made, we have a sum which, in the case of a company, may be used as dividend on the share capital, and, in the case of a municipal concern, may be regarded as a clear surplus, to be held as a reserve against future working at a lower price per unit, or to be expropriated for relief of the ratepayers. In regard to the items of capital, in order to obtain a basis for the comparison between one concern and another, we give a column showing the capital per unit of plant capacity, and for this unit of capacity we prefer the kilowatt to the 8 c.p. lamp, as being more suitable for rating machinery and plant used for other purposes besides lighting. Indeed, although we make some of the returns in terms of the 8-c.p. lamp, we would much rather that the more rational kilowatt should be generally adopted as a measure of plant capacity; and, to encourage this practice, we also make corresponding returns in terms of the kilowatt.

Turning now to matters connected with revenue and expenditure out of revenue, we have considered it useful to show the various important sources of revenue, and the amount received from each per unit actually sold; and we have presented the various items of expenditure with practically the same degree of fulness, and under the same headings, as in the returns to the Board of Trade. The total expenditure for the year has been first divided under two heads: (1) works costs, including generating and distributing costs, and (2) management and charges upon property, including rent, rates, taxes, royalties, insurance, establishment charges, &c. The surplus of gross revenue over total expenditure for the year has been designated the "working profit for the year," and from this sum the fixed interest charges and appropriations for depreciation, contingency, and reserve fund have to be deducted, and to the remainder the balance from last account must be brought forward, before the net sum available for distribution or disposal in the nature of a net profit upon the working of the concern is determined. Where this sum is a negative quantity it is placed against "Deficit," and the manner in which it is covered will generally be stated in a footnote. In addition to the financial results represented by the gross and net profits and the sums set aside for various purposes, a number of other financial results are appended, these including items showing the expenditure and revenue per unit of plant capacity, and the percentage ratio of the total expenditure to the gross revenue for the year's working. Where the comparison would be useful, the financial results per cent. of the mean capital expended have been given in a separate column, the mean being that between the capital expended at the beginning and end of the year. It will be seen, therefore, that the new tabulated statements and analyses of accounts give even fuller information than in our previous Supplements, and that they embody all that it is useful or interesting to know in regard to the financial progress of electricity works.

THE HULIN ELECTROLYTIC ALKALI PROCESS.

BY JOHN B. C. KERSHAW, F.I.C.

In an article upon "Electrolytic Alkali Processes," published in the issue of *The Electrician* for February 12, 1897, the present writer referred to the Vautin process. This process had been worked for a short time experimentally at Bolton in Lancashire a few years before without success. The electrolyte used was fused salt, while a cathode of fused lead was designed to form an alloy with the sodium at its moment of liberation, and thus to remove it at once from the further action of the current. The advantages claimed for the process were the possibility of employing without danger

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very high current densities, and the absence of secondary reactions at the cathode.

The difficulties that were met when the process was tested experimentally arose from the action of the fused mixture of salt, lead, and sodium upon the material of the crucible, and from the non-renewal of the cathode surface when the lead-sodium alloy had once commenced to form. After the current had been passed for a short time, the surface of the fused lead cathode was found to be entirely crusted over with the alloy, and the liberated atoms of sodium finding no lead with which to combine, rose to the surface of the fused mass, and burned slowly away, or formed sub-chlorides with the chlorine liberated at the anode. This phenomenon was accompanied by a great increase in the back E.M.F. of the cell, so that the amount of current passing through it gradually decreased.

In the year 1890 M. Léon Hulin, a French chemist, without knowing anything of the Vautin patents or trials in England, commenced to experiment with a similar procedure at Mödane, in France. The idea of using fused lead as cathode was suggested to him by noticing that when fused lead was used as cathode in an aluminium pot, with fused cryolite as the electrolyte, sodium and not aluminium was obtained at the cathode. The early experiments made by M. Hulin with this new electrolytic soda process quickly revealed the difficulties noted above. M. Hulin was, however, convinced of the value of the process, if regularity of the electrolytic action could be obtained, and after the expenditure of much time and energy in continuance of his experiments he was successful in overcoming the difficulty caused by the crusting over of the surface of the molten cathode. The method adopted by M. Hulin was simple and yet effectual. The electrolyte of fused salt was changed for one containing a definite and fixed proportion of lead chloride. Thus lead and sodium were simultaneously liberated at the cathode, while at the anode chlorine alone was liberated as before. The ions of lead and sodium arriving at the cathode surface together, on release from their electric charges, combined to form molecules of the lead-sodium alloy, which diffused into the molten lead with regularity and ease. The destructive action of the fused mixture upon the material of the crucible was also found to be much lessened when free sodium and sub-chlorides of that metal were no longer present.

The process described above has been operated upon a small industrial scale at the paper works of MM. Matussière et Forest at Mödane. The power used in these trials (120 H P.) sufficed to produce 2,000 amperes at 32 volts, and this current was sent through four of the specially-designed crucibles containing the fused mixture of lead and sodium chlorides. Each crucible was found to require an E.M.F. of 7 volts when at work under the normal conditions. A current-density varying between 560 and 934 amperes per square foot was used, but the best results were obtained when one of 700 amperes was used. This is 30 times greater than that, feasible when aqueous solutions of sodium chloride are electrolysed, and indicates that an output 30 times as great could be obtained from a plant equal in cathode area. In order to keep up the supply of lead chloride in the fused mixture which forms the electrolyte, part of the current was led into the crucible through a lead anode, while the major portion of the current passed into the cell by a carbon anode. The chlorine liberated at the former attacked the lead and produced lead chloride, which diffused into the electrolyte; 12 per cent. of the current was diverted in this way, and each crucible was provided with ammeters, in order that the proportions between the two branches of the current might be kept constant.

The yield per horse-power hour is stated to have been 81 grammes chlorine and 54 grammes sodium, or 1·85 kilos chlorine and 1·24 kilos sodium per horse-power day of 23 hours. M. Hulin originally intended to extract the sodium from the lead sodium alloy by means of steam, and to return the lead in the molten state to the cell. The advantages of this method were a saving of heat, and the production of a very highly concentrated solution of soda. In practice, however, the method proved to be dangerous, and it was discarded in favour of one depending upon the use of water, or solutions of various chemicals. By this method fairly strong solutions of sodium hydrate were obtained, and the lead remained in spongy form. If the market demand for lead peroxide is better than that for spongy lead, this can also easily be obtained as a by-product. The alloy is roasted in a current of air at a dull red heat, in order to cause oxidation of both metals. After cooling it is lixiviated as before with water, and the solution of sodium hydrate is separated from the insoluble lead peroxide. In this case the lixiviation, of course, yields no hydrogen. Both spongy lead and lead peroxide are much used at present for secondary or storage cells, and M. Hulin believes that these by-products of his electrolytic soda process may be utilised in connection with the manufacture of these. The nascent hydrogen given off when the unroasted alloy is lixiviated with water may also be utilised to obtain reduction effects, and it is hoped that the production of nitrites, or of some organic preparations in which reduction is necessary, may also be carried on in connection with the soda manufacture. By using the leaching solution repeatedly M. Hulin has obtained solutions of sodium hydrate containing 750 to 800 grammes NaOH per litre (about 1·54 specific gravity), without any concentration by external heating, and this high strength of the solution, together with its freedom from chlorides or sulphates, renders the further operations for the production of solid caustic much less costly than in the Le Blanc soda process.

Efficiency and Costs.—The efficiency of the Hulin process is lower than the efficiencies of other electrolytic soda processes now in operation in this country. The high current-density employed of course demands a high E.M.F. in order to force the large current through the electrolyte, and there is in addition the loss of energy due to the diversion of portion of the current through the lead anode. In order to permit a comparison to be made between the yield of chlorine and sodium hydrate by the Hulin process and by the English electrolytic soda processes, the table of efficiencies given in the article of February 12, 1897, is reprinted below, with the corresponding figures for the Hulin process. The fact that the latter is a dry process, and that the *theoretical* figures are therefore lower, must not be lost sight of when comparing the two sets of figures. The current efficiency of the Hulin process is lower than one would expect, since if one adds the 12 per cent. which is used for keeping up the supply of lead chloride, there is still 19 per cent. or nearly one-fifth of the current which is wholly unaccounted for.

Table I.—*Wet Processes. Current and Energy Efficiencies.*

Process.	Volts.	Actual yield in grammes.				Efficiency, %.	
		Per amp. hr.		Per k.w. hr.		Current.	En'rgy
		NaOH.	Cl.	NaOH.	Cl.		
Hargreaves-Bird ...	3·4	1·196	1·057	351	310	80	54
Castner-Kellner ...	4·0	1·363	1·136	340	284	91	52·3
Richardson-Holland	6·0	...	...	...	...	97½	37·3
Ditto	4·0	...	...	...	...	97½	56·0
Theoretical figures	2·3	1·495	1·322	650	574	100	100
Dry Processes.							
Hulin	7·0	1·052	0·907	150	129	69·3	41·5
Theoretical figures	4·2	1·495	1·322	356	314	100·0	100·0

The advantages which compensate for the much lower yield per kilowatt-hour by the Hulin process (150 grammes NaOH, as against 351 grammes by the Hargreaves-Bird process) have already been mentioned. They are: much greater output from a small plant, a concentrated solution of soda without evaporation, and by-products of commercial value. The actual money value of these gains cannot be given, and therefore the following comparative figures for the cost of the electrical energy required to produce 1 ton 70 per cent. caustic soda and 2·1 tons 35 per cent. bleach by the different processes are no guide to their relative economic positions. Nevertheless, they are of interest, as showing the money value of the extra electrical energy demanded by the Hulin process, the cost of which must be obtained from the advantages already enumerated.

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Table II.—*Energy required to produce 1 ton 70 per cent. caustic and 2·1 tons 35 per cent. bleach.*

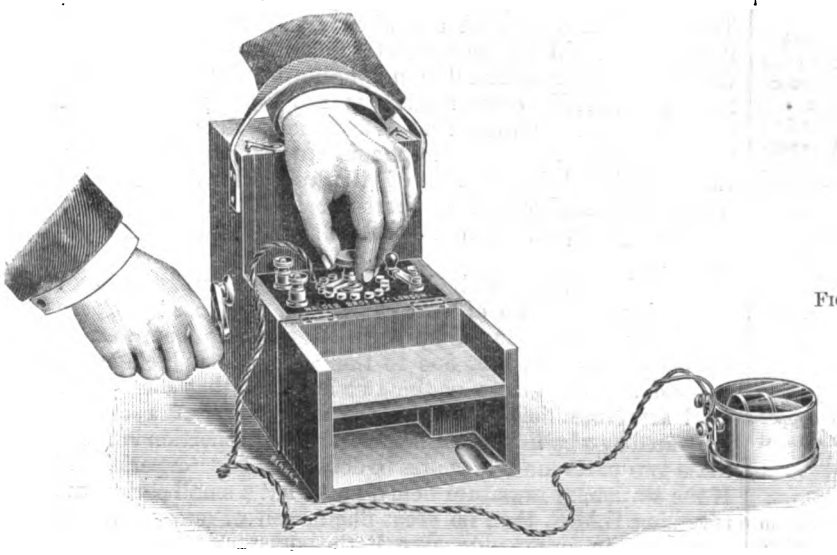
Process.	Kilowatt-hours.	Value.
Hargreaves-Bird	2,609	£2 1 8
Castner-Kellner	2,694	2 3 0
Hulin	6,106	4 17 7

The estimated cost of the E.H.P.-hour, given in a previous article by the present writer,* has been used in calculating the above values. The experiments carried out at Mòdane have yielded results sufficiently successful to justify the commencement of works for the operation of the process upon an industrial scale. A company, the Société des Soudières Electrolytique, has been formed with a capital of 3,000,000fr. (= £120,000), and offices at Grenoble. The works are situated at Clavaux Isère, and the electrical energy is to be obtained from dynamos driven by the water power of the river Romanche. A steel pipe line, 900 metres in length and 2·5 metres in diameter, conveys the water to the turbine house, and the normal flow under a head of 42 metres is estimated to be equal to 5,000 H.P. The dynamos are direct coupled to the turbines, are direct-current machines, and yield each 375 kilowatts of electrical energy. A daily output of 4 tons caustic soda and 8 tons bleach is expected. The works are at present in course of construction, and it is hoped that they will be ready to commence operations during the present year.

The further operations of this process will certainly be followed with interest by electro-chemists in this country, and the writer hopes that no unforeseen difficulties will hinder the successful development of the Hulin process upon the larger scale of operations now planned at Clavaux.

A HANDY TESTING SET.

The figure below shows a very convenient form of testing set which is now being made by the Davies Motor Company. It is



A Handy Testing Set.

intended for the testing of insulation resistances, having a range from 0·01 to 50 megohms. The box, which measures 9½in. by 5¾in. by 8in. and weighs about 14lb., contains a continuous-current hand generator and a direct-reading Wheatstone bridge, with a sliding contact-arm instead of plugs. The insulation resistance to be measured is connected to one pair of terminals, and the galvanometer to the other pair, the latter and the terminals of the galvanometer itself being coloured red and blue, so that use can be made of the letters H (higher) and L (lower) marked on the galvanometer scale. The galvanometer being placed at sufficient distance from the generator, the handle is turned and the slider is adjusted until balance is obtained. The contact-arm on the right has two positions, one for absolutely direct reading from the figures on the dial (0·1 to 50 megohms), and the other marked with the instruction "Divide by 10." We may add that the proportion in the figure between the size of the hands and that of the instrument need not necessarily be observed in practice.

* *The Electrician*, December 25, 1896.

A COMPACT TELEPHONE SET.

A diminutive telephone set, the design of Mr. A. W. B. Pearson, is now being put on the market by Messrs. Anderson, Kant and Co. As shown in Figs. 1 and 2, it combines in a very small volume a transmitter, receiver, bell-push, and the equivalent of a switch-hook. The instrument is in two parts, the lower portion, drawn in section in Fig. 2, being the receiver, and the cover, containing the transmitter and bell-push. The construction of the receiver itself is evident from Fig. 2. On the horse-shoe magnet is fixed the two-way spring switch which is controlled by the brass piece A. When

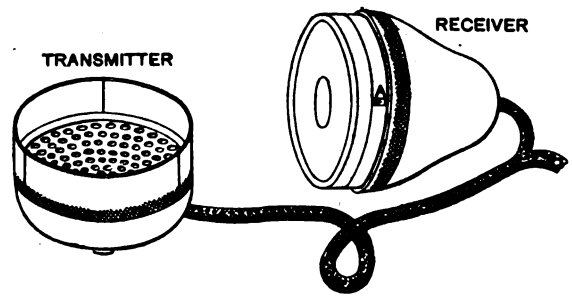


Fig. 1.—Instrument as used for Conversation.

the cover is on, the projecting part of this piece is pressed inwards, a small block of ebonite on it holds the flat spring B against the spring C, and the bell and push are in circuit. On the removal of the cover the pressure on A is released and B makes contact with the other spring D, connecting the transmitter and receiver to line. For long distances an induction coil is added, it being contained in

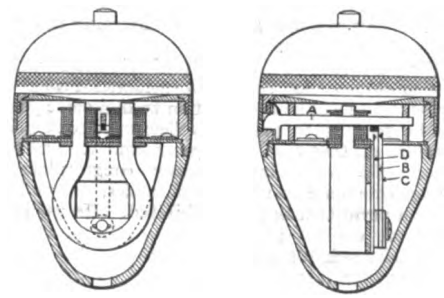


Fig. 2.—Part-Section showing Spring Switch. Half actual size.

the wall block from which the flexible cord to the telephone is led. The microphone is of the carbon type, and as it is constantly moved about in use there is little liability for the carbon to pack. Fig. 2 is drawn to a scale of half actual size. The instrument appears particularly suitable for use in hospitals and for invalids, in place of the ordinary pear-shaped bell-push, and it should also be appreciated in offices where desk-room or wall-space is limited.

AN ELECTROLYTIC PROCESS FOR THE MANUFACTURE OF PARABOLIC REFLECTORS.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers, on February 9th, in connection with Mr. S. Cowper-Coles' Paper on the above subject. Speakers who have returned their proofs revised are denoted by an asterisk :—

DISCUSSION.

*Mr. C. E. GROVE said that he had had an opportunity of examining one of these reflectors and it had struck him as being of particular value, if only for the reason that it could be handled without that excessive care that was necessary in the handling of the mirror of an ordinary projector.

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It seemed to him that the surface was not quite so bright as the surface of a silvered glass reflector, but they must remember that in ordinary work the silvered reflector of a projector very soon became covered with a blueish white soot from the carbons. He was not aware whether that deposit would adhere in equal degree to these reflectors—probably not, and if not, a further advantage would be gained there. He thought there was another application in connection with projectors to which these might be applied with advantage. In front of an arc lamp a small opaque screen was usually employed, which served the purpose of preventing the arc being seen, and also helped to retard the divergent rays from the back of the arc which would interfere with the parallelism of the beam. Could not a metallic reflector be substituted for this which would throw upon the mirror rays of light which would otherwise be lost? All experiments, hitherto, had been hopeless on account of the intense heat of the arc destroying the metallic surface and volatilising the silver or anything else that might have been used. It had occurred to him that if palladium could withstand the heat so well, it should prove very useful for such a secondary screen, and so help to increase the efficiency of a projector equipped on this method.

*Major-Gen. WEBBER said that when he first had to do with reflectors used as projectors, for land defence purposes, he remembered that the great difficulty was not only the cost but also the monopoly in the manufacture of reflectors. But it was now so long ago that many changes might have taken place and the conditions quite altered, and he would not press the question of cost; in fact, he did not see that it could interest the meeting. He could very well conceive that this field of improvement would be of immense benefit in connection with purposes of defence and attack, especially if, as he imagined, the cost of projectors was probably half that of ten years ago. If that were the case, Mr. Cowper-Coles' invention would be welcomed by those who looked forward to seeing the whole of our coasts illuminated in cases of danger or threatened invasion.

*Mr. O. A. PILCHER asked if these reflectors were much lighter than those usually made of glass. The ones he had had to deal with had usually weighed about 56lb., and he remembered an instance of one being dropped overboard by those handling it, through its unexpected weight.

*Mr. C. W. SPEIRS asked if it was not possible, after making the first reflector, to make a copper matrix from it, and use it instead of the glass mould. Such a matrix would have the advantage of being lighter than a glass one.

Mr. W. M. MORDEY protested against Major-Gen. Webber's statement that the question of cost had nothing to do with the meeting. It seemed to him that it was most important not only to produce things in as simple a way as possible, but to produce them as cheaply as possible.

*Major-Gen. WEBBER: What I meant to say was that it had nothing to do with the subject of the Paper.

*Prof. AYRTON: It has nothing to do with the Paper this evening.

Mr. MORDEY thought this was quite a mistake. As engineers, they had to "direct the great sources of power in Nature for the use and convenience of man," but if they spent so much in doing this that the man had nothing to eat, there was not much good in directing the sources of power in Nature to man's advantage.

*The PRESIDENT (Mr. J. W. Swan), referring to Mr. Speirs' remarks, said the question of distortion has to be considered if a lighter mould were used. Major Bagnold had put the question to him some years ago whether it would not be feasible to produce reflectors electrolytically, but the difficulties seemed at that time very great, and he had not ventured to combat them. He must very warmly congratulate Mr. Cowper-Coles on having overcome the many difficulties, and on having produced reflectors of such perfection as those exhibited. He would like Mr. Coles to be a little more explicit as to the proportion of acid in the solution. Was it 3 per cent. by weight? [Mr. Cowper-Coles intimated that it was so.] It would also have been interesting if they had been told exactly what was the comparison between the amount of light reflected from a palladium reflector and a silvered one. There was a strong tendency to distortion in electrotyping, and he was surprised that Mr. Coles had been so successful as he had been.

*Prof. W. E. AYRTON did not think Mr. Speirs had really explained his point. Mr. Speirs used the process he described every day, not for making mirrors, but for making perfectly smooth plates. He started with a perfectly plain sheet of glass, silvered it, then deposited copper on that, removing the copper afterwards. This sheet of copper formed his matrix for the future, instead of the original sheet of glass.

*The PRESIDENT: Is the surface dealt with a large surface?

*Mr. SPEIRS: From 15in. to 2ft. square.

Mr. G. A. BRADE asked Mr. Speirs how he separated the copper from the glass. It seemed an impossibility to separate a curved copper plate without distorting it.

*Mr. SPEIRS said the plates were slightly silvered chemically. If they took a highly-polished sheet of copper and gave it a very slight silver deposit, a plate deposited on it would separate quite easily without any pressure.

Mr. BRADE thought this would probably ruin the mirror for any reflecting purposes. It was utterly out of the question to polish the mirrors afterwards.

*Mr. SPEIRS said the copper he spoke of was not polished afterwards.

*Mr. COWPER-COLES, replying, said he had tried a number of experiments on glass and different mirrors in the manner suggested by Mr. Spiers, and invariably found it impossible to separate them. It was only due to the unequal expansion of the glass and copper that they had been able to separate them. If that difficulty had been overcome, he saw no reason why the method should not be used. He had succeeded to a certain extent, but he could not retain absolutely true and accurate surfaces that would stand optical tests. There had been no accurate measurements made as to the light reflected from a palladium reflector and that of a silvered glass reflector.

After a vote of thanks to Mr. Cowper-Coles, the meeting adjourned.

CORRESPONDENCE.

COMMUTATION OF CONTINUOUS-CURRENT DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to the objections raised in your "Notes" of Feb. 25 to the views expressed in my letter of the same issue, my statements admit of simple proof.

Consider an armature rotating in a magnetic field in free space away from iron or conducting masses. If commutation proceeds uniformly, the magnetic field of the whole armature remains constant and stationary, and a fixed circuit placed round the armature in the plane of commutation experiences no change of magetic flux through it *so long as commutation is uniform;* hence the whole inductive E.M.F. in the commutating section may be reckoned from the armature field cut during the process of commutation. This is equivalent to saying that the flux produced by the n coils distributed round the armature, over a space of $\frac{1}{n}$th of the circumference near the plane of commutation is equal to that produced by one coil over a space of half the circumference. Then, if there is no reversing E.M.F., so that commutation is delayed, the armature field rotates as a whole, and the commutating section does not cut it; but upon this section being thrown into the main circuit with its current still unreversed, reversal is produced by the spark E.M.F. supplied from the main circuit, and the field is rotated back to its original position. The integral reversing E.M.F. is equal to either the inductance of the section × the current-change, or the armature field cut by the section, if the effect of resistance be neglected.

When an armature is placed between iron pole-pieces the armature field is still stationary, as was pointed out many years ago by Mr. Swinburne and others, when commutation is uniform; but when commutation is delayed the armature field can no longer rotate quickly *as a whole.* A small part of that due to coils midway between the pole-pieces may rotate, the rest is stationary, and is cut by the commutating coil. Thus the armature field cut when commutation is complete is still equivalent to the magnetic flux due to the reversal of the current where commutation is uniform; but if there is no reversing E.M.F. commutation is not merely delayed but starts in the wrong direction. When the spark takes place its integral E.M.F. is equal to the increased current change × the "choked" inductance of the coil = the deficiency of reversion E.M.F. × time of short-circuit = the resultant field cut, always supposing that brush contact resistance is negligible.

It is of course possible to consider the reversing E.M.F. required as made up of two parts, that due to cutting the stationary field produced by coils in the neighbourhood of the pole-pieces, and that due to the "choked" inductance of one coil: but the sum of the two is oqual that due to the total armature field-cut, or to the inductance of a coil as measured by a ballistic galvanometer. The proportion between these two parts must of course be determined by "experience." If the stationary armature field absorbs but a small part of the reversing E.M.F. then no great fluctuation of current during commutation is possible, even if the slope of the reversing field is considerable; if, on the other hand, it is the more important factor, then the fluctuation of current will be great. Experience with multipolar machines points to the latter view as more correct.—Yours &c.,

R. H. HOUSMAN.

Birmingham, Feb. 26, 1898.

SYNCHRONISING ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As "H. H. N." is still unable to see the point, I will endeavour to explain further. He now says that he is "perfectly aware that two or more steam alternators when running in parallel on their governors, with the stop valves wide open, will share any change of load between them." But his first letter can hardly be said to convey that impression, and they

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will certainly not take the load—that is, keep up the voltage—unless the excitation is adjusted. "H. H. N." now assumes an extreme case, and endeavours to make me responsible for it. A reference to my article will show that I said, "distributing the load amongst them in any proportions desired," and "usually the load on any machine can be adjusted," &c.; but if there is no load on one machine, as in "H. H. N.'s" supposed case, then the load is not distributed or adjusted in any sense of the words, but is, on the contrary, transferred as a whole. Further, when one speaks of desired proportions, one assumes that what is desired by engineers will be something in reason; for instance, that if one machine is doing, say, 20 per cent. more or less over its share, and the other a similar amount under, then it will be desired to make them take the load in equal proportions. In such a case as this it can frequently be done entirely by the excitation, and in many cases a much greater change in the distribution can be made. That this can be done is not a matter of argument or opinion, but of fact, and has been daily carried out by me with plant under my charge for some years past. I have given "H. H. N." the opportunity of seeing it done, and he should avail himself of that offer before talking so glibly of my being mistaken.

As to *how* it is done, that may be a matter of opinion. My own view is as follows:—Suppose two steam alternators in parallel, partly loaded and on their governors. Now steam alternators may be looked upon as having two governors; there is the governing due to the centrifugal governor on the engine, and there is also the governing due to the give-and-take of synchronising current between the two alternators. If, now, the excitation on only one machine is increased it will be called on to do more work, and will receive synchronising current from the other machine to assist it in maintaining its speed. But the other machine is also doing exactly the same amount of extra work, as it is providing the synchronising current. Both alternators will therefore lose speed equally, and the governors can now act. But as the governor on the first machine moves to meet the increased demand, the synchronising current given by the second machine is no longer needed, and sinks to little or nothing; so that, as the extra load on the second machine has been thrown off, it can now maintain its speed without a further admission of steam. The first machine is now doing more work, while the second retains its original load. If the excitation had been equally increased to both they would have shared the extra load between them; while if the second machine had received the increased excitation it would have taken the extra load, while the first machine retained its original load.

If "H. H. N." has any further questions to ask, will he kindly quote from what I really did say, instead of assuming cases that do not conform thereto?—Yours, &c.,

Feb. 26, 1898. H. E. M. Kensit.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, *February 18, 1898.*

Water-Power Transmission Plant.—The Dolgeville Electric Light and Power Company has completed a water-power transmission plant for the supply of power in the towns of Dolgeville and Little Falls, New York State. The plant is installed at High Falls, on the Auskerada River, near Utica. The total effective head on the turbine is 72ft. From the dam a 10ft. steel flume, supported on masonry piers sunk to the rock level, carries the water 500ft. to the power house. The initial installation includes two 36in. Victor turbines, with a capacity of 750 H.P. each, coupled to two Westinghouse 450 kilowatt alternating generators, whose pressure is 2,200 volts at a frequency of 120 ∿ per second. A rotary converter in the power house gives 500 volts continuous current for motors, the lighting load being provided by step-down stationary transformers. The step-up transformers give 10,000 volts, for transmission to the city of Little Falls, eight miles distant, the voltage there being stepped down to 2,000 volts for local distribution. The generators are excited by one exciter with an independent waterwheel. The Company will market the power at approximately $25 per horse-power per year at Dolgeville and Little Falls.

A Destructive Fire in Montreal.—On the evening of Sunday, February 6th, the sub-station at Côte Ste. Paul, Montreal, belonging to the Lachine Rapids Hydraulic and Land Company, was entirely destroyed by fire, the origin of which has not yet been determined. The loss is estimated at $100,000. The sub-station contained three pairs of stationary transformers, each of 300 kilowatt capacity, which were used to reduce the three-phase line current from 4,500 to 2,000 volts two-phase for distribution to lighting and power circuits in the vicinity. Several synchronous motors driving arc dynamos were also installed in the same station, and there was also an equipment of steam machinery which had been used prior to the completion of the Lachine Rapids plant. As a result of the destruction of the station, several churches and dwelling houses were left in darkness. The incandescent service was re-established promptly, there being a sufficient number of transformers on hand to replace those destroyed. The station will be re-built as a fire-proof structure, and new apparatus, which was ordered before the fire will be installed in it. The heat was so intense that it melted the vulcanised bushings of the transformers and expanded the oil inside, in spite of the water jacketing, until it came through the openings. Notwithstanding this, the transformers appear to be uninjured internally.

Concentration of Generating Plant.—It is reported on good authority that the Edison Electric Illuminating Company of New York will erect on the East River front in this city a large electric generating plant, in which will be concentrated the Company's entire generating system, with the possible exception of the Duane-street plant, the intention being to employ high-voltage transmission to distributing stations located at different points throughout the city. This is in line with the tendency in modern central station practice in this country. This system of generation and distribution has already been adopted by the Chicago Edison Company and the Brooklyn Edison Company. The Boston Electric Light Company has made a contract with the General Electric Company for the equipment of its new generating station now in course of erection in South Boston. The Company has also decided to consolidate all the small stations into one large plant, and will use a three-phase alternating current, for the generation of which it will employ four dynamos, each of 1,500 kilowatt capacity. These machines will be of the revolving field type, and current will be generated at 2,200 volts. To excite these dynamos two smaller ones, each of 100 H.P., will be driven by a synchronous motor. In addition, 18 large synchronous motors, each of 200 H.P., will drive 36 are-lighting machines, each motor being set between two Brush 125-light arc dynamos.

LEGAL INTELLIGENCE.

Leicester Corporation v. Hill.

At the local County Court, last week, before His Honour Judge Wightman Wood, the Corporation of Leicester sued Mr. H. Warren Hill, electrician, King-street, Leicester, for the recovery of £4. 19s., the price of goods sold and delivered. Mr. W. Simpson, for the plaintiffs, said that so far as the purchase was concerned there was no dispute between the parties. Defendant purchased a number of appliances in September, 1895, from the electrical department of the Corporation, but declined to pay for them on the ground that the Corporation were trading *ultra vires*. There were altogether eight items in the purchase, and in respect of the first item 10s. 6d. had been paid into Court. The point was whether the Corporation were entitled to sell and recover the price of articles and apparatus used in connection with the supply of electricity. He maintained that under the various clauses of the Acts under which the Corporation supplied electricity they had the power to trade in electrical appliances. The first Act was the Electric Lighting Act of 1882, under which corporations were authorised to supply electricity, either by licence from the Board of Trade or by means of a Provisional Order, the latter being obtained for Leicester. Section 10 of that Act gave them the power "generally to do all such acts and things as might be necessary and incidental to such supply." This, it was contended, conferred upon them the right to sell lamps or appliances which were incidental to the supply of electricity. Mr. Simpson quoted also from the Act of 1890, and put in a printed form of account supplied by the Board of Trade to corporations, in which occurred the items "sale and repair of lamps" and "sale and repair of

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other apparatus," clearly indicating that those items were such as came within the scope of their trading powers. So far as the general law was concerned, it provided that "anything reasonably connected with the primary object was sanctioned, unless it could be shown by the defendant that it was outside altogether, and quite remote from the original intention. In conclusion, Mr. Simpson said he was entitled to throw upon the defendant the onus of proving that the Corporation were acting *ultra vires*.

For the defence, Mr. NEWELL said that the plaintiffs were a public Corporation, and held delegated powers. It had in its possession a fund derived from the public, and the particular purposes for which that fund should be used were clearly defined by statute. He should submit that under the Statute of 1882 and the Provisional Order under which the Corporation acted, the only power they possessed was to supply electrical energy. But they had deviated altogether from that power, and were selling lamps and appliances which were not necessarily connected with the supply of electrical energy. They had become traders and shopkeepers, and had thereby damaged the local tradesmen with whom they were unfairly competing. The Corporation competed with the local tradesmen by means of the very rates which those men partially contributed.

The JUDGE: I suppose this case is brought to try that principle. It is really to test the principle on behalf of the private traders?

Mr. NEWELL: It is. We are here to ask you to say that the Corporation in selling these lamps are going outside their powers. The lamps are quite a distinct industry. Proceeding, learned Counsel said the Corporation not only claimed to sell appliances to those to whom they supplied the electric light, but to sell them to anybody. The defendant who bought these lamps was a trader, and himself supplied lamps abroad.

The JUDGE: But he is also a householder.

Mr. NEWELL said Mr. Hill had not the electric light in his house. He (Mr. Newell) contended that in this matter the plaintiffs were in the position of a statutory corporation, and could only exercise the powers conferred by their charter.

Mr. SIMPSON remarked that their charter dated from Elizabeth.

The JUDGE: Do you say that before the passing of the Electric Light Act of 1882 the Corporation had no power to trade?

Mr. NEWELL: I should say not.

The JUDGE: Is there any authority that they shall not trade?

Mr. NEWELL: Where they go beyond such powers as they have in the charter that charter is revocable. I think the point your Honour puts does not arise in this case.

The JUDGE: Surely it does arise. The Corporation have traded; a man buys some lamps from them, and you say that contract of sale, so made between them and him, is void because they had no power to enter into such a contract. Is it the case that they had no such power before this Electric Light Act passed? If they had the power before your contention must be that this Act of 1882 takes it away; if they had not the power your argument must be that this Act does not give it to them. I want you to say which it is. What I am not satisfied about yet is that they had no general power apart from this Act.

Mr. NEWELL: If they had the power before why should a statute be obtained granting that power?

The JUDGE: Oh, the statute does much more than that. What I want is an authority that they had not the power before.

Mr. NEWELL went on to quote from Bryce with the object of showing that Corporations possessed only the capacities given at their inception. The authorities generally expressed very great doubt as to whether Corporations had the power to trade.

The JUDGE: It seems to me there are two points to consider. One is whether the sale of these articles was reasonably incidental to the supply of electricity; the other is whether the defence of *ultra vires* can be raised on an executed sale.

Mr. NEWELL gave numerous quotations from the Act of 1882 with the object of showing that the supply of electrical energy was the gist of the whole power given to the Corporation, and that they had no power to charge for anything else but the energy. But even if supplying the energy carried with it the power to sell appliances where electricity was supplied, the Corporation were still wrong in this case, because they claimed to be able to sell appliances to anybody, apart from supplying them with electricity. He therefore submitted two points—first that the Corporation could not supply lamps at all, because it was an independent industry; and, second, that if they could, they could only sell them to those who had received their supply of electricity.

The JUDGE thought if the Corporation were entitled to supply lamps at all they could not be expected to ascertain whether every customer had or had not been supplied with their electric light. If they were entitled to sell at all it seemed to him they were entitled to sell to stray persons, because that would be a mere incident to their selling at all.

Mr. NEWELL: If your Honour holds against me I shall have to ask your permission to appeal.

The JUDGE: Yes, you may appeal if I am against you.

Mr. NEWELL said this was a serious matter to private traders, whose business was being injured.

The JUDGE: Are the Corporation underselling them?

Mr. SIMPSON: No.

Mr. NEWELL: They have, I am instructed, taken two-thirds of the trade.

The JUDGE: I will take time to consider my judgment. The matter is important, no doubt.

Flannery v. National Telephone Company.

The Lord Chief Justice and a special jury heard an action this week in which Mr. J. F. Flannery, M.P., residing at Norwood, and carrying on business in the City, sued the National Telephone Company for damages for breach of contract in failing to supply his house at Norwood with telephonic connection within reasonable time according to the terms of an agreement. In 1893 Mr. Flannery desired to stand for Parliament, and wished to be connected by telephone in order that he might be the better equipped to conduct his business in the City from his residence, and to so secure more time for parliamentary work. He entered into a contract for connecting his house with an exchange on March 8, 1893. As there was considerable delay he complained, and the company notified him that they could not obtain wayleaves by the route they were proposing to adopt through Streatham. The nearest exchange to Mr. Flannery's house was the Streatham exchange, 1¼ miles away. There was also an exchange at Sydenham, 3¼ miles away, but there was a wire on the Sydenham route within three-quarters of a mile of Mr. Flannery's house, and Mr. Flannery suggested that they should adopt the Sydenham route. The Company, however, declined to adopt this suggestion, on the ground that they would be called upon to put up ornamental iron posts along the Beulah Hill-road, and the expense would be too great, as the plaintiff was the only subscriber in that district, while along the Streatham route they hoped to obtain a number of subscribers. Eventually at the end of May, 1896, the plaintiff's house was connected with the Sydenham Exchange. Mr. Flannery claimed that he had been put to great inconvenience by this unreasonable delay, and brought this action in the interests of the public. The defendants' case was that, considering the fact that the plaintiff was the only person in the district who desired to be connected, it was reasonable that they should connect him with the nearest exchange, and they had made every endeavour to get the wayleaves necessary for that purpose. It was admitted that they had entered into the contract without first ascertaining whether they could carry it out. They maintained that the Sydenham connection along the Beulah Hill-road would have cost nearly £270. The plaintiff was a £20 subscriber in London, and therefore was entitled to obtain telephonic connection for a reduced rental of £12. 10s. a year, to be paid in advance.

His LORDSHIP asked the jury to consider whether the defendants had taken reasonable and proper steps to carry out their contract or whether they had been guilty of unreasonable delay.

The jury found there had been unreasonable delay on the part of the defendants, and gave a verdict for the plaintiff for £5. Judgment accordingly, with costs.

Westminster Engineering Company v. Kent.

In the Westminster (London) County Court a case was heard last week in which the plaintiffs sued the defendant, a builder, at Whitehead-grove, Chelsea, to recover the return of certain monies alleged to have been overcharged in respect of commission on orders given for electrical work. The plaintiffs' case was that the defendant gave them orders to carry out some electrical fittings and wiring, and in due course it was carried out, and the defendant became entitled to a commission of 10 per cent. but he deducted 15 per cent. from the account, and it was in respect of the extra 5 per cent. that the present action was brought. The defence was that 15 per cent. was a recognised rate of commission on this class of work. Judge Lumley Smith said he was not satisfied as to that, and gave judgment for the plaintiffs for the return of £6. 5s. 10d. and costs.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

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"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is *now ready.* Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898, and contains about 150 additional pages over last year's book. Supply houses will find the book very reliable and complete for circularising.

Tenders Invited.—The Great Central Railway Company (M.S. and L.) require tenders for the supply of certain stores and materials for the twelve months ending April 30, 1899. A list of these requirements is set out in an advertisement elsewhere. Patterns can be seen, from the 7th to the 14th inst. inclusive, on application to the storekeeper, Mr. A. W. Longden, Junction-street Mills, off Ducie-street, London-road, Manchester, and specifications, &c., can be obtained of Mr. Oliver S. Holt, secretary, London-road Station, Manchester, to whom tenders have to be sent not later than 10 a.m. on Tuesday the 15th inst.

——— The Plymouth Corporation invite tenders for the supply of alternating-current electricity meters for the twelve months ending March 31, 1899. Specification, &c., may be obtained by bona fide meter manufacturers or their authorised agents on application to the borough electrical engineer (Mr. John H. Rider), Fleet-street, Plymouth, and tenders must be delivered to the town clerk (Mr. J. H. Ellis), Town Hall, Plymouth, not later than March 23. Further particulars are given in an advertisement elsewhere.

Tenders Invited.—From our advertisement columns it will be seen that the Visiting Committee of the Wilts County Asylum, Devizes, require tenders for the supply and delivery at their new engine house of two 40-kilowatt continuous-current belt-driven dynamos. Short specifications and particulars may be obtained from Messrs. Massey and Allpress, 25, Queen Anne's-gate, Westminster, London, S.W. Tenders must be sent to Mr Joseph T. Jackson, office of clerk to the Visiting Committee, Devizes, by noon of Monday, the 21st inst.

——— The Corporation of Blackpool invite tenders for the supply and erection of the following plant at their electricity works:—One tubular boiler with superheater; superheaters for five existing Lancashire boilers; surface condensers, pumps, pipes, and storage tanks; two 55-light rectifiers; ten 15-kilowatt boosters; high and low-tension lead-covered cables; ten 50-kilowatt transformers; 20 arc lamp pillars, and 100 arc lamps. Tenders to Mr. T. Loftos, Town Hall, Blackpool, by 10 a.m. of March 22.

——— The Wallasey Urban District Council invite tenders for the supply of (*a*) engine, alternator and exciter; (*b*) two Lancashire boilers and one water tube boiler; and (*c*) condensing apparatus. Tenders to Mr. H. W. Cook, Church-street, Egremont, by 4 p.m. March 17.

——— The Watford Urban District Council require tenders for generating plant, switchboard and connections; overhead travelling crane; conduits and mains; transformer sub-stations, switch gear, electric lamps and posts, &c., &c. Tenders to Mr. H. Morton Turner, Council Offices, Watford, by noon of March 16.

——— The Electric Lighting Committee of the Coventry Corporation invite tenders for the supply of (*a*) 300-kilowatt steam alternator and exciter; (*b*) 25-kilowatt steam dynamo and accumulators; (*c*) condenser, air; pump, circulating pump, and footplates, &c.; (*d*) steam, exhaust, suction and discharge pipes, valves, oil separator, &c.; (*e*) main switchboard, &c., &c. Tenders to Mr. Lewis Beard, 10, Hay-lane, Coventry, by 4 p.m. March 8.

——— Tenders are required by the Edinburgh Municipal Council for the supply of electric lighting materials for Powderhall destructor, and for upholding the electric light installations for one year from May 15. Tenders to the Town Clerk, City Chambers, Edinburgh, by March 9.

——— The Shoreditch (London) Vestry require tenders for the supply of electric cables, engineers' stores, ironmongery, tools, &c., for the 12 months ending March 25, 1899. Tenders to Dr. H. Mansfield Robinson, Shoreditch Town Hall, Old-street, E.C., by 4 p.m. of March 8.

——— The West Derby Guardians invite tenders for work in connection with the electric lighting of the Mill Road Infirmary, and the wiring of infirmary administrative buildings, and Nurses' home, &c., &c. Tenders to Mr. Harris P. Cleaver, Broughamterrace, West Derby-road, Liverpool, by noon of March 8.

——— The Council of the County Borough of West Ham invite tenders for wiring and fittings for the electric light of various public buildings in the Borough. Tenders to Mr. Fred. E. Hilleary, Town Hall, West Ham, E., by 4 p.m. of March 8.

——— The Electric Lighting Committee of the Ipswich Town Council invite offers for carrying out the terms of their Provisional Order. Tenders to the Chairman of the Committee, Town Hall, Ipswich, by the 25th inst.

——— The St. Pancras Vestry invite tenders for building a brick chimney shaft, about 240ft. high, at the Regent's Park electricity works. Tenders to the Vestry Clerk, Vestry Hall, Pancras-road, London, N.W., by the 17th inst.

——— The Plymouth Corporation require tenders for the erection of a chimney and flues at the electricity works at Prince Rock. Tenders to the borough engineer and surveyor (Mr. J. Paton), Municipal Offices, Plymouth, by the 10th inst.

——— The Prussian State Railway authorities in Berlin are inviting tenders for the supply of 43,300 porcelain insulators, 6,755, insulator supports, and 316 tons of telegraph wire. Particulars from, and tenders to, Die Königliche Eisenbahn Direction (Der Rechnungs Bureau), 1-4, Schöneberger Ufer, Berlin, W., by 10th inst.

Tenders Accepted.—The Electric Lighting Committee of the Portsmouth Town Council recommend for acceptance the tender of Mr. T. W. Quick for the erection of a boiler-house and chimney stack, &c., for the electricity department, at £4,198. The tender of Messrs. Yates and Thom for the supply of the boilers, steam-pipes, economisers, &c., at £7,900, has been adopted, but with a deduction of £93 if electrical feed pumps are used. Messrs. Tinkers Ltd. also submitted a tender at £9,215. Messrs. Yates and Thom obtained an order for laying outlet pipes at £2 and £2. 6s. per yard, the total of their contract being estimated at about £8,500—about £500 less than the estimate of the consulting engineer.

Tenders Accepted.—The following tenders have been received by the Gloucester Corporation for the supply of plant and machinery for the municipal electricity works of the city. Mr. Robert Hammond is consulting engineer.

Boiler House Plant (Lancashire Boiler and Accessories, Mechanical Stokers, Feed Pump, Injector, Economiser, Electric Motor).

Yates and Thom	*£2,409	H. T. Danks, Limited	£2,590
Tinkers Limited	2,478	Holdsworth and Sons	2,665
E. Danks & Co, Ltd. (Oldbury)	2,478	Joel and Potter, Limited (Yates & Thom boilers)	2,821
India Rubber Co. (Adamson boilers)	2,553	J. Fraser and Son	2,910

Engine House Plant (Steam Dynamos and Accessories).

b India Rubber Co.	*£5,917	*w* Laurence, Scott & Co.	£6,994
C. A. Parsons and Co.	4,570	*w* Electric Construction Co	7,035
s Siemens Bros. and Co.	6,495	*b* P. R. Jackson & Co.	7,052
w Easton, Anderson & Goolden	6,535	*w* Siemens Bros. and Co	7,060
s Crompton and Co.	6,614	*b* Crompton and Co.	7,402
b Siemens Bros. and Co.	6,720	W. Sisson and Co	7,415
b Electric Construction Co	6,753	*w* Crompton and Co	7,640
s Crompton and Co.	6,820	*w* Brush Company	7,749
w Joel & Potter, Limited	6,882	*w* J. C. Howell, Ltd	7,752
b Thomas Parker, Limited	6,980		

b = Belliss engines, *s* = Sissons engines, *w* = Willans engines.

Overhead Travelling Crane.

James Spencer and Co.	*£265	Humpidge, Holborow & Co.	£285
Bedford Engineering Co	240	Carrick and Ritchie	306
India Rubber Company	262	Joel and Potter, Limited	310
Marshall, Fleming and Jack	267	Summers and Scott	315

Switchboard and Instruments.

Crompton and Co.	*£1,111	Veritys Limited	£1,275
James White	1,074	General Electric Company	1,300
Nalder Bros. and Thompson (*alternative*)	1,083	Ernest F. Moy, Limited	1,318
Edison and Swan Company	1,083	Electric Construction Co.	1,357
Nalder Bros. & Thompson	1,120	Joel & Potter, Ltd.	1,393
Williamson and Joseph	1,211	Siemens Bros. and Co.	1,530
P. R. Jackson and Co.	1,265	India Rubber Company	1,555
		Burbey and Hutton	1,559

Accumulators.

Electrical Power Storage Co.	*£1,350	Joel and Potter, Ltd.	£1,868
Lithanode Syndicate	1,384	Allan and Adamson	1,943
India Rubber Co.	1,537	Hill, Gifkins and Co.	2,036
Pritchetts and Gold	1,576	Tudor Accumulator Company	2,043
Chloride Electrical Storage Syndicate	1,700	D.P. Battery Company	2,119
Epstein Elec. Accumulator Co	1,808	J. C. Howell, Limited	2,247
Peto and Radford	1,862	Elieson Lamina Accumulator Company	2,508

Mains.

Callender's Cable and Construction Company ..... *£13,500 (approx.)

Also tendered at schedule prices :—British Insulated Wire Co. ; Western Electric Co. (Fowler Waring Cables) ; W. T. Glover & Co. ; W. T. Henley's Telegraph Works Co. ; India Rubber Co. ; Siemens Bros. & Co.

Public Lamps (allocation of tender deferred).

Stewart Electrical Syndicate (Part I. only)	£828	W. Lucy and Co.	£2,488
Brockie Pell Arc Lamp, Ltd. (Part I. only)	1,053	British Insulated Wire Co.	2,550
Phaeton Electrical Company	1,552	Brush Company	2,680
Taylor and Fairbrother	2,138	Siemens Bros. and Co.	2,702
General Electric Company	2,205	India Rubber Company	2,717
Crompton and Co.	2,223	British Blahnik Company	2,859
Hill, Gifkins and Co.	2,387	Johnson and Phillips	3,144
		Electric Construction Co.	3,330
		Drake and Gorham	3,681

Meters.

Chamberlain and Hookham	*£1,121	General Electric Co., Ltd. (British Aron meters)	1,210
S. Z. de Ferranti, Ltd.	1,207	James White (Kelvin meters)	1,210
India Rubber Co. (Hookham meters)	1,207	Downie and Adams (Brillie meters)	1,439

* Tenders marked thus are accepted.

——— The Lincoln Corporation have accepted the tender of the Callender Company for cables for the street arc lamps.

Plant for Sale.—Particulars will be found in an advertisement elsewhere of a quantity of generating plant for sale in first-class condition and working.

Appointments Vacant.—The Governors of the Battersea Polytechnic, London, S.W., invite applications for the position of head of the physics and electrical and engineering department. A small advertisement elsewhere gives some further particulars.

——— The Carlisle Corporation require a clerk of works in connection with the erection of electricity supply station buildings. Applications to the city engineer and surveyor (Mr. H. C. Marks), 36, Fisher-street, Carlisle.

——— A teacher of mathematics and physics is required for the Municipal Technical School, Blackburn. Salary £200 to £250 per annum. Applications to the secretary by March 10.

Appointment.—Mr. J. Stanley Richmond, of Derby, has obtained the recently-advertised appointment of electrical engineer to the Government of Trinidad "to examine and report upon the various systems—light, power, and telephone—using electric current in the port of Spain and its vicinity, with a view to determining the risk to life and property now involved." Mr. Richmond leaves England on March 9 to take up his duties forthwith. His varied experience in the Colonies, in America, and in this country especially fit him for the duties to which he has been appointed. The appointment is for three months, with option to the Government up to twelve months' extension.

Appointments.—Mr. Willoughby Meares has been nominated by the Bengal Government for the post of Inspector of the Electric Light for the city of Calcutta, which appointment has been sanctioned by the Secretary of State.

——— The St. Helens Corporation have appointed Mr. J. S. Highfield, of Stafford, resident electrical engineer, at a salary of £200 per annum. There were 39 applications, but this number was reduced to seven.

Business Notices.—Mr. J. W. Barnard informs us that his engagement as secretary to the Electrical Power Storage Company (Limited) having terminated, he has been appointed by the Company their sole agent in the United Kingdom for the sale of the "Q" and "V" types of E.P.S. cells. These cells are manufactured especially for use in connection with carriage, cycle, miners' lamps, domestic hand lamps, electro-medical appliances, and similar apparatus. Mr. Barnard is on the spot, having secured offices at 4, Great Winchester-street, London, E.C., where he will welcome every opportunity of consulting with the numerous customers of the E.P.S. Company interested in this particular branch of its manufactures.

——— We are informed that Mr. Wm. I. Taylor, M.I. Mech. E., of 50, Fenchurch-street, London, E.C., has been appointed successor to the late Mr. Archibald Thompson to represent the Darlington Forge (Limited) for London and the south of England for all work of their manufacture, excepting railway work. Mr. Taylor has represented Messrs. Clarke, Chapman and Co. for the past 15 years, a position which he still holds.

——— Mr. Geo. Stegman notifies his removal to larger premises at 45, St. John's-hill, Clapham Junction, London, S.W.

——— Messrs. Henderson, Bunn and Co. (Limited) ask us to state that they are placing upon the market an insulated iron-armoured conduit for electric wires, the insulation being porcelain enamel. The same firm have also a new dry battery constructed "upon an entirely new principle."

——— We are informed that the jurors of the recent Brussels Exhibition have awarded a special prize of 1,000 francs to Geipel's patent steam trap, "in recognition of its exceptional merits." This is in addition to a gold medal obtained for this exhibit.

Bankruptcies.—A receiving order has been made against Messrs. Trehearne, Son and Crump, electrical engineers, 155, Fenchurch-street, London, E.C.

——— A petition has been presented for the discharge of William Gray, jun., electrical engineer and ironmonger, formerly trading as the Scottish Electrical Engineering Company and as Gray and Son, 53, Frederick-street, Edinburgh.

Inland Telegrams.—Some important modifications of the rules in regard to the counting of compound words in inland telegrams have been issued by the Postmaster-General, and speaking broadly, compound words will now be allowed to pass as one word so long as they are not written as two words, as in the case of "twenty-five" or "twentyfive." It is stated to be the desire of the Department that all expressions which by the usage of the language are written as single words with or without hyphens are to be accepted as single words in these telegrams, whether they appear in a dictionary or not, and in all cases the benefit of any reasonable doubt is to be given to the sender of the telegram.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 23 to March 1, with the ports of destination :—

Argentina—Buenos Ayres, £647 (including £127 telegraph material). *Australasia*—Adelaide, £23 ; Auckland, £2,758 ; Lyttelton, £2,897 ; Melbourne, £168 (including £25 telegraph material) ; Sydney, £1,726 ; Wellington, £112. *Belgium*—Antwerp, £229 ; Ostend, £75. *Ceylon*—Colombo, £100. *China*—Shanghai, £7 ; Tientsin, £31. *Egypt*—Alexandria, £77. *France*—Boulogne, £89. *Gibraltar*, £277. *Holland*—Amsterdam, £23 ; Flushing, £25. *India*—Bombay, £433 ; Calcutta, £84 ; Madras, £10. *Japan*—Yokohama, £488. *Malta*, £72. *Mauritius*, £42. *Russia*—Novorossisk, £27 ; Reval, £62. *Siam*—Bangkok, £477. *South Africa*—Cape Town, £1,250 ; Delagoa Bay, £1,076 (telegraph material) ; Durban, £205 ; Port Elizabeth, £135. *Spain*—Passages, £29. *Straits Settlements*—Singapore, £44. *Sweden*—Gothenburg, £723. *Turkey*—Constantinople, £230. Total £14,108, against £14,649 in the corresponding week last year (Feb. 24 to March 2).

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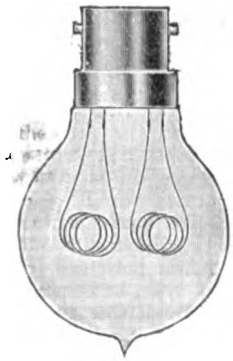
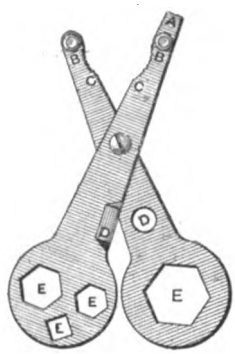
High-Voltage Lamps.—We illustrate below the latest form of high-voltage incandescent lamp, manufactured by Messrs. E. Goossens, Pope and Co. The illustration is half size of the actual lamp, and it will be seen that the double filament is arranged so that if the lamp is required to be used horizontally, there is no danger of the filaments touching the sides of the bulb. This has been effected by a careful stiffening of the filaments, obviating the necessity for any support to keep the filaments in position. We have previously referred to the Pope lamps in our issues for May 17, 1885, and October 16, 1896, and the makers are now to be congratulated upon the issue of an improved lamp, for which a large demand should ensue. Previous mention has in particular been made of the special type of fittings for these lamps. Plaster is entirely done away with, and an effective air-insulation is provided



in the interior of the cap. This is claimed to render the lamp damp-proof, and consequently specially suited for outdoor work and for use in exposed positions and on board ship, in collieries, and other places where damp seriously affects the life of the lamp. The features enumerated are reasonably claimed to make these lamps particularly suitable for high voltages, and in a complete catalogue just issued the Company announce that they guarantee "the average life of ordinary lamps (3½ watts) to be 1,000 hours if burned at normal voltage, and that the candle-power at the end of that time shall not decline more than from 10 to 15 per cent."

A New "Adjuster."—The New Fowler Lancaster Company have recently introduced the Lancaster adjuster, which serves as a useful wrench. It was originally intended for cycle work, but has been found serviceable to wiremen in jointing, &c. It acts as a powerful screw driver, suitable for connecting lamp holders, ceiling



roses, &c.; while the spanner sections, as shown in the illustration, will fit all the usual size nuts. A is the screwdriver, B are pegs for cycle discs, &c.; C is a milled edge, useful for various purposes; E serves as a spanner for the usual standard sizes of nuts and bolts. The whole closes up and can be carried in the waistcoat pocket.

Cassier's Magazine.—The contents of the March number of this magazine include articles on "Liquid Fuel for Locomotives," "The Building of a Ship," "Can Coke be used as a Smokeless Fuel," "The Danger of Tall Steel Structures," "The American Naval Officer of the Future," "Fortunes in Nuggets of Gold," "The Magnetic Concentration of Ores," and "The Central Operation of Distant Devices."

"London Directory."—We are in receipt of a copy of the "London Directory" (Firms and Trades) for 1898, published by the London Directory Company, 25, Abchurch-lane, E.C. This is the sixth annual edition of a very useful book of reference, and is claimed to form "the most complete commercial directory of greater London ever placed before the public." The book contains lists of manufacturers, wholesale and retail trades and mercantile professions, throughout London and suburbs. Traders and others will find the "London Directory" of Firms and Trades a useful compilation. The published price is 20s.

"Willing's Press Guide."—The twenty-fifth annual issue of this, the handiest of all the lists of British and Irish papers which reach us, is now to hand, and seems as complete and reliable as ever. Many much more pretentious publications dealing with this branch of business can be obtained, but the majority of those having occasion to refer to such a compilation will find the 1s. edition of "Willing's British and Irish Press Guide" serve their purpose.

Aberdeen.—At the meeting of the City Council last week the accounts of the electricity department, which were set out in our issue of Feb. 25, were discussed and passed. It was decided to modify the price of current for motive power purposes, and in future the charge will be 6d. per unit for the first hour, and 1½d. afterwards, instead of a uniform rate of 3d. per unit as at present.

An Electric Floor Scrubber.—An American firm is putting a new labour-saving appliance on the market for scrubbing the floors of large buildings by means of motor-driven brushes. The frame carries three scrubbing brushes, which are pressed against the floor by a spring. The brushes are geared with the motor so as to revolve at a speed of about 400 revolutions per minute. The gearing between the motor and the brushes is by means of a sprocket chain, leading from the motor to the axle, on which the larger wheels loosely revolve, and from that axle by another sprocket chain to a shaft connected by bevel gears with vertical shafts, to which the brushes are attached. This permits of the machine being used as a hand machine in case no electric current is available. For the scrubbing brushes, sandpaper blocks or blocks of stone may be substituted, and thus the machine may be used to dress down wood floors or mosaic. A suitable governing device is provided on the handle. The machine weighs about 300lb., and its frame is about 30in. square. The three brushes are so arranged that the short axis of the middle one is always parallel to the longer axis of the side brushes, and *vice versâ*. Thus the machine scrubs a path as wide as the distance between the outer ends of the side brushes when they stand end to end. The current is led to the machine by a flexible cord, a reel being fixed on a short pole to one side of the machine to take up the slack. The machine is said to have been in actual use and to have given satisfaction.

Bangor.—Col. Durnford, R.E., held a Local Government Board inquiry last week into the application by the Town Council to borrow £450 for the purchase of land for a site for the electric lighting station. The application was supported by the Chairman of the Electric Lighting Committee, Dr. Grey Edwards.

Barnes.—On the 21st ult., the District Council sent out cards to the principal ratepayers in order to ascertain the support likely to be given to the proposed electric lighting scheme, and within five days of the issue of the cards applications for the equivalent of nearly 5,000 16 c.p. lamps were received. The Council are at present applying for a Provisional Order.

Bath.—The delay which has arisen in the progress towards completion of the electricity supply works is causing some anxiety as to whether the station will be in full working order for next winter's supply. Mr. Metzger, the borough electrical engineer, anticipates that about four months will elapse before the engines and boilers can be fixed. Mr. Robert Hammond, consulting engineer to the Corporation, informed the Council this week that for the boilers and accessories had long been ready delivery, and that the engine-house plant had been completed for months—that, in fact, the bulk of the engines were stored in the city. All the remaining machinery was ready for the foundations. Mr. Hammond expresses no doubt that the station will be ready in time for the winter's operations.

Beckenham.—The Electric Lighting Committee are to report upon the probable demands for electric current throughout the district. The Council some time ago decided to introduce electric light.

Belize (Honduras).—Some time ago this municipality advertised for an electric lighting plant, but it appears the scheme was disapproved of by the Secretary for the Colonies, and consequently the matter has been laid aside for the present.

Bradford.—The question of reducing the price of electric current is under the consideration of a sub-committee of the Corporation.

Brewery Lighting.—The Candleriggs Brewery of Messrs. George Younger and Son has been supplied with an extensive electric lighting installation, the yard, offices, storage cellars, brewing premises, &c., having been wired. The consulting engineers were Messrs. Burstall and Monkhouse, of Old Queen-street, London, S.W., and the contractors for the plant Messrs. Lowdon Bros., of Dundee, the engines being supplied by Messrs. Morton, of Errol.

Bridlington Quay.—The District Council have informed a Company who applied for sanction to an application for a Provisional Order that the Council intend to retain the electric lighting powers in their own possession.

Bristol.—At a recent meeting of the Sanitary Committee the city electrical engineer (Mr. H. Faraday Proctor) submitted a

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lengthy report on the tramway question, in which particulars of the tramways in other cities and towns in the kingdom are given. Certain conditions were suggested upon which an agreement might be come to with the Tramways Company. The Company's reply to Mr. Faraday Proctor's report has now been issued, and, although certain of the conditions are acquiesced in, the principal points of difference between the parties still remain to be settled.

Bromley.—The arrangements for the transfer of the Provisional Order to the Bromley Electric Lighting Company are practically completed, and it is probable that the formal sanction of the Council to the transfer will be given at the next meeting. The Company has a nominal capital of £20,000, and about £8,600 has already been taken up. The same Company will supply electric current at Chislehurst.

Cable between Vancouver and Victoria.—The Canadian Pacific Railway's Telegraph Company has decided to lay a second sub-aqueous cable from Vancouver to Victoria. This step has been taken in consequence of the rapid development of the western division of the country. The new cable is 45 miles in length, and of the latest type. The cable was placed on board the C.P.R. steamship "Tartar," which sailed from Southampton on the 5th ult. for Vancouver.

Camberwell (London).—At its last meeting the Vestry considered a report from the General Purposes Committee, recommending that notice be given to the County of London and Brush Provincial Company, requiring them to sell their undertaking to the Vestry. The terms to be £133 for every sum of £100 properly expended by the Company, and 5 per cent. per annum dividend. The proposal led to a very lively debate, and an amendment to refer the matter back was carried. A special meeting of the Vestry is to be called to further ventilate the question.

Cape Town.—Mr. A. P. Trotter has recently prepared a report for the Municipal Council on the subject of the electric lighting of Woodstock, a suburb of Cape Town. Mr. Trotter reports that it would not pay to put down electric plant for street lighting only, and that the question resolves itself into one of electric supply for the district. On the subject of an offer before the Council to provide incandescent gas lamps at £4. 10s. per lamp per annum, Mr. Trotter advises that if any such contract is entered into by the Municipality it should be strictly defined in the terms of actual candle-power. This is necessary because the candle-power of all incandescent gas burners falls off very quickly—25 per cent. at the end of 150 hours and 50 per cent. in from 450 to 500 hours is Mr. Trotter's figure; and he points out that agents for the sale of these burners are as a rule quite unaware of this weakness. The numerous defects which the mantles of incandescent gas burners promptly display when put into actual use are set out by Mr. Trotter, who points out that, notwithstanding, by means of a carefully prepared contract incandescent gas lighting might probably be found the cheapest way to light the streets of a small suburb. Mr. Trotter presents comparative figures of electrical supply in England, dealing mainly with the smaller companies and districts, and expresses his difficulty in understanding why the cost of electric lighting is so high in Cape Town and the southern suburbs. He recommends small arcs for the public lighting, of from 140 to 200 c.p., and concludes by advising the Council to have no apprehension about the plant becoming obsolete in a few years, or of suffering from new and untried inventions, if they place themselves in the hands of a competent consulting engineer to act in their interest.

Central London Railway.—The following particulars of the electrical working of this railway will be of interest:—The total length of continuous railway over which electric traction is to be provided on this line is about six and a-half miles, exclusive of cross-overs at stations and sidings. It is intended to run a two and a-half minutes' service with trains of seven carriages each, with a total seating capacity each of 336 passengers, and weighing 105 tons loaded, exclusive of the locomotive. The average speed of the trains is to be 14 miles per hour, including stoppages at stations. The electric plant, to be installed by the British Thomson-Houston Company, is on the three-phase system, and has been designed by their Consulting Engineer, Mr. H. F. Parshall. There are to be three sub-stations in the lower portion of the lift shafts at the Davies-street, Notting Hill-gate, and Post Office stations. The additional plant to be installed at the Marble Arch station will, at present, be in the nature of spare plant. The boiler plant will consist of 16 Babcock-Wilcox boilers, in 8 batteries of two each. The evaporative power of each boiler is to be 12,000lb. per hour, the heating surface 3,580 square ft., and the pressure 140lb. per square in. The boilers are to be fitted with mechanical stokers, supplied with coal by a conveyer from a storage tank on the top of the boiler house, having a capacity of 1,500 tons. The coal conveyer also serves to remove the ashes, and will be driven by electric motor. Each engine is supplied with an independent combined jet condenser and air-pump of sufficient capacity to take the maximum quantity of steam. The condensing and injection motor will be forced to the top of four cooling towers, each tower being furnished with two fans driven by electric motors. The engines are six Reynolds-Corliss cross-compound condensing engines, running at 94 revolutions per minute, to give 1,300 I.H.P. each, with cylinders 24in. and 46in. diameter and 48in. stroke. These engines can be run non-condensing, and either high or low-pressure side can be run independently. The steel flywheel is to weigh 100,000lb., and is built up in eight segments. The three-phase generators will have 32 poles, a capacity of 850 kilowatts 500 volts and 25 cycles, and are of the revolving field type, the coils of the stationary armatures being held in slots, and ventilating ducts are provided through the body of the armature similar to the standard armature construction of the British Thomson-Houston Company. The total weight of each generator is 80,000lb. Four of the six units will be sufficient for the average load, leaving a margin of 50 per cent. over the present requirements of the plant. The switchboards have been specially designed, the high-tension switches being double brake, half of the brake on each side of the panel.

The Notting Hill-gate and Davies-street sub-stations will contain one rotary converter in each station, with necessary transformers and switchboards. At the Marble Arch and Post Office sub-stations there will be two rotaries in each, each with a capacity of 900 kilowatts. These rotaries are of the 12-pole type, running at 250 revolutions per minute, and are capable of being run up either from the three-phase or the direct-current side. Step-down transformers will reduce the line potential from 5,000 to 330 volts. They are of the air-blast type, but instead of following the usual plan of forcing the air through the transformers the air is drawn through, and the hot air is expelled through sheet-steel pipes running up the centre of the spiral staircase of the stations, thus providing ample ventilation for the sub-stations as well as effectively cooling the transformers. The weight of each transformer will be 8,000lb.

The cables connecting the power house with the sub-stations will be carried through the tunnels on brackets, and are of the British Insulated Wire Company's standard paper insulation type. The third rail will be of steel, weighing 80lb. to the yard of channel section, supported on creasoted wood insulators, each joint being bonded with four flexible crown bonds. The rails of both up and down lines will be divided into four sections, and interconnected by circuit breakers. The locomotives will be mounted on two trucks, each truck carrying two motors of 150 H.P. The total weight of the locomotive is about 42 tons; total length, 29ft.; total height, 9ft. 8in. The motor will be controlled by series-parallel controllers, provided with magnetic blow-out, which will place the four motors in series, two in series, and two in parallel, or all four in parallel, as desired. The trains will be fitted throughout with Westinghouse air brakes. Lifts will be provided at each station, and it is proposed that these should be operated electrically, with current taken from a separate power wire.

Coventry.—During the past twelve months the number of customers of the electricity department increased from 72 to 100, and the equivalent number of 8-c.p. lamps connected, from 5,662 to 8,149. The revenue from the sale of current and meter rentals increased from £1,245. 16s. 6d. to £1,958. 19s. 8d. The profit on working is £106. 2s. 8½d., against a loss last year of £41. 0s. 8d. Interest on capital amounted to £860. 1s. 4d., on temporary loans £27. 2s. 4d., and payment to Stock Redemption Fund £777. 7s., a total of £1,664. 10s. 8d. The total deficiency, after meeting all charges, is £1,558. 7s. 11½d. against £1,706. 13s. 8d. last year. The accounts were presented and adopted at the meeting of the City Council on Tuesday.

Croydon.—The County Council have received the sanction of the Local Government Board to the borrowing of £5,000 for electric lighting extensions. The south end is to be lighted by 15 arcs. Various minor extensions of the electric light mains were also sanctioned at the last meeting of the Council.

Durham.—The Town Council have received a communication from Edmundsons' Electricity Corporation to the effect that there are difficulties in the way of utilising the water power belonging to the Dean and Chapter in the generation of electric current, and inquiring whether the Council would consent to the erection of a steam-driven plant. The Durham Gas Company intimate their readiness to put down an electric lighting plant if the Council will give sanction to their application for a Provisional Order. The Gas Lighting Committee have the matter in hand.

Forthcoming Books.—Messrs. Whittaker and Co. announce that they will be publishing shortly a translation from the French of "Alternate Currents in Practice," the translation being by Mr. F. J. Moffett; "Electrolytic Methods of Analysis," translated from the German by Mr. J. B. C. Kershaw; a book on "Radiography," by S. Bottone; and a "Popular Guide to Commercial Telephony," by M. Byng and F. G. Bell.

Gloucester.—We give elsewhere the full list of tenders recently invited for the supply of plant and machinery for the municipal

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electricity works about to be constructed by the Corporation. These tenders were discussed by the Council, and all but that for public lamps were awarded, the latter being referred back for further particulars. A site has been selected on the Bearland estate at a cost of between £7,000 and £8,000.

Glossop.—Councillor Whelan has notified that he will bring forward the question of the erection of municipal electricity works at the next meeting of the Town Council.

Greenock.—Mr. Francis Teague has presented his report on the electric lighting question, and this is being prepared for circulation amongst members. It recommends the Police Board to retain the electric lighting powers in its own hands. The initial cost of an electric light installation is put at £25,000.

Hanley.—The report of the electricity department for the third complete year's working is issued. The various loans sanctioned amount to £60,990 and the capital expenditure to date is £51,634. 8s. 2d., the amount expended during the year being £7,491. 5s. 8d. The working expenses were £4,000, and the receipts, £6,520. 1s. 7d., leaving a gross profit of £2,519. 13s. 11d., representing 4·88 per cent. on the capital expended. After meeting all charges, including interest, sinking fund, &c., the deficiency was £188. 11s. During the year the price of current was reduced, and additional customers were connected to the mains.

Hull.—The price of current for motive power purposes has been reduced from 4d. to 2½d. per unit as from the 31st inst.

Kingston-on-Thames.—Mr. J. E. Edgcome, borough electrical engineer, has presented his report for the year ended Dec. 31, which forms the fourth annual report of the working of the Corporation electricity undertaking. The total revenue for the year is £3,929, against £3,013 for 1896 and £2,442 for 1895. The credit balance is £868, compared with £301 for 1896. This sum is sufficient to pay interest charges and leave a balance of £44 towards the repayment of loans. Extensions of the electricity works buildings are being proceeded with, and foundations have been put down for a new steam alternator and three additional boilers. The work of putting in the new generating plant is proceeding satisfactorily, and additional mains have been laid during the year to meet the increasing demand for current in different parts of the borough. Further extensions of mains are in hand. There has been an addition to the number of consumers of 34, bringing the total up to 163. The number of additional lamps connected is 2,375, making a total of 9,250 8 c.p. The total units supplied were 194,268, against 155,681 for 1896.

Lectures.—Dr. J. A. Fleming delivered at the Storey Institute, Lancaster, last week, an instructive lecture on "Electrical Invention during the Victorian Era." The lecturer, as usual, kept his hearers' complete attention during the whole lecture, and was heartily applauded at its conclusion.

Prof. S. P. Thompson delivered a presidential address to the Wolverhampton Literary and Scientific Society last week, on the "Coming of the Electric Horse." At the conclusion of the lecture, which proved most interesting and instructive, Prof. Thompson expressed the opinion that the horseless carriage would shortly revolutionise our mode of travelling. A cordial vote of thanks was accorded the lecturer.

Mr. W. B. Hird, B.A., lectured at Glasgow, last week on "Electric Transmission of Power," to the Technical College Scientific Society. The lecturer was assisted by a large number of lantern slides, showing types of electric generating plant, electric locomotives, motors, &c.

Before the Gloucestershire Engineering Society, Mr. Hamilton Kilgour delivered a lecture, last week, at the Gloucester Guildhall, entitled "Notes on Electric Lighting and Electric Works." The fifty members of the Society present were entertained with a comprehensive review of the progress of electrical science and engineering during the present century, and Mr. Kilgour was accorded a vote of thanks for his entertaining lecture.

Mr. Mervyn O'Gorman will deliver a lecture on "Trade Unions and Factory Management," to the Brixton Literary Society, in the Lecture Hall of the Brixton Independent Church, London, S.W., on March 9, at 8 p.m.

Leeds.—The Parliamentary Committee recommend the City Council to make a definite offer to the Yorkshire House-to-House Electricity Company for the purchase of their undertaking.

Lewisham (London).—The Works Committee have reported upon the proposals of the Great Western Electric Light and Power Company for the erection of electricity supply and refuse-destructor works in the district. The Committee, which comprised the whole of the members of the District Board of Works, decided to report against granting the Company's application, and this attitude has now been formally approved by the Board.

Light Railway Schemes—On Thursday last the Light Railway Commissioners (the Earl of Jersey, Mr. FitzGerald, and Colonel Boughey) held an inquiry into the applications of the Bournemouth, Poole, and District Light Railways (Electric) Company and of the British Electric Traction Company for powers to construct electric tramways between Christchurch and Poole, running through Bournemouth. Mr. E. F. Vesey Knox, M.P., for the Bournemouth and Poole Company gave a general description of the project, which included the construction of branch lines radiating from the centre of Bournemouth to Poole, Constitution-hill, Winton, Springbourne, Pokesdown, and Southbourne. Mr. J. E. Waller, M.I.C.E. (Kincaid, Waller and Manville) said he had gone fully into the scheme, and gave his reasons for considering the project a practical one and in the public interest. It was proposed to work all the lines by electric traction. Mr. W. M. Murphy gave a list of the various undertakings he had promoted, and said that in Dublin the opposition was somewhat similar to that of Bournemouth, where they objected to the line coming to the centre of the town, but that opposition had died away when the town had seen what the system was like as adopted in the suburbs. Mr. Balfour Browne appeared for the British Electric Traction Company, whose scheme consisted of one line from Christchurch to Poole, and a branch to Winton by the East Station. Mr. G. Marshall, Mayor of Christchurch, said his Council had passed a resolution in favour of electric railways. He preferred a tramway that went direct from Christchurch to Poole. Other witnesses gave evidence in favour of this scheme, and Mr. S. Sellon gave technical details and Mr. E. Garcke submitted figures as to the financial condition of the promoting Company. The inquiry was adjourned until Friday, when evidence on behalf of the Bournemouth Town Council against the applications was given. Eventually the Commissioners intimated that they were not prepared to overrule the decision of the borough of Bournemouth, or to grant powers for any mutilated scheme.

The Parliamentary Committee presented at Wednesday's meeting of the Leeds City Council a recommendation that the terms of the promoters of the Leeds and Bradford Light Railway be not accepted, and that the previous resolution of the Committee to oppose the scheme be confirmed. The matter caused much discussion, but ultimately the minutes were approved.

Lincoln.—The Electric Lighting Committee expect to supply current by October.

Liverpool.—At the City Council on Tuesday, Sir Arthur Forwood moved that Mr. Arthur Bromley Holmes be appointed electrical engineer-in-chief for both the electric lighting and tramway departments of the Corporation, on condition that he gave up private practice, and that his salary be increased from £400 to £1,000 per annum, the increase being in lieu of private practice.

The Tramways Committee on Friday discussed the scheme prepared by the city electrical engineer (Mr. A. B. Holmes) for the erection and equipment of two new generating stations to supply current for lighting, traction and power purposes. The Lighting and Tramways committees, who have both considered the matter, recommend that the existing lighting stations remain under the control of the Lighting Committee, and that the power stations to be hereafter provided be managed by a special committee, to include eight members of the Lighting and eight members of the Tramways Committees, and that the erection of the additional generating stations be considered by the joint Special Committee.

Llandudno.—Mr. A. H. Preece, consulting engineer to the Council, has been requested to report upon the cost of the extension of the electric light mains to the Craigside Hydro. The Pier Company have also offered to take current on special terms.

Londonderry.—The Corporation have received an offer from an electric lighting company to take over the municipal electricity undertaking at its present value. The company would undertake to supply current for public and private lighting. On the reading of this communication at the last meeting of the Council, it was decided to mark it "read," and it was resolved to send a deputation to English towns where current is supplied for public and private lighting. The sub-committee which was recently appointed to deal with this matter has presented a report in which it is urged that a properly-designed and well equipped station at a cost of from £25,000 to £30,000 would in all probability prove a success, and current for private lighting could be supplied at a figure which would compare favourably with the present charge for gas.

Manchester.—The City Council decided, on Wednesday, to promote a Bill next Session to enable the Council, and any neighbouring local authorities, to make arrangements for working their tramways in conjunction with those of the City.

Metropolitan Asylums Board.—At the last meeting of the Board a letter was received from the Local Government Board approving of the contract with Messrs. Crompton and Co. for the supply of two dynamos for the "Exmouth" training ship, at a cost of £105. Messrs. Burstall and Monkhouse, of Old Queen-street, Westminster, were appointed consulting engineers for the installation of the electric light at the Northern Hospital.

Muirhead's Rolled Steel Railway Chairs.—The Liverpool Overhead Railway Company are laying down Muirhead's steel railway chairs, in view of increased speed and heavier cars. This is the first electric railway to make use of these chairs.

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Newcastle-on-Tyne.—The question of the purchase of the local electric light undertakings was raised at Wednesday's meeting of the Town Council. Councillor Cairns wished to know whether, in view of the report that the works of the Newcastle-on-Tyne Electric Supply Company at Pandon Dene were in the near future to be removed and reinstated elsewhere by the North-Eastern Railway Company, any endeavour had been made to ascertain upon what terms the Company would be prepared to dispose of their undertaking, as the new station could then be placed where most convenient for the Corporation. In reply, Mr. Smith, the Chairman of the Electric Lighting Committee, said the Committee had not lost sight of the matter, and as soon as the Railway Company's Bill passed through Parliament they would approach the Electrical Company on the subject.

Owen's College, Manchester.—It is announced that anonymous donations of £10,000 and £5,000 have been given to this College for the erection and maintenance of a new physical laboratory.

Pier Lighting.—The Herne Bay Pier Company has recently been inviting applications for capital with which to construct various works, including an electric tramway on the pier. The Company also intend to light the pier electrically.

Presentation.—On Monday last, Mr. T. W. Vaughan, managing director of Vaughan and Brown (Limited), was the recipient of a gold watch and an illuminated address on the occasion of his fiftieth birthday. Mr. Vaughan referred to the excellent relations which existed between the firm and their employés, some of whom had been with them from 20 to 35 years.

Private Bill Legislation.—Owing to non-compliance with the standing orders, the London County Council (Northern Tramways) Bill and the Blackpool and Fleetwood Tramroad (Tramway Extensions) Bill have been dropped.

Railway Station Lighting.—The Carlisle Citadel Station Joint Committee have decided to light the station electrically. Current will be supplied by an independent generating station erected on the premises. The necessary plant has already been ordered, and the London and North-Western Company's electrical department will start work in the erection of the machinery at once.

Reduced Charges for Current in the City of London.—The City of London Electric Lighting Company give notice of a considerable modification in the charges for electric current for lighting and power purposes, to come into effect from Jan. 1st last. For lighting, the scale is from 7d. to 4d. per unit, according to consumption; and for power, heating and cooking purposes (measured by separate meter) 4d. to 3d. per unit. In order to qualify for the latter charge, the consumer is required to give a guarantee in writing that motors or other apparatus will be in use for not less than 45 hours per week.

Saltburn.—The Cleveland and South Durham Assets Company have submitted a proposal to the Urban District Council for the erection of a generating station for the supply of electric current for private lighting in the district. It is proposed to put down a gas engine plant, and Mr. T. P. Osborn Yale is the consulting engineer. The scheme will be discussed at a special meeting of the Council.

Shanklin.—Proposals for the erection of electricity supply works have been submitted to the District Council by an electrical engineer.

Stockport.—At Wednesday's meeting of the Town Council, Mr. Webb, Chairman of the Electric Lighting Committee, announced that contracts had been let for certain parts of the electric lighting installation. It is anticipated that current will be available by September.

St. George's, Southwark (London).—The Vestry have decided, on the recommendation of the Electric Lighting and Dust Disposal Committee, to apply to the Board of Trade for a Provisional Order. The Vestry proposes to lay down electric lighting plant as soon as the Order is obtained.

Sunderland.—The Borough electrical engineer (Mr. J. F. C. Snell) has presented an important report to the Lighting Committee on the extension of the electricity supply undertaking. The report states that the demand for electric current is increasing so rapidly that further extensions are immediately necessary. In order to meet the requirements of the department up to 1901 the sum of £12,728 would be required for additional generating plant, extension of the station building, &c., and a further sum of £12,540 would be required for mains, &c. Although immediate requirements would be met by an expenditure of £7,800, Mr. Snell recommends that application be made to the Local Government Board for sanction to borrow not less than £25,000. With this sum it is thought that all districts in the Borough can be brought within the area of supply. The estimated profits for the first year are £105; second, £670; in 1901, £1,370. A special meeting of the Committee will be held to consider the matter.

Swansea.—The Electric Lighting Sub-Committee had a conference with the consulting electrical engineer (Mr. E. Manville) on Saturday with regard to the proposal to erect electricity supply and refuse-destructor works. After a lengthy discussion, it was decided to proceed with the joint project, and Mr. Manville expressed an opinion in favour of a low-tension scheme, but a fresh report upon the whole matter will be prepared by him and submitted at an early date.

Telephone Extensions in France.—A Dalziel telegram announces that telephonic communication was opened on the 25th ult. between Paris and several towns in the South-west of France, including Dax, Pau, Bayonne, Biarritz, and St. Jean de Lux.

Train Lighting.—The East and West Junction Railway Company have recently introduced the electric light in their carriages. The work has been carried out by Messrs. Eccles, of Stratford-upon-Avon.

Ventnor.—The District Council have passed the plans of the proposed electricity supply works, and the streets to be lighted electrically were selected at the last meeting. The works are being erected by the Ventnor Electric Light Company.

Wakefield.—Last week the new municipal buildings for the West Riding County Council were opened. The buildings have been erected under the direction of Messrs. Gibson and Russell, of Gray's Inn-square, London, at a cost of nearly £130,000. Mr. T. H. Churton, of Leeds, has put down an electric lighting installation for about 1,100 lights, the fittings for which have been specially designed by the architects, and are all of a highly artistic character. The buildings are furnished throughout with a complete telephonic installation, with five exchanges, all on the twin-wire system. This part of the work was carried out by the Private Wire and Telephone Installation Company, of London, the electrical work throughout the buildings having been under the direction of Mr. Sidney à Court, of London.

Waterloo (Liverpool).—The District Council have arranged with the Liverpool District Lighting Company for the supply and erection of 12 arc lamps in the South-road at £216. It is probable that further extension of electric street lighting will shortly be decided upon.

Whitehaven.—Property adjoining the electricity works has been purchased for station building extensions.

Worcester.—The accounts of the electricity department for the year 1897 show receipts of £4,682 from private lighting, against £3,767 in 1896, £1,265 from street lighting against £712, and meter rental, &c., £344, making a total of £6,291. The deficiency, after allowing for sinking fund, interest, &c., amounts to £1,474, against £1,616 in 1896. The capital expenditure amounts to £67,293, of which £6,575 was expended during the past year. The number of units generated was 559,275, of which 83,700 were supplied for public lighting and 325,130 to private consumers, and 5,155 were used at the works. The equivalent number of 8 c.p. lamps connected has increased from 21,958 to 24,712.

Workhouse Lighting.—The architect (Mr. Knightley) has submitted his report upon the electric lighting of Edmonton Workhouse, and the Committee to whom the matter was referred recommend that effect be given to the report, as a considerable saving (£100 a year) will be effected in the charge for lighting. The present cost of gas lighting is £500 a year. The Committee were authorised to obtain plans and estimates for the work, with power to consult an electrical engineer.

The Exeter Board of Guardians have received terms from the City Council for the supply of electric current for lighting the workhouse. The House Committee is considering the offer.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specifications accompanies application an aster isk is suffixed.*

January 17, 1898.

1,258. F. W. HEATON and H. SMITH. Salford. An improved cord grip ceiling rose for electrical work.

1,290. H. WOLFF and W. BRASE. London. Means for augmenting lifting-power by electricity.*

1,294. F. J. CLENDINNEN and G. A. P. WEYMOUTH. London. An improved coin operated telephone instrument for public call.*

1,301. F. B. HERZOG. London. Electric signalling apparatus.*

January 18, 1898.

1,379. P. M. JUSTICE. London. Improvements in electrical insulating conduits, and in the method of and apparatus for making same (The Lithosite Manufacturing Company, United States.)*

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1,380. F. A. JOHNSON. London. Improvements in the regulation of dynamo-electric machines and motors.*
1,391. E. PECKHAM. Glasgow. Improvements in electromagnetic brakes for cars.*
1,416. S. PRICE, W. P. PHILLIPS and R. H. WEINY. London. Improvements in telegraphic transmitters.*

January 19, 1898.

1,464. W. MCGEOCH. Glasgow. Improvements in and relating to holders for incandescent electric lamps.
1,465. J. BUCHANAN, JUN. Glasgow. Improvements in and relating to moulds for shaping glass globes for gas or electric lights or like articles.
1,489. H. W. COX and C. M. TAYLOR. Nottingham. An automatic interchangeable electric and mechanical advertiser.
1,493. H. L. BUTLER. London. A new or improved system comprising a method of, and means for, making connection between an underground conductor and vehicle motor, such as a tramcar or the like.*
1,511. J. G. DIXON. London. Improvements in terminal fuses.
1,535. C. A. RITTER VON WELSBACH. London. Improvements in incandescence electric lamps and processes for the production thereof.

January 20, 1898.

1,557. A. S. SCULL. Bristol. Improved clockwork-operated mechanism for switching electrical current.
1,564. H. WHIDBOURNE. Plymouth. Electric-striking mechanism for clocks and the like.
1,628. W. A. CROWDUS. London. Improvements in and relating to secondary batteries.

January 21, 1898.

1,678. F. O. PRINCE. London. Improvements in and connected with dynamos and electric motors.
1,686. W. A. CROWDUS. London. Improvements in secondary batteries and in means for combining electric lamps therewith.
1,687. S. P. THOMPSON. London. Improvements in electric signalling apparatus.
1,691. J. G. DIXON. London. Improvements in electric switches.
1,697. M. HAAS. London. Apparatus for the electrolytic treatment of bleaching liquids.*
1,702. M. REYNARD. London. Improvements in electric batteries.
1,706. R. PEARSON. London. Code telegraphing and circuit-testing apparatus for fire alarms and other purposes.
1,715. W. I. DOUGLAS. London. Improved device for locking electric lamps.

January 22, 1898.

1,735. A. G. ADAMSON, T. W. ALLAN and ALLAN AND ADAMSON (LIMITED). Glasgow. Improvements in electrical accumulators or storage batteries.
1,742. C. MCCALLUM. Glasgow. Improvements in and relating to electromagnetic engines or motors.
1,787. P. U. ASKHAM and R. HERD. Sheffield. Improvements in tools and appliances for bonding the rails of electrical railways, tramways and the like.
1,803. L. B. CODD and J. A. CODD. London. Improvements in and relating to electric arc lamps.
1,809. E. A. CLAREMONT. Manchester. Automatic time switch.
1,826. H. B. CUTTER. London. Improvements in rheostats.*
1,828. J. WALTER. London. Improvements relating to the transmission of drawings, handwriting and the like by telegraph and telephone.

January 24, 1898.

1,833. J. EDMONDSON. Halifax. Improvements in the brakes of electric arc lamps.
1,855. A. GRAY. Dumbarton. An improved telegraph cable grip.
1,869. E. RENAULT. London. Improvements in insulators.*
1,872. W. O. SMITH. London. Curve tracer of electrical measurements. (E. Ross, United States.)*
1,880. F. JONES. London. Improvements in electric pendulum indicators.
1,912. J. D. F. ANDREWS. London. Improvements in telephones.
1,921. J. EXNER and C. KRAFT. London. Improvements in telephones.*
1,923. J. S. LEWIS and F. J. HOWITT. London. Improvements in dynamo electric machinery.

January 25, 1898.

1,970. J. G. DIXON. London. An improved electric switch or contact-maker.
1,994. L. A. FERGUSON. London. Improvements in safety fuses for electrical conductors.*
2,007. E. WILSON and C. J. EVANS. London. Improvements in or relating to transmitting electrical impulses and signals.
2,021. P. JENSEN. London. Electrical log-recording instrument for the cabin. (P. Svea, Sweden.)
2,022. M. LEVY. London. Improvements in Röntgen tubes.
2,024. C. KOENIG. London. Improvements in and relating to primary batteries.*
2,025. W. P. THOMPSON. Liverpool. Improvements in rheostats for regulating the current used in electro-plating and other processes. (The Zucker and Levett and Loeb Company, United States.)
2,030. E. GIGLIO. Liverpool. Improvements in primary batteries.

January 26, 1898.

2,039. T. B. BROWNE and J. M. JAMES. London. An improved relay-switch.
2,040. W. BLENHEIM. Egham. An electrical fire call telegraph.
2,063. A. E. TANNER. Manchester. Improvements in switches for electric light service.
2,106. J. O. GIRDLESTONE and C. F. G. THORKELIN. London. An improvement in and connected with electric arc lamps.

January 27, 1898.

2,167. J. MOORES and H. O. FARRELL. Manchester. Improvements in and connected with electric generators for cycles and other vehicles.
2,171. S. J. GODWIN. London. An electric bell piano.
2,172. C. H. STEARN. Surrey. Improvements in attachments to electric incandescence lamps.
2,215. M. CLARK and J. B. DE ATZUGARAY. London. Improvements in and connected with the generating of electricity through the motion of rolling stock and the like.

January 28, 1898.

2,266. J. MATTHEWS and T. VANN. London. Improvements relating to electro-plating.
2,284. J. R. PAYNE. London. A new application of the electric incandescent lamp.
2,292. H. PETERS. Germany. Improved insulator for telegraph wires and the like.
2,299. P. H. GUÉRIN. London. Improvements in joints between the glass globes of electric arc lamps and the supports by which they are carried.
2,308. P. C. POPE and J. F. SIMPSON. Liverpool. Improvements in electrical advertising apparatus.

January 29, 1898.

2,375. J. CAMPBELL. Edinburgh. A teletypograph for transmitting, receiving and recording messages through a telegraph wire electrically.
2,382. P. PICARD. London. Improvements in or relating to electric telegraphy.
2,389. J. V. SHERRIN. London. Improvements in secondary batteries.
2,415. H. MAXIM and W. H. GRAHAM. London. Improvements in methods or processes for electro-thermally treating materials, and particularly with reference to the manufacture of calcium carbide and apparatus therefor.
2,417. M. BOUCHET. London. Automatic electric circuit breakers. (Date applied for under Patents, &c., Act 1883, Sec. 103, July 2, 1897, being date of application in France.)
2,420. W. A. KER. London. Improved means for controlling the working of lifts, motors and other appliances operated by electric energy.
2,423. R. MULLARD. London. Improvements in the manufacture of filaments for incandescent electric lamps.
2,426. M. DERI. London. An improved method of and means for facilitating the starting of single or polyphase alternating current motors and like apparatus.*
2,427. R. WAYGOOD AND CO. (LIMITED) and P. I. UNWIN. London. Improvements in variable electric resistances or rheostats.
2,428. A. WYDTS and O. M. ROCHEFORT. London. An improved electrical transformer for currents of high potential and variable frequency.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

43. JOEL. Electric motors and apparatus for propelling cars, carriages, cycles and boats.
246. GIBBINGS. Means for adjusting electric light carbons.
265. GRIFFITH. Electrical indicating railroad signalling.
1,337. VERLEY. Electrical apparatus for the production of ozone or for other purposes.
1,430. WADE. Electrical storage batteries.
1,581. SWIFT. Electric lamp holders, wall sockets, and the like.
1,627. COOK. Apparatus for the electro-deposition of metals.
2,301. KEIM. Time meters for telephonic conversations.
2,534. BELFIELD. (Westinghouse.) Systems of electric traction.
2,558. SIEMENS BROS. AND CO., LIMITED (Siemens and Halske). Measuring apparatus for rotary phase currents.
3,113. VON BERKS and RENGER. Electrical accumulators.
3,115. SCHIMPFF. Electrically-propelled agricultural implements.
3,177. MARCHANT. Adjustable holder or rest for telephone receivers.
3,330. DAVY. Electric arc lamps.
3,594. WEST. Telephone systems for common or party telephone lines and switch devices for use therein.
4,916. HEYL. Electrical accumulators.
5,569. ABEL. (La Société Anonyme pour la transmission de la force par l'électricité). Construction of asynchronous motor for single or polyphase alternating electrical currents in combination with an auxiliary synchronous motor.
5,805. FITZ-GERALD. Improvements in and in the manufacture of elements for secondary batteries.
6,081. MCLEAN. Apparatus for electric lighting.
6,306. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske). Jacks for telephone exchanges.
6,307. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske). Pegs and their cords for telephone exchanges.
6,309. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske). Calling-off apparatus for telephone exchanges.
6,351. HALL AND CLARK. Electric incandescent lamp-holders.
6,398. HOOKHAM. Electricity meters.
9,587. EVERSHED AND VIGNOLES (LIMITED) and EVERSHED. Electric measuring instruments.
22,236. DARLING and HARRISON. Porous diaphragms for electrolytic apparatus.
29,155. JOSEPH. Electric lamp-holders.
29,726. LE ROY. Electric heating devices.

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COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

An extraordinary meeting of the shareholders of this Company was held at Winchester House, Old Broad-street, yesterday, under the presidency of the Marquis of Tweeddale, for the purpose of confirming as a special resolution the resolution passed at the extraordinary general meeting of the Company held on the 15th ult. as follows: "That the Regulations of the Company be varied by adding the following Article of Association, viz.: 85A. 'Continuing Directors may act notwithstanding any vacancy in their body.'"

The CHAIRMAN, in proposing the confirmation of the resolution, said that its object was to enable the Directors to carry on the business of the Company when the number of Directors allowed by the Articles of Association was reduced below the minimum, which was seven. If there should be only seven Directors, when one of them died of course that would be a reduction, and under the Articles of Association as they were at present the Board would not have the power to carry on the business until the vacancy was filled. That might cause great inconvenience, and he believed that the shareholders generally approved the proposed change.

Mr. J. DENISON PENDER seconded the motion, which was at once carried unanimously, and the proceedings terminated.

City of London Electric Lighting Company (Limited).

The ordinary general meeting of this Company was held on Wednesday at Winchester House, Old Broad-street, under the presidency of Sir David Salomons, Bart., Chairman of the Board.

The MANAGER AND SECRETARY (Mr. J. Cecil Bull) read the notice calling the meeting, and, after the report and accounts had been taken as read,

The CHAIRMAN said: Gentlemen, another year has gone by, and, although we find ourselves older, it is pleasant to reflect that we have not become less prosperous. You have, no doubt, all read the report, in which we recommend that a dividend of 10 per cent. shall be paid. To effect this you will find by the accounts that £5,000 has been taken from the premium fund, towards depreciation. Approximately a similar sum was so taken for the same purpose in 1896. You will find these figures in the account described under Depreciation Reserve Fund No. 1. I must point out to you that in 1896 the revenue was aided, from the fact that the allowances to customers were some £6,000 less than in 1897. There was also in 1896 a sum exceeding £5,000 added to revenue which was profit on investments; in other words, last year we paid 7 per cent., aided by this £10,000; this year we shall pay, subject to your approval, 10 per cent. without this additional £10,000. This shows that our business is improving, to say the least of it. It also proves what I have said in the past, that, after the business has reached a certain point, the revenue can be increased by a comparatively small additional outlay. The standing charges, and other matters of that kind, remain virtually the same. It is merely a question of burning a little more coal and keeping your machinery going for a longer period. In 1896 the sum of about £10,000 was taken from the Premium Fund to assist Depreciation Reserve Fund No. 2. This year it is proposed to place £20,000 from the Premium Fund to that account, and your Board consider that this course is prudent, notwithstanding the fact that the fund in question is a permissive one, in order to provide against any contingencies which may arise in the future. On referring to account No. IX., you will see from item 9, on the right-hand side, £78,750. 13s. has been invested against depreciation and reserve funds, whereas, in the same account, item No. 5 on the left-hand side, the funds stand at £88,072. 19s. 7d. In other words, there is a difference of, roughly, £10,000, and the Board has given instructions to invest another £10,000 in order that these funds shall be represented by investments. That is only a businesslike way of doing things, and I think you will agree with us that your funds should be represented by actual investments, and that it should not be simply a matter of book-keeping. I do not think that there are any more important points to which I need call your attention in the accounts beyond that it may appear curious to some of you that your freehold investments this year appear to be less than they were last year. This is accounted for, however, in a very simple manner. Some of these are freeholds transferred from the stations properties, and to investments against our depreciation and reserve funds. As a matter of fact these stations freehold investments, instead of being less, are more than in the preceding year. As I have previously stated, these freeholds, which we have so transferred, have nothing to do with our station property; they are independent freeholds, situated around our stations, but not forming part of our works. Naturally the capital expenditure in 1897 was increased beyond that shown in the 1896 accounts, and the expenses for running the concern also increased during the period under review. This is due to the continued growth of our business. Of course, it is only natural that we should have to spend more money in order to obtain a larger revenue. If any gentleman desires to obtain any further information, I shall be glad to reply to his questions at a later stage of the meeting. I am pleased to state that applications for the electric energy continue, and that the number of our customers on Feb. 23rd were 6,517, and the number of lamps applied for are 318,741, and the lamps connected to the circuits are 305.163. These facts prove better than any argument I can offer you that, not only is the electric light appreciated in the City of London, but that we have given satisfaction to our customers. As a subject of interest to those gentlemen interested in City matters, I should like to say that the whole of the 10,000 shares, numbered 90,001 to 100,000, have been subscribed. A special settlement has been granted and an official quotation has been applied for. It is with satisfaction that I can state that the great fire in Cripplegate—which was at one time a source of some anxiety to the Board, as they could not, tell, for the moment, to what extent it would affect the Company's property—entailed but a nominal loss, some £200 to £300, on the Company, and we trust that the old saying about the "ill wind" may be true in this case. We have sent round a suitable circular to the owners and tenants of the destroyed buildings, as far as we have been able to trace them, pointing out the advantages of electric light, and we trust that in the new buildings which will be erected the electric light will be used. At last the Wool Quay question is approaching a conclusion, and, as little reference has been made to this place for some time past, I will briefly put before you what has been done there. You will remember that we were practically compelled to take this site over with the Eastern Provisional Order, and that the shareholders agreed with the Directors in giving it up for use as a generating station, as it was found to be unsuitable. One of the chief reasons for abandoning it was that the bulk of the machinery would have been below Thames water-mark, which in itself might be regarded as a great risk. Then the rent was £4,000 a year, and the Board were desirous of saving the Company from the payment of so large an annual sum. After long negotiations, our secretary and manager, Mr. Cecil Bull, succeeded in finding a shipping company to become our tenants. Negotiations were entered into with the Fishmongers' Company to obtain a release from the covenant which had been entered into to build an electric light station on the land. They met us very fairly in the matter, and consequently the negotiations with the shipping company were able to be concluded. In order that the quay could be used by larger vessels, it became necessary to dredge the river where it adjoins the quay. This dredging is now practically completed, and we hope in the course of the present year to see the greater part of the buildings now being erected there, finished; so that, before long, the Company will save the rent on the one hand, and receive 5 per cent. on the outlay on the other. There should consequently be a considerable sum to assist the revenue after this year. The condensing plant is not yet completed; I suppose the engineers' strike has had something to do with the delay which has occurred, but that portion which has been finished has proved satisfactory. What appeared at one time to be almost an impossibility—viz., that of obtaining a regular and sufficient supply of Thames water in the works—in consequence of the rubbish in the river entering the suction pipes and stopping the strainers, has now been overcome, although not one of the experts on these matters whom we consulted was able to suggest a system of obtaining the water which was practical. But our engineer, Mr. Frank Bailey, with his usual inventive genius, has devised an exceedingly, I will not say simple, but ingenious apparatus, not likely to get out of order. It has now been working for nearly a year, and has completely solved the problem to which I have alluded. I think as soon as the whole of the plant is placed on a condensing basis there will be economies effected in regard to fuel and in other respects. There is also just completed at the Central Station a large fan for increasing the draught in the flues, and the experimental runs have proved a success. The addition of this fan will enable the fuel to be consumed in a more economical manner, and will enable a larger number of boilers to be erected without the necessity of erecting another chimney shaft for a considerable time to come. I think that I have now covered the general progress which has been made during the past year. Of course there are thousands of little details, with which I need not trouble you, nor would they be of any special interest. But perfection is made up of details, and it is owing to the attention bestowed by our officials on all sorts of little things that the success of the Company is due. There is one question which has been repeatedly asked, and which will no doubt be put again, and I will take this opportunity of replying to it in advance. The question is: Will the Directors give the ordinary shareholders an interim dividend instead of waiting for the dividend at the end of the year? The answer is: If the business of your Company continues to prosper in the present year, as it has done in the past, the Board sees no objection to meeting what appears to be a desire upon the part of a number of shareholders, but I would qualify this statement by pointing out that such dividend must necessarily be small, because the first half of the year is not the best half, and it would not be prudent to forestall the results of the year's working. I am now going to trespass on your patience for a short time to deal with matters outside our annual report. Their importance is by no means confined to our shareholders, and, in order that it may not be thought that I am speaking hastily or from any feeling, I take the exceptional course of reading to you the remarks I have to make. We hold contracts with the City Commissioners of Sewers—now termed the Public Health Department of the Corporation—both in regard to the public and the private lighting. Of course, as you know, the contracts are regulated by Acts of Parliament. By dint of some years of hard work and caution, and through the growing demand for electric light, our Company has become an undoubted success. I can assure you that ever since the Company was established the position of those directing and managing your property has been by no means a bed of roses, and, without desiring to take undue credit for the labours of those to whom you have entrusted the business, I may say that success has only been achieved at the cost of incessant anxiety, watchfulness, and work. In carrying on and developing the Company's business the Board have had, and have no other wish, than fully to respect the obligations of the Provisional Orders, the City of London Electric Lighting Act, 1893, and the contracts which have been made with the City authorities; and I wish to state publicly that your Board desire to have amicable relations with the Corporation, and to meet any representations made by that body in a conciliatory manner, whilst steadfastly upholding the rights of those who have invested money in this Company on the faith of definite contracts, entered into by the Corporation. Your Board cannot think that the members of the Corporation would wish to do anything which would give rise to a belief that the Corporation desire not to carry out the terms of contracts which it has entered into, or would unduly hamper this Company.

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To explain how the present position has come about and to show how fair the contracts were at the time they were made, and to prove that no advantage of any kind was taken of the Commissioners of Sewers, I will briefly refer to the history of the electric lighting of the City. As far back, at least, as 1880, the question was under the consideration of the City authorities, and numerous and important experiments for lighting the thoroughfares of the City were made, many of which are probably within the recollection of most of you, but they ended in no practical results. Eventually, contracts were entered into by the Commissioners with the Brush Company and the Laing Wharton and Down Company. Provisional Orders were obtained, and all other formalties complied with. These companies had not the means to carry out the contracts. A pioneer company was, therefore, formed, with the sole object of starting the work with a small capital in order that the Provisional Orders should not be lost. The contracts and Provisional Orders were not transferred to the pioneer company. The present Company was then formed, and it was at this stage that I came upon the scene, and I was present when the first allotment of shares was made. The Company was brought out at a time when the public had not that confidence in the electrical industry which they have to-day. The technical press, with one exception, doubted whether the city was a good place in which to make an electric lighting company pay. The journal which was the exception, made the same remark, but added the reservation that no doubt the gentlemen who were acting as Directors, had made themselves thoroughly masters of the probable future of electric lighting in the city, and it was possible that their judgment might prove correct. The public were invited to subscribe £400,000, and the response was very small. Had it not been for a number of friends of those who projected the undertaking, who came forward at the eleventh hour to subscribe, the allotment would not have been made, in which event the chances are that the citizens would not have had the electric light at the present time, or at least that it would have been greatly delayed. I would therefore appeal to you as business men whether you do not consider that the City authorities were right at that time not to enter upon what they naturally regarded as a speculative enterprise. The fact of the Company having proved to be a success ought to be a subject of congratulation on all sides Any questions which may arise with the Corporation your Directors are desirous to settle in a friendly spirit. As an instance may be mentioned the lighting of the side streets, which last November your Directors proposed should be referred to arbitration, and suggested as arbitrator a gentleman high in authority in electrical and commercial matters, but to this proposal, only two days ago, we received a reply to the effect that a friendly action would be preferred, and this is now under our consideration. Speaking generally, I need scarcely remind you that our Company has been formed for commercial purposes. We are therefore a peaceful body. Consequently, it is only natural that we are anxious to avoid the Law Courts, and we should only have recourse to these in the event of being forced in that direction, in defence of our just rights, in which case it would be the duty of your Board not to hesitate in taking this step. If you adopt the report to-day, a dividend of 10 per cent. will be paid, and the Directors are of opinion that, notwithstanding the fact that by the wording of the Provisional Order, a much larger dividend may be paid on the Ordinary shares before a reduction in price takes place, yet we feel that we should be fair in our prosperity, and give and take, and your Board have decided to reduce the maximum price of the unit in the City from 8d. to 7d., and we hope hereafter to reduce this still further, if the business permits. I am sure this is the right policy to adopt, and that it is one you will adopt whether you are users of current in the City or not. We have also settled upon a sliding scale which will apply both to our small as well as our large customers. The reduction in price, as well as the sliding scale, has been advertised, and will take effect from January 1st last. Your Directors trust that the reduction in the maximum price will produce that satisfaction which they hope for. It must be borne in mind that during the whole of the summer there is but little business, and always the evening load is comparatively small. On Saturdays there is very little demand, and on Sundays none at all. By examining the curves of supply (as shown on a diagram exhibited to the shareholders) you will see how very capricious the demand for light is. In the summer the average load is less than one-tenth the winter load. At times, almost without notice, and within three-quarters of an hour, a supply for 35,000 lamps rises to 138,000. In other words, a demand for 2½000 H.P. has to be increased to 9,000. This is, of course, due to fog, or sudden dull weather. Yet to the Company it is a serious matter, for in doubtful weather a large number of boilers have to be kept ready for immediate use, and days may elapse without a demand upon them. Hence the cost of production is greatly increased compared with other places. Again, everything connected with the City Company has cost more than elsewhere; the price of land, the difficulties of laying tubes and mains in the streets, and many incidental expenses have tended to increase the initial cost.

We at the present time give considerable reductions to consumers' to the extent you will observe last year of nearly £14,500, against a little less than £9,000 in the previous year, which is at about the rate of 8½ per cent. on our gross revenue for private lighting. It has always been the desire of your Board to encourage the use of electromotors on the Company's circuits, and the best means of supplying current for this purpose is under consideration. There appears to be only a small demand at the present time in this direction, but it is hoped that before long the demand will increase. I think that I have said sufficient to show our bona fides, and that the public authorities have really no ground whatever for complaint, unless it be that they are sorry that their predecessors did not enter upon what, at the time, was regarded as a risky speculation. We shall carry out our contract in a loyal manner, and trust that after what I have said, whether my words are agreeable or the contrary—at least they are frank—the City authorities will not only deal with us in a friendly spirit, but will see how the position has been created, and that they have really no cause for dissatisfaction. The two gentlemen who retire by rotation this year are Mr. F. Reynolds and Mr. E. Lucas. They are eligible for re-election, and place themselves in your hands. Both Mr. Reynolds and Mr. Lucas form indispensable units—I do not know how many Board of Trade units—in the going concern, and that if you are satisfied with the manner in which your business is being conducted, you will consult your best interests by re-electing these gentlemen as your Directors. I have also to add what I have never failed to do—and I do not do this as a matter of form merely, but as a matter of real feeling, not only for myself but for the gentlemen who sit on the right and left of me—the compliments and thanks of the Board to our staff. Our officers know well how highly we appreciate their services, and at all times when difficult questions arise we consult Mr. Bull, our secretary and manager, and Mr. Bailey, our engineer. I must not forget to mention Mr. Morris, our solicitor, and although I hope we shall not require his assistance very often, yet I am bound to say that his services, when required, are most valuable. I can assure you that at all times we receive their views with the greatest consideration, and it is a great advantage to the Company to possess such able men to consult with and advise the Board on all matters that have continually to be dealt with. There is also another gentleman whom I must allude to by name. It is too often the case that those who are out of sight are forgotten, but it is not so in this case. I refer to Mr. Jackson, our assistant engineer. I must also add to those I have mentioned the accountant, the head clerks, and all others in the employ of the Company, right away down to the humblest labourer. They have all acted in a loyal manner and done their duty, and I think the thanks of you gentlemen are due to them as much as to the Board. I will now move—

"*That the report of the Directors and the statement of accounts for the year ended December 31, 1897, with the appropriations to the reserve and depreciation funds, as shown therein, be and the same are hereby received and adopted.*"

Col. B. H. MARTINDALE, C.B., seconded the resolution, and said he would add nothing to the able and lucid speech of the Chairman.

Mr. ATKINSON said he did not understand what the question at issue was between themselves and the Corporation. Was it merely a simple reduction in price that they asked the Company to give, or was it a question of some other company coming into the field?

Mr. WANCKE inquired if the Board were disposed to take steps for dividing the shares of the Company into two shares of £5 each.

The CHAIRMAN, in reply, said the question as between the Corporation and the Company, as you may judge by putting two and two together, is simply this: As the result of the Provisional Orders, the Contracts with the City authorities, and the Act passed in 1893 we are, in a way, working with the City, and I may repeat that we are anxious our relations should be most amicable. But, of course, there are a number of gentlemen now connected with the Public Health Department of the Corporation who are not conversant with all that has occurred, and very likely as new members —it is said, you know, that new brooms sweep clean—they wish to show their zeal, I will not say to overstep the bounds of what is right and fair, as, perhaps, that would be rather too hard an expression, but that there is a tendency to undue interference and zeal on their part. I am anxious to show—as the report of our preceedings are read outside this room—that it is the desire of this Company to work amicably with the City, and we think it is only fair that they should co-operate in the same friendly spirit with us. That is putting the thing in a nutshell. In regard to the division of the shares, the Board certainly would not welcome anything of that sort, and I think all the genuine shareholders in this concern will agree with them. It has been the bane of railway companies, which have divided their shares, by introducing an amount of speculation. Such a state of things renders the work of the Board exceedingly difficult. We have always worked this concern without looking at market prices. Of course, I do not mean that we have been ignorant of the price of the shares, but that we have striven to advance the prosperity of the Company without having in view the desirability of increasing the price with the object of getting people into the Company. We have a constituency which is thoroughly sound. Most of our shareholders have remained with us steadfast from the first, and now that the Company is prosperous the Board do not consider it would be fair or judicious to do anything which would introduce an element of speculation into the dealings in the Company's shares. Personally, I like everything to be thoroughly sound, free from all taint of speculation.

The resolution was then agreed to unanimously.

The CHAIRMAN then moved—

"*That the following dividends be and are hereby declared: On the Company's Preference shares—6s. per share for the six months ended December 31, 1897, making, with the interim dividend already paid, a total distribution of 12s. per share, or at the full rate of 6 per cent. per annum; on the Company's Ordinary shares, Nos. 40,001 to 80,000—£1 per share for the twelve months ended December 31, 1897, being at the rate of 10 per cent. per annum; on the Company's Ordinary shares, Nos. 80,001 to 90,000 (February, 1897, issue)—10s. 7d. per share, being at the rate of 10 per cent. per annum, calculated from the due dates of the respective instalments to December 31, 1897. That the respective dividends be paid, less income tax, on March 3, 1898, to all shareholders on the register of members of the Company on February 16, 1898.*"

The EARL of SUFFOLK AND BERKSHIRE seconded, and the resolution was agreed to.

The CHAIRMAN: I now have to move—

"*That Mr. Edward Lucas and Mr. Frederick W. Reynolds be, and are hereby re-elected Directors of the Company.*"

The EARL of SUFFOLK AND BERKSHIRE, in seconding the resolution, said that the cordiality with which they had received the Chairman's remarks, and the unanimity with which they had adopted the report was

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by far the best commendation that could be given to the two gentlemen who sought re-election.

The resolution was agreed to unanimously.

Mr. LUCAS, on behalf of Mr. Reynolds and himself, thanked the shareholders for the renewal of their confidence.

Mr. WANCKE proposed—

"*That Messrs. W. H. Pannell and Co. be, and are hereby re-elected auditors of the Company for the year ending December 31, 1898, at a fee of 125 guineas.*"

Mr. BALL seconded the proposal, and it was agreed to.

The proceedings then terminated with a vote of thanks, proposed by Capt. WATSON, to the Chairman and the Board, and also to the staff.

Notting Hill Electric Lighting Company (Limited).

Sir William Crookes, F.R.S., presided on Wednesday, March 2, 1898, at Winchester House, Old Broad-street, London, E.C., over the annual general meeting of this Company.

The SECRETARY (Mr. R. G. Rawkins) read the notice convening the meeting.

The CHAIRMAN then said: Gentlemen, I address you to-day with a somewhat different feeling to that experienced a few years ago, when I had to face you with the accounts showing a balance on the wrong side and the shares considerably below par. Since then, however, our prosperity has so increased that I now have the pleasure of presiding and asking you to declare a dividend of 6 per cent. on our Ordinary shares, the full 6 per cent. on the Preference shares having already been distributed. The accounts are published in the form prescribed by the Board of Trade, and are so complete that probably little explanation is needed. It may, however, be advisable for me to follow my usual plan of going through them *seriatim*, drawing your attention to any points likely to interest you, and as you have all received a copy I presume you will be willing to take them as read. Our No. 1 (share capital) account is now complete, the whole £100,000 of share capital having been issued and paid up. No alteration can therefore occur here until new shares are created. The Directors do not at present anticipate such a creation, as it will be noticed in the No. 2 account that there are still £40,000 of Four per Cent. Debentures available for issue against further capital expenditure. By making use of these the shareholders reap the benefit, as the debentures carry interest at 4 per cent. only, whereas a further issue of shares would rank for dividend with the old ones, and would, therefore, have to receive the full 6 per cent.; by issuing debentures, however, the odd 2 per cent. goes to increase the share dividends. During the year the Directors allotted £10,000 of the Four per Cent. First Mortgage Debentures at £106 per cent., being part of an issue of £50,000 secured on the Company's undertaking by a trust deed dated June 17th last, when Mr. R. B. Martin, M.P., one of our shareholders, and myself accepted the appointment of trustees for the debenture-holders. The remaining £40,000 is therefore available to cover additional capital expenditure. We anticipate requiring about £11,000 this year, and the issue price of the debentures will be increased to £107. 10s. per cent., which will yield over 3½ per cent. on the capital invested. I should like to take this opportunity of saying that any shareholder desiring an allotment of these debentures should apply to our secretary for a form of application. We already have applications in hand for about £12,000 at this price, but applications from other shareholders will be considered before an allotment is decided on. No. 3 (capital) account shows the receipts from shares and debentures and the expenditure on works, mains, &c., to the end of the year. It will be seen that the amount of capital expended on lands, buildings, mains, and machinery is £3,184 in excess of the amount received from shares and debentures. To this sum should be added the £1,973 appearing on the general balance-sheet against preliminary expenses, compensation, &c., and for stores, working expenses and carrying on the business we require about £2,000. In addition to this we anticipate expending £7,000 this year on new mains and machinery. All these bring the additional capital required up to £14,150, against which, as previously stated, we propose allotting debentures for £11,000, the difference being made up by the £3,340 belonging to the depreciation and renewal fund. We therefore so regulate it that, in accordance with the principle laid down some years ago, our capital will continue to be just the equivalent of the actual money in the business; in other words, we shall have no watered capital and no allowance for goodwill. New shareholders may be reminded that in this Company there was paid no money for concessions, existing works, or goodwill, so that whatever we possess stands in our books at prime cost.

Very little capital was expended during the year, except on new mains, which represent £11,769 of the total expenditure of £14,079. The reason for this large expenditure is that we have now seriously commenced to lay mains in the principal streets of our new area, most of the compulsory ones being already supplied with current. We have every reason to be satisfied with the number of customers on the new extensions; these appear an almost certain source of additional revenue, but there is still a large field for further development. Other small extensions of the mains have to be made in the old area. Our No. 4 (revenue) account is, it must be admitted, in a very satisfactory state, the number of units sold having increased during the past twelve months from 230.787 to 354,969, or 50 per cent. and the total revenue from £8.550 to £11.620, or about 40 per cent., the difference of 10 per cent. in the revenue compared with the output being attributable to the reduction of the charges per unit, which, on the face of it, was a loss to us of about £1.200, or 1 per cent. on the total capital. On the other hand, however, we are now reaping the benefit of the reduction, as new customers are coming on more rapidly than heretofore, and many would probably not have come on at all but for the reduction in the price per unit. The increase in the revenue compared with the previous year is over £3,000, but the expenses show an increase of only about £900. The principal increases are for coal, repairs, and rates. It can easily be understood that the total works-cost must naturally grow with our increased output, but the initial cost per unit gradually decreases, and at present it compares favourably with other companies selling ten times our number of units, showing that every economy is practised and careful attention is paid to this department of the business. The members of the engineering staff have control of so many items connected with the expenditure that they are allowed a bonus on the savings. We find this works extremely well for the Company, and I believe the staff also find it works well for them. The management expenses, however, do not increase in anything like the same ratio, and the staff in this department is no larger than originally. The whole of the machinery and mains are kept in an efficient state of repair; the entire cost being taken out of revenue. Rates alone have increased some £130, the Vestry having raised our assessment considerably. We appealed against this in the usual way to the assessment committee without success, and acting on the advice of counsel it was decided not to carry the case to the sessions on this occasion. With a greater output we all know the work in every department must necessarily increase, and I would take this opportunity of expressing our entire satisfaction at the excellent manner in which our engineering staff, under Mr. Schultz, have carried out the duties devolving on them, more especially in view of the very anxious times at the end of the year. Owing to the labour troubles at that time in the engineering trade, the contractors were unable to deliver the large engine and dynamo which should have been completed last summer, ready for the winter load. Had one of our machines failed at the critical moment we should have been in a most awkward predicament, having no spare plant whatever to fall back upon. Happily, no accident occurred, and the new machinery was delivered last week The No. 5 (net revenue) account shows that after providing for depreciation and interest on debentures, the total net profit for the year was £5,652. 12s. 5d. while account No. 6 (depreciation, renewals and reserve fund) shows that this has now increased to £3,340, and it is gratifying to be able to report that we have had no accident which has caused us to trench upon it. The policy of the Board is to increase this fund to such a point that the Company shall be in a position to bear the strain of any breakdown to which, with all our care, we may be liable, without necessarily inflicting a loss of dividend upon the shareholders. No accident has occurred in the works during the year, but the breakdown of a boiler or a dynamo would make a serious inroad into this amount, and the Directors therefore feel sure that the establishment of a suitable reserve will meet with your approval. Finally, the general balance-sheet speaks for itself, the only item I need allude to being on the credit side. The "preliminary expenses, compensation, &c.", £2,375. 12s. 9d. was reduced during last year to £1,973. 16s. 7d. by the premiums received on the issue of debentures. We hope to entirely eliminate this item in course of time out of the premiums received on the issue of new capital.

I should like to make a few remarks on the position of the Company generally. As regards our advancement, nothing can better illustrate it than the following table. I need not read the whole of the table, as a report of these proceedings will be sent to you; but I may say that the revenue has increased from £1,623 in 1891 to £11,625 last year:—

Year	Houses conn'cted	Lamps connected.	Units sold.	Revenue.	Expenses.	Profit or loss.		Div. on Ord. shrs.
1891	77	6,056	30,162	£1,623	£2,178	Loss	£554	nil.
1892	124	9,438	75,667	3,513	3,301	Profit	112	nil.
1893	173	12,153	107,580	4,329	4,329	,,	1,481	nil.
1894	234	15,669	130,266	5,123	3,021	,,	2,101	1%
1895	307	20,307	182,327	6,940	3,712	,,	2,227	2%
1896	396	25,716	230,787	8,552	3,816	,,	4,736	4%
1897	571	33,000	354,969	11,625	4,771	,,	6,854	6%

Our revenue per 8-c.p. lamp still continues low, being about 6s. only, showing that our district is not so good as most of the others in London where the average consumption per lamp is, I believe, above 10s. New houses are being built in many places, and we find they almost invariably adopt the electric light as a matter of course. We also hope to derive considerable benefit from our contract with the National Electric Free Wiring Company, who undertake to wire houses and provide suitable fittings free of initial cost to the consumer, who merely has to pay an additional penny per unit, which penny is handed over to the Free Wiring Company. By this means we hope to get many shopkeepers and others to adopt the light who for some reason or another do not care to go to the expense of providing their own wires and fittings. Already over 20 houses have been connected on these terms. Houses are still coming on as fast as last year, and we have every confidence in looking forward to a steadily increasing prosperity; our position being naturally strengthened as we proceed. We have every reason to be satisfied with the result of the reduction in the price per unit to 6d. at 200 volts; and although our principal thought must be to benefit our shareholders, we must not overlook the claims of those who supply the dividends, viz., the consumers. As many of our shareholders are also using our light I can assure them that their interests will be very carefully considered, and immediately it is possible to make a further reduction they may rely that this will be done. The dividend of 6 per cent. on the Ordinary shares which we are now recommending you to declare marks a period in our history. After this is paid our Preference and Ordinary shares rank equally for dividend and the Founders' shares come in for their proportion. To simplify matters, we propose to regard our ordinary dividend as a 6 per cent. one, payable half-yearly, and at the end of the second half-year we propose to pay in

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addition such bonus as the profits may allow. The total amount of profits available for dividend after payment of the 6 per cent. will be divided into two moieties, and one moiety will go to the 9,450 Preference and Ordinary shares *pro rata*, and the other moiety to the 550 Founders' shares *pro rata*. Taking everything therefore into consideration, I think we can confidently look forward to increased dividends in future; and I now conclude by moving—

"*That the Directors' report and accounts to December 31, 1897, presented to this meeting, be adopted, and that a dividend at the rate of 6 per cent., less income tax, on the Ordinary shares be and is hereby declared payable forthwith.*"

Mr. ARTHUR E. FRANKLIN seconded the resolution, and remarked that the Directors felt very gratified, after the long struggle they had had, that they now saw their way to prosperity. The good management of the Company was shown by the fact that out of their revenue of £11,000 their bad debts had only been £14.

The CHAIRMAN, in answer to Mr. DAWES, said that the expenditure on new mains in the past year had been £11,769. They had laid between three or four miles of mains in the year. They had their own staff, and utilised them, in some cases, in the laying of mains, but sometimes it was cheaper to have the work done by contract. The staff did the work whenever it was found advantageous that they should do it.

The motion was carried unanimously.

Mr. SWAIN proposed and Mr. CROMPTON seconded the re-election of the retiring Directors—Mr. Arthur Ellis Franklin and Mr. Francis Radford.

Mr. DAWES inquired what constituted a Director's qualification, and what number of shares was held by each of the retiring Directors.

The CHAIRMAN stated that the qualification for a Director was 15 shares, and that Mr. Franklin and Mr. Radford were among their largest shareholders.

Mr. DAWES said he was within his right in asking to be informed of the exact holdings of the retiring Directors, but at the general wish of the meeting the Chairman stated that he must decline to give the information, which, however, could be ascertained at the offices.

He then put the resolution, which was carried unanimously.

Mr. DAUBENEY afterwards proposed a resolution fixing the Directors' remuneration at £200 each, with the addition of £100 to the Chairman. He stated that although the Directors were entitled to £1,000 a year, they had only received £300, £400, £550, and £650 for the past four years, representing a saving of £2,100 to the shareholders.

The motion was seconded by Mr. BURNESS, and supported by Mr. Dawes, and carried unanimously.

The CHAIRMAN having acknowledged the vote,

The retiring auditors were re-elected with a fee of 30 guineas.

Votes of thanks were afterwards passed to the Chairman and Directors and also to the staff, the services of the Board and of Mr. George Schultz, the engineer and manager, being warmly commended.

The proceedings then terminated.

Kensington and Knightsbridge Electric Lighting Company (Limited).

The eleventh ordinary general meeting of the shareholders of this Company was held last evening, under the presidency of Mr. Granville R. Ryder.

The SECRETARY (Mr. R. S. Erskine) having read the notice calling the meeting,

The CHAIRMAN said: The first resolution I have to move is:—

"*That the report and accounts now read be adopted and entered on the minutes.*"

You will observe that the form of accounts adopted on the present occasion is different from what we have issued hitherto. This form is the one which is required by the Board of Trade. Up to the present time we have had to prepare two sets of accounts—one on the old form we used to have, and one according to this of the Board of Trade. Personally I must say that I prefer our old form of accounts, as it set out our affairs more clearly than these voluminous and, I think, somewhat pedantic figures. However, the point is the substance and not the form of the accounts, and I think it is very gratifying to us to be able to submit to you so satisfactory a statement for the past year. During the year the number of houses and shops that have taken the light has increased by 295 as compared with the preceding year, whereas in 1896 the increase was only 216 as compared with the preceding year. That is satisfactory. On the other hand, the actual increase of lamps for the year was not so great as the year before; in fact, last year it was only about 18,000 lamps, against 25,000 in the year before. But there is ample evidence that the district, as a whole, is taking more light, because, as a matter of fact, the increase in the number of units of electricity taken last year was 383,000, against an increase in the previous year of only 285,000 units. With respect to the capital account, you will observe that the amount of increased capital that has been issued during the year has been £1,160 of the Four per Cent. Debenture Stock and £10,000 of the Second Preference Five per Cent. That has been issued at a premium which has produced within the year £2,079, of which £558 has been used to wipe out the remainder of the cost of the conversion of the debenture stock two or three years ago from 4½ per cent. to 4 per cent. The balance of the premium, £1,521, has been written off against the Kensington Court purchase account, which stood at £13,000, and which has thereby been reduced to about £11,500. The next point I will advert to is with respect to the renewal account. You will observe that the sum of £8,061 is the amount put to that account after paying off the maintenance of the plant of all kinds, including buildings, motors, and everything else, which was done at a cost of £3,190. That sum of £8,061 may possibly be thought a large sum to put to that account in one year, but those most competent to advise us on this subject consider that the point in which we should strengthen the Company and give it the stability we wish is to make that particular fund a very strong one. When you come to consider how fragile and short-lived electrical plant is, and how necessary it is that we should be in a position to take advantage of all the improvements in electrical science that may come, you will see that such a fund as that is most useful, and one that should always exist in a Company like ours. With reference to the units sold the figures are satisfactory. In 1896 the units sold were 1,574,729, as compared with 1,898,362 in 1897, showing an increase of 383,633. It is satisfactory to find that the increase has been earned at an additional cost of £1,819, but at the same time the profit has risen from £34,371 to £41,681. Therefore that £1,819 has practically earned an additional amount of £7,309. Of course what that shows is that when you increase your output you decrease your cost to an enormous extent. I hope that that will go on, and it must go on until your output has increased so largely that you have to go in for extensive new works or large additions to existing works. Those are the principal points to which I would call your attention. You notice that one item is again higher—it is always increasing—the rates. That item has increased in the year by about £1,000, and as far as we can judge we see no chance of a diminution under that head. As far as the rates are concerned, the system used to be practically to tax you according to the burden you were to the parish. Now, however, they look at your profits, and you are really charged a second income tax. I now move the resolution.

Sir FREDERICK J. BRAMWELL, Bart., F.R.S., seconded the motion.

A SHAREHOLDER inquired whether they could not have their shares quoted on the Stock Exchange.

The CHAIRMAN: I hope that we are gradually working up to that point, but you must have a certain amount of share capital against your debentures. A quotation would no doubt be a decided advantage, and we have always got it in view.

A SHAREHOLDER asked whether it was intended to carry such a large sum to the renewal account as had been transferred to it in the past year.

A SHAREHOLDER inquired how long the existing plant was likely to last before it would have to be increased.

Mr. CROMPTON stated that the plant was now about up to the capacity that it was originally expected the district would take. The district was so much better and richer than was at first expected. Many small tenements were being pulled down and large flats were being built, so that there was quite an unexpected demand for electric light in the district. It was therefore quite possible that they might have to increase their works in two years' time.

The CHAIRMAN then put the motion, which was carried unanimously, and subsequently he proposed the payment of a further dividend on the Ordinary shares at the rate of 12 per cent. per annum for the half-year ended December 31st last, making, with the interim dividend, 10 per cent. for the year.

Mr. G. H. HOPKINSON seconded the motion, which was carried unanimously.

The retiring Directors and Auditors were afterwards re-elected.

A cordial vote of thanks to the Chairman, Directors, and staff was then proposed, seconded, and carried unanimously.

The CHAIRMAN, in acknowledging the vote, warmly recognised the services rendered to the Company by the staff.

Richmond (Surrey) Electric Light and Power Company (Limited).

The fourth ordinary general meeting of this Company was held yesterday, at the offices, Moorgate-court, London, E.C., Mr. F. W. Reynolds presiding.

The SECRETARY (Mr. H. B. Renwick) having read the notice calling the meeting,

The CHAIRMAN congratulated the shareholders that the Company had now reached a stage which enabled the Board to recommend the payment of a dividend. The improvement shown in their business had been well maintained during the past year, and the Directors regarded the progress as satisfactory, bearing in mind the conditions prevailing at Richmond. The capital account exhibited an increase of £3,000, which had been received on loan from the County of London and Brush Provincial Company. This £3,000 had been expended chiefly on mains, extensions, accumulators, and meters. It would be seen that the capital expenditure during 1897 had been augmented by £3,828; the sundry debtors, mainly for current supplied, represented £1,803; and the suspense account, which originally stood at £1,710, amounted to £1,500, from which a further £250 was proposed to be written off out of the revenue of the year. The revenue account showed that the receipts for the sale of current had increased by £1,116, making the total income for 1897 £4,468 against £3,194 for 1896. The balance to credit of net revenue, including the amount brought forward, and after payment of interest, depreciation and reduction of suspense account, was £1,072, compared with £33 odd in 1896, and the Directors out of that amount recommended the payment of a dividend of 3 per cent. on the share capital. The lamps connected at December 31 were equivalent to 9,512 8 c.p. The units sold were 138,916. The work costs were equal to 1·82 per unit, which he thought very satisfactory, in view of the fact that they used the best smokeless steam coal at 19s. per ton. Having regard to the encouraging prospects of the business, it was the intention of the Board to lay down, in time for next winter's lighting, addition plant, so as to be

able to meet the growing demand for current. They also contemplated extending their mains to a number of the principal residential streets of the borough. After expressing the indebtedness of the Board to the Company's staff, mentioning, in particular, Mr. A. J. Lawson, the engineer, Mr. Renwick, the secretary, and Mr. Flemyng, the station engineer, he moved the adoption of the report and the dividend therein recommended.

The Chevalier SOARES seconded, and it was unanimously agreed to.

The Chairman was re-elected a Director, and Mr. Marsh as auditor, and the proceedings terminated.

W. T. Henley's Telegraph Works Company (Limited).

The ordinary general meeting of the shareholders of this Company was held on Friday, the 25th ult., at the offices, 27, Martin's-lane, Cannon-street, under the presidency of Mr. Sydney Gedge, M.P.

The SECRETARY (Mr. A. E. Salmon) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, it is one of the pleasantest days in the year to me when I have the honour of meeting the shareholders in Henley's Company at our annual meetings, because for some years past the Company has been going on well, improving in every way its position and its prospects; and the same tale that has been told to you in previous years may be repeated to-day. I therefore congratulate you and ourselves upon the success which has attended the efforts of those who have the management of the Company in their hands. It is just four years since we first held a meeting of the shareholders in this room, and I have looked back on what we were doing at that date and what we had done the year before; and I thought that you might think that this was a very good time for a little retrospect to mark our growth and progress in those five years. In 1893, which was just concluded, and the accounts of which year we were then passing we had raised and had had the benefit of £30,000 of Preference capital, which we had been obliged to raise partly for the purpose of clearing off our debts and inducing creditors to take Preference shares in payment, and partly for the purpose of raising fresh capital. I think that one-half of the £30,000 went to one purpose and one-half to the other. The benefit of that was felt in that year, for we made the substantial profit of £10,777 and some odd shillings and pence, and we were able to pay a dividend of 5 per cent. Looking back to the speech I made to you that year I find that I then pointed out that our shares were standing at about £7 to £8, having gone up gradually to that figure, and I said that I thought it was likely that the operations which the Directors had in view might have a very beneficial effect on them, and make your property more valuable. I then told you that I thought that as we had £37,000 of debentures, of which we had to pay off a portion every year, thereby limiting our dividend to 5 per cent., it would be a very good thing if we could raise £50,000 of debenture stock wherewith to pay off those debentures, get rid of that liability of repayment, and lower the rate of interest. In the following year we carried out that operation. I hope that we might get the money at 4½ per cent. or 5 per cent., and we got it at 4½ per cent. It cost us about £1,000, including the payment of interest, &c., in lieu of notice to the holders of the then existing debentures; but the result was that we increased our available capital for working by £12,000 at an annual increase of interest of only £253, and we were enabled to commence paying better dividends. That was done in 1894, and it was achieved greatly to the advantage of the Company. In 1895 we again wanted more capital. We increased it from the nominal £70,000 to £100,000, issuing, in fact, £31,630, the whole of which was taken up by the shareholders and their friends at par, without any expense for commission or anything of that kind, which is so usual when fresh capital is issued. By this time we had a total capital of £180,000, consisting of Ordinary £100,000, Preference £30,000, and Debenture stock £50,000. We went on with that capital until 1896, but last year we found it was again necessary to increase our capital. We were able, as your report tells you, to obtain the closing of the Victoria-road and so to throw our works all into one square wall, or, as is said in the report, to put our property "within a ring fence." We are four square walls to the world; but we have one entrance, and we have got rid of all the difficulties we formerly had owing to the works being divided by a road, and we have cleared room for the extension of our works which we are going to make. We issued £25,000 of further capital, being half of the £50,000 you authorised us to issue; and we did not issue this, as we did before, without expense at par, but without expense at a very considerable premium. In fact, we pocketed £15,000 by the job. Our shareholders, however, were very glad to take up the £10 shares at £16, and in the result we were able to add £15,000 to the Reserve Fund. But I do not think that any shareholder who took up his shares at that price will have any occasion to regret it, because we hope very soon to get a quotation on the Stock Exchange for these new shares, on the same footing as in the case of the old shares, and after March 1 they will be on precisely the same footing, while as regards dividend, they will share with the old shareholders as from January 1st. We hope to get this quotation, but, in order to do so, we want the shareholders to help us. There is a small amount which is not paid up in full. Why they do not pay up in full and get a dividend of 12 per cent. on the amount we do not know, but it has been a small saving to the Company. However, until they are paid up in full we cannot get the quotation from the Stock Exchange, and therefore I hope that the shareholders will pay up the small amount due on their shares, and enable us to get a quotation, which will benefit us all. Over and above that £180,000 we have this £40,000 more of real capital—£25,000 more of nominal capital—wherewith to improve our works and earn dividends, and that, I think, is a satisfactory progress. Further, I may say that our business has so increased, and it is so absolutely necessary that we should keep well in front in having well-arranged works and the best machinery, with all the newest improvements, that it is not at all unlikely that before the year ends we may find it necessary to issue the balance, £25,000, of the capital which has been authorised, but which has not yet been issued. I have no right to pledge my brother Directors, but I think it probable that we shall do as we did before, and offer these shares to our shareholders at a price that will tempt them to take them up without expense to the Company or without going outside; but I do not think that they must expect to get the shares again at £16. I think they will have to be asked for more; but if so, it will be for their own benefit and for the benefit of the Company generally. Now let me trace back our profits for five years. In 1893 we made £10,780 profit, and paid you a dividend of 6 per cent.; in 1894 we made £16,450, and we divided £6,200; in 1895 we made £21,820 and brought into the pot also a sum of £1,600, which, strictly speaking, had belonged to the previous year, but which we could not bring into that year, and we then divided £9,500; in 1896 we made a profit of £26,080, but from that had to be deducted £500, which you were generous enough to vote to the Directors for a bonus and for our encouragement, and we divided £12,400; and last year we made £29,585, and we propose, with your sanction, to divide £15,800. You see, gentlemen, that our net profits have continuously progressed and increased, and that the amount we have paid you in dividend has also steadily increased year by year. At the same time we have always been able to pay the dividends out of the profits actually earned in the year for which they were paid; we have had no necessity to go back to the reserve fund or to the money brought forward. The actual earnings of the year have paid the interest on the debentures and also the dividends, and during the five years we have written off £10,000 against depreciation of our plant and machinery, £11,000 has also been spent on maintenance and charged to revenue, we have added £20,000 to the reserve fund besides the £15,000 received as premium on the issue of shares, and we have paid you £50,000 in dividends, while we are carrying forward £14,700 to the year 1898. Now I think you will admit that that shows that there has been good management—good management both at the works and here. For this we are mainly indebted to Mr. Sutton for the excellent orders we get, and also for the good management of our funds when we have made them. I think that we have acted prudently. We have paid you dividends which have gone on progressing, and I hope that we shall continue to do so, although, of course, we cannot forecast the future. We have gone on steadily, which has given confidence to the public generally in the management of this concern, in the value of our property, and in the excellence of our business. With regard to our investments, we have debentures and shares in other Companies which are shown in our balance-sheet at £2,816. These are entered at cost price, but I am happy to tell you that at the present moment their market price is about twice as much. With regard to the stock-in-trade, that is an amount that has been increasing year by year. It has increased from £34,000 in 1893 to £85,000 in 1897. But do not be alarmed; do not suppose that that means that we have got a lot of unsaleable stock. I do not believe that there is any unsaleable stock in it. There is a certain amount of stock—larger than in former years—which we have to keep ready for purchasers who want elaborate goods sent to them sometimes at 24 hours' notice; but we keep that stock as low as we can. It consists largely of raw material bought when it can be bought cheaply—gutta-percha, india-rubber—and also expenditure on orders in hand unfinished at December 31st. That item, therefore, is one we may regard not only without apprehension, but really with great satisfaction. You will see that the amount due to us from debtors is £33,500. It is not a very large sum. We are able, I am happy to say—dealing with good customers—to get our money in; and on our large transactions I think that the amount I have mentioned is a modest sum to be outstanding at the end of the year. On the other side of the account you will see that we are adding £7,500 to the reserve account out of the profit and loss account, besides the £15,000 obtained from premium on the sale of our shares, and that is irrespective of the £14,789 we carry forward, which is £500 more than we brought forward. The item on the debtor side of the balance sheet of "reserve under cable-repairing contract invested in the joint names of Trustee for the Company and the Crown Agent for the Colonies" is an amount which increases year by year very considerably, and it is invested for the purpose of providing a repairing fund for the Florida and Bahamas cable. We are happy to say that hitherto not a shilling has been expended on the repair of that cable, in that respect following the example of the sister cable from Halifax to Bermuda, which, we believe—but this is not in our own hands—has also not required a shilling to be expended on it for repairs. To have laid down two such cables as these and not to have required any expenditure for repairs is of itself high testimony to the goodness of our work and the care of our management. I think I have now pretty well exhausted everything I had to say to you excepting on one point—the engineers' strike, and you may be anxious to know to what extent we suffered from it. We had to consider the question whether or not we should join the Federated Union of Employers, and we thought it right to do so, and we did join it. The necessary consequences followed. Some of our men struck, but I am happy to say that the foreman—a very worthy man, who had been a few years in our employ—did well for himself; but it is not every man who has the courage to do well for himself in such circumstances. He resisted all temptation, "and remained an Englishman" in our employ; he gave up his Trade Union and remained with us. What was the result? Why, partly by his help, still more by Mr. Hatton's very careful superintendence, a number of non-union men were put on to do work. We are happy to say that the result has been that these men have done more and better work than those who struck; and while they are very well satisfied with their wages, the result has been beneficial also to the Company. The only people one cannot help but being sorry for are the men who struck. They have applied to be taken on again, but all we could do was to put their

names down for appointment when any vacancies occur. I cannot sit down without paying my usual tribute of thanks to all our staff, both here and at the works. I now move:—

"*That the report and the balance sheet now presented to the meeting be and hereby are received and adopted.*"

Mr. R. J. JENKINS seconded the motion, and observed that after the very able manner in which the Chairman had laid all the figures relating to the Company before them there could be but little observation or criticism.

Mr. DRYSDALE congratulated the Directors on the position the Company had obtained. With regard to the Chairman's remarks respecting the possibility of issuing further shares, and at a better price than on the last occasion, he was not altogether assured that it was a wise policy to issue shares at a premium, because the premium was only capital—taken out of the shareholders' pockets—on which the Company paid nothing. He desired to suggest to the Directors that there were two sides to the question.

The CHAIRMAN then put the resolution, which was carried unanimously.

The payment of the dividends recommended on the Preference and Ordinary shares, less income tax was approved.

Mr. Sidney Gedge, M.P., and Mr. F. Newton were elected as Directors.

The CHAIRMAN afterwards proposed a cordial vote of thanks to the staff for their services.

A vote of thanks to the Chairman, the Directors and to the Managing Director (Mr. George Sutton) terminated the proceedings.

Telegraph Construction and Maintenance Company (Limited).

The thirty-fourth ordinary general meeting of the members of this Company was held at the offices, 38, Old Broad-street, London, on Tuesday, under the presidency of Admiral Sir Anthony H. Hoskins, G.C.B.

The MANAGING DIRECTOR (Mr. William Shuter) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I am very sorry to inform you that our Chairman (Sir Robert Herbert) is laid up with a severe illness, and is unable to preside over this meeting to-day. It is, however, only a temporary ailment, and I am sure you will all wish with us that it may soon be over. As for the report of the year's work of the Company, which is in your hands, I presume that you will allow it to be taken as read. I am glad to say that while we have had no important contract to carry out, yet our factories both at Wharf-road and East Greenwich have been actively employed, and I am pleased to state that we have been able to maintain the dividend at the same rate of 15 per cent. for the whole year, as last year. You will see, however, that the amount carried forward is a somewhat smaller one than that shown in the balance-sheet for 1896. This is, of course, owing to the fact that we consider it better that the dividend should be maintained as nearly as possible at a fixed rate, and that the carry-over should vary rather than the dividend itself. I think you will be interested to learn that this is the 50th year of the most important branch of our manufactures—namely, the insulation of telegraph wires. The gutta-percha works of this Company were started in May, 1845, to cleanse and prepare an almost unknown gum called gutta-percha, a small quantity of which had been imported into Europe from Singapore in the previous year 1844; but it was not until the beginning of 1848 that the great value of gutta-percha as an insulator of telegraph wires was fully recognised, and patented machinery was erected at the Wharf-road works to supply copper wire covered with this material. Various experiments were successfully carried out, which afterwards led to the first important step in submarine telegraphy, namely, the construction of a line between Dover and Calais as an experiment in 1850, and permanently by cable in 1851. Since then much has been done, as the following figures will show. The total amount of raw gutta-percha imported into this country has been officially given at about 84,000 tons, of which 40,000 tons were for the use of this Company alone, and since the total amount imported includes a fairly large proportion of a low class of allied gums not strictly gutta-percha, it will be noticed that we have been by far the largest consumers. Of course, the greater part of the gutta-percha manufactured by us has been for electrical purposes, mostly submarine cables, for which we have constructed about 145,000 knots of various-sized cores. Despite many efforts, gutta-percha still remains without a rival as an insulator for submarine cable cores. It is also interesting to note that we are now manufacturing for the British postal telegraphs a telegraph cable of about 60 knots in length, to be laid between England and Ireland, and having a core of novel design possessing considerable electrical advantages: and it is hoped that this form of cable will help to solve the existing difficulty of direct telephonic communication between Great Britain and her Continental neighbours. This form of cable has been designed by the manager of our gutta-percha works, Mr. Willoughby S. Smith, and his assistant, Mr. Granville. I may add that a small section has been laid down in the Southampton water, which was on too small a scale probably to be of any decisive value, but it was quite successful so far as it went. The case in the corner of the room I thought I might call your attention to, apropos of this being the fiftieth year of the development of gutta-percha. That was one of the original specimens of gutta-percha manufacture, and the coat of arms you see there was carried about upon the Company's vans. It is an excellent specimen of manufacture, and has lasted uninjured to this day. The case contains interesting and historical specimens of gutta-percha manufactures, some of which were in the Great Exhibition of 1851, and there are also pieces of the Dover-Calais core, to which I have referred, as well as of the 1858 Atlantic cable. Turning to another branch of our business, I may tell you that we have entered into a contract for the building of a new cable steamer, which, when completed, will be the largest telegraph ship in the world. In planning and designing her we have had the benefit of accumulated experience extending over a great many years. We may therefore reasonably expect that she will be thoroughly up-to-date in her fittings and equipment. It was found absolutely necessary, in the interest of the Company, that a vessel of her capacity and dimensions should be brought into use, with a view of securing the contracts which may be forthcoming in the future. She is to lift a dead weight of 8,000 tons, which will enable her to carry and lay the longest ocean cable in one length. This cable steamer will be fitted with twin screws, and her engines and boilers are to be of the most approved modern types, and will give her a speed of about 12 knots per hour on a very moderate consumption of coal. I do not think there is anything more to add, but I shall be glad to answer any question that any shareholder may be disposed to put to me. I now beg to move—

"*That the report and accounts of the Directors to December 31, 1897, submitted to this meeting, be and the same are hereby received and adopted, and that a dividend of 24s. per share (in addition to the 12s. per share interest, or interim dividend, paid to June 30, 1897) be paid upon all shares of the Company for the year ending December 31, 1897, and that such dividend be paid free of income tax.*"

Sir JAMES PENDER, Bart., M.P., briefly seconded the resolution.

Mr. CROFT said he was sure the shareholders would endorse the Chairman's remarks respecting Sir Robert Herbert, in whose absence, however, the Chairman had given them a very interesting retrospect of the proceedings of the Company. He thought it would have been a little more satisfactory if the shareholders had been given ome information as to the future, but they had always been accustomed to receive reports which conveyed very little information with reference to the future, and, if he might venture to say so, for very good reasons—reasons which had commended themselves to the shareholders. It was obvious that in the acute competition which existed, it would be injurious to the interests of the Company if the Directors gave more information to the public than they thought, in the exercise of their discretion, would be beneficial to the shareholders. He did not himself intend to depart from the system which had always been adopted at their meetings of not pressing the Directors to give information with reference to the future which they thought it best not to mention. He did, however, propose to ask them to look at a very interesting article which appeared in the *Standard* in January, and which, no doubt, the Chairman and his colleagues had carefully studied. The article was headed "The Strategic Value of Cables. New All-British Lines." Having quoted at some length from the article, he remarked that it was a very important one, and he had no doubt that it had been most carefully studied by them. He thought it might be satisfactory to the shareholders if the Chairman could inform them whether there was any prospect of the scheme referred to in the article being carried out, and whether their Company, which was the most important telegraph construction company in the empire, would have a good chance of participating in it.

Mr. GIBSON inquired at what date the new cable ship was likely to be completed.

Mr. WHISH asked whether wireless telegraphy would affect their interests so far as could be at present seen.

The MANAGING-DIRECTOR: I think you need not trouble your head about that.

The CHAIRMAN: The question which has been raised by the gentleman who quoted from the article in the *Standard* is one of the very highest national and strategic importance. Speaking, not as representing this Company, but as an ex-Admiralty official, I know that it is occupying the attention, in the most marked degree, of the Government, and I have no doubt it will take certain developments in the future to safeguard the national interests in these matters. I do not think that the importance of it has at all been overstated; but so far as this Company is concerned, I do not think it will have anything to do with it, except that when the cable or any extension of the sort pointed out in the *Standard* is decided upon, we should be prepared to take our share in carrying out the work. It is entirely a governmental and strategical question. Another gentleman asked about the cable ship we are building. We have every reason to hope that she will be ready towards the autumn—September or October. I am informed that she has been a little put back by the engineering strike, but not to any important extent. We had hoped that she would be ready by July, but I think it will probably be the early autumn before she is ready. As to wireless telegraphy, I think that that matter is quite unimportant as far as we are concerned. There is no probability whatever of its superseding cable telegraphy to any extent. Of course, we have a small instance of it in the interesting experiment at the Fastnet Rock, where telegraphy is carried on without the wire connection. Except on a very small scale like that, I do not think there is any development of it which need at all affect the future of submarine telegraphy. He then put the motion and declared it carried *nem. con.*

Mr. COLIN F. CAMPBELL afterwards proposed, and Mr. WILLIAM SHUTER seconded, the re-election of the retiring directors—Sir Robert G. W. Herbert, G.C.B., and Sir James Pender, Bart.

The resolution was carried unanimously.

The retiring auditors (Messrs. John Gane and Patrick A. Glegg) were also re-appointed.

Mr. CROFT afterwards proposed a vote of thanks to the Chairman for presiding, and to the Directors and staff for the very able manner in which the business of the Company had been carried on. They all hoped that the worthy Chairman of the Company might be able to preside over their next meeting.

The motion was seconded, and unanimously adopted.

The CHAIRMAN: In the name of my brother Directors and myself, and of the staff of the Company I beg to return you our sincere thanks for your very kind expressions with reference to our work.

The proceedings then terminated.

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County of London and Brush Provincial Electric Lighting Company (Limited).

The Directors of this Company forward a copy of their report for the year ended Dec. 31st last, which states that the capital expenditure during the year in respect of the Company's London districts amounted to £141,066. 3s. 9d., of which £138,078. 5s. 10d. was expended at St. Luke's and Clerkenwell and at Wandsworth, making the total expenditure on the two London stations to Dec. 31 £410,801. 12s. 1d. This expenditure was met by the balance of instalments falling due on the second issue of 100,000 6 per cent. Preference shares, and by the sale at a premium of the balance of the second issue of Ordinary shares. In order to provide funds for additional requirements during the current year, a further 10.000 Ordinary shares at par were allotted *pro ratâ* to the Ordinary shareholders on Dec. 6 last. The premium received on the balance of the second issue of Ordinary shares has been applied—to reduction of general preliminary expenses (£3,253. 19s. 6d.); to writing off costs in connection with applications for Provisional Orders (£869. 15s. 6d.); and to additions to reserve (£1,500). The interests of the Company in the Bournemouth and District Electric Supply Company (Limited) have been disposed of to the Bournemouth and Poole Electricity Supply Company (Limited) at a substantial profit. The net revenue for the year, including balance forward, and after payment of general establishment charges, rent, rates, taxes, interest, &c., is £21,400. 14s. 2d. An interim dividend on the Preference shares for the half-year to June 30th, at the rate of 6 per cent. per annum, has been paid; and the Directors now recommend the payment of the remainder of the dividend on these shares. This leaves a balance of £10,090. 14s. 2d. to carry forward.

The Company's two London generating stations are now fully equipped and in good running order, having a joint plant capacity sufficient for the supply of 120,000 8 c.p. lamps connected. It is intended to supply the Company's districts north of the Thames from the St. Luke's station in City-road, N., and those on the south side from the station on the Wandle. The station buildings and the equipment thereof are practically completed. The plant installed is capable of supplying 80,000 8 c.p. lamps connected.

The St. Luke's and Clerkenwell station had an equivalent of 23,757 8 c.p. lamps connected to the mains at Dec. 31, an increase of 9,578 for the year; and applications representing a further 1,073 were awaiting connection. A considerable demand having arisen for motive power, separate mains have been laid and a supply of current for power purposes is now available in most of the important thoroughfares in the district. Current is also being supplied from the City-road generating station to consumers in the eastern division of the Holborn district, for which a Provisional Order was obtained last session.

The supply of current from the Wandsworth station was commenced in the early part of 1897, and since September has been available throughout the 24 hours. The equivalent of 13,907 8 c.p. lamps were connected to the mains at Dec. 31st, an increase of 13,690 for the year, and applications representing a further 2,927 were awaiting connection.

Birmingham Electric Supply Company (Limited).

The annual report of the Directors of this Company for the past year states that the amount of net profit, including balance of £1,042. 15s. 6d. from last year, is £13,656. 1s. 7d., out of which, after placing £4,460. 8s. 6d. to credit of depreciation reserve fund, the Directors recommend the payment of a dividend of 5 per cent., absorbing £8,206. 9s. 4d., and carrying forward £989. 3s. 9d. The premiums obtained on the issue of the remaining portion of the Company's capital amounted to £5,475. 8s. 1d., and of this £3,366. 17s. has been added to the special reserve against Provisional Orders; with this addition the cost of the Provisional Orders, amounting to £4,027. 4s. 8d., is now fully provided for. The balance of the premium (£2,108. 11s. 1d.) has been carried to general reserve fund. The total reserves and undivided profits now amount to £22,536. 16s. 6d. There has been a steady increase in the Company's business during the past year; the total number of equivalent 16 c.p. lamps at Dec. 31, 1896, was 25,876, and in 1897 39,232, while the additions since the close of the financial year bring the number to 40,707. Expenditure on capital account during the past year has been £35,250. 9s. 4d., included in which is the completion of the works in connection with the new boilers at Dale End station. The extension at the Company's Water-street depôt was completed in time for the winter's supply. Extensions have been made in the underground main system in various parts of the Company's area. The reduction in the charge for current, introduced in the early part of the year, although slightly decreasing the revenue per unit, have been amply justified by the greatly increased demand for current.

A large number of motors have been added to the system during the year, and the economy and convenience of electricity as a source of power are now generally recognised in the district. In view of the continued increased output, orders have been placed for further engines and boilers for the Water-street depôt for completion by the end of the summer. The capital of the company is now subscribed, paid up, and expended. As certain capital outlay is necessary during the year, a resolution will be submitted to the shareholders next week to authorise the increase of the capital by the creation of 20.000 additional shares of £5 each, to be issued at the discretion of the Directors.

Hove Electric Lighting Company (Limited).

The report of the Directors of this Company for the year to Dec. 31 last records continued progress and improvement in the position of the Company. A considerable reduction in the price of current was made from Jan. 1, 1897, which practically amounted to 20 per cent., and has had the effect of increasing the number of consumers and the consumption of electricity to such an extent that the reduction is more than compensated for by the increased consumption. The revenue from sale of current has increased to £6,838. 17s. 10d., and after deducting cost of generation and distribution, and management expenses, there remains a net profit of £3,602. 9s. 8d., compared with £3,114. 5s 6d. in 1896. £183. 7s. 10d. brought forward brings this amount to £3,785. 17s. 6d., and after deducting debenture interest paid and accrued, and the interim dividend paid in Oct. last, there remains a net balance of £2,092. 7s. 11d. The Directors propose to write £150 off preliminary expenses account, to place £600 to reserve, to declare a dividend (payable on April 15) at the rate of 6 per cent. per annum for the half-year on the share capital (making, with the interim dividend, 5 per cent. for the year) and to carry £218. 7s. 2d. forward.

The number of lamps attached to the Company's system has increased to the equivalent of 27,777 8-c.p. lamps, and the number of consumers to 397, compared with 21,756 lamps and 314 consumers at Dec. 31, 1896. Out of the sum of £600 which has to be set aside for repairs and maintenance, in accordance with the contract with the Hove Commissioners, the unexpended sum of £390. 13s. 11d. has been placed to depreciation and maintenance reserve, bringing the total to £914. 10s., while the general reserve will stand at £2,259. 17s. Since the date of the last report the Directors have issued £2,400 4 per cent. Debenture stock, bringing the total amount issued to £17,000.

The increase of the Company's business, and the continued applications for supply of current from residents in new streets entail further outlay on mains and machinery, for which additional capital is required, and it is proposed to increase the capital to £50,000 by the creation of 2,000 new shares of £5 each, ranking with existing shares, 1,000 of which will be offered to the members *pro rata* at a premium. It is also proposed to increase the limit of the Directors' borrowing powers from £25,000 to £50,000.

Dover Electricity Supply Company (Limited).

The Directors' report for the year to Dec. 31 last states that the capital expended during the year amounted to £11.932. 7s. 9d., bringing the total to £62,836. 7s. 9d.; £7,915. 0s. 3d. was for additional generating plant necessary for the supply of current to the cars of the Dover Corporation tramways, the running of which has given satisfaction to all concerned.

An issue early in the year of £25,000 Four and a-Half per Cent. Debenture Stock was subscribed at a considerable premium, of which the balance, amounting to £761. 2s. 6d., after payment of all legal and other charges in connection with the issue, has been applied to reduction of the previous debits to revenue account. The Directors consider the result of the year's working very satisfactory, since, against a loss of £455. 19s. 11d. in 1896, there has been a gross profit of £1,127. 17s. 5d. The Directors believe that, in view of the completion of the national harbour at Dover, the annual increments in gross profits will at least equal, if not exceed, those for the year just ended, as the trade of the town is likely to largely increase.

Applications have been received for the equivalent of 2,748 8-c.p. lamps, including nine additional arcs for street lighting (of which there are now 40), making the total applied for to Dec. 31 10,376, of which 10,137 were then connected. With the view of inducing an increased average daily use of electricity by householders it was decided to adopt (from July 1 last) the demand indicator system of charging, and to reduce the cost of current after the first two hours' daily consumption from 5d. to 3½d. per unit.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 25d. per oz. (March 3). Consols (2¾ per cent.) 111⅞—112⅛ for money, 112⅛—112⅜ for account; 2½ per cent. 105—106 (March 3). Stock Exchange Settling Days: Consols, April 1; Stocks and Shares Continuation Days, March 9 and 28; Ticket Days, March 10 and 29; Pay Days, March 11 and 30; Mining Share Carry-over Days, March 8 and 26.

BARCELONA TRAMWAYS COMPANY (LIMITED).—Mr. E. M. Underdown, Q.C., at a meeting of this Company on Wednesday, referring to the introduction of electric traction on to the Company's routes, said they had been raising capital for the purpose of applying electric traction to their lines, and had obtained the capital at a premium. They had entirely cancelled their 6 per cent. Debentures. The Company had during the past year obtained a valuable extension known as the Gran Via loop, by which they had secured an additional road. With regard to the Ensanche Tramway, which the Company acquired some years ago, they hoped shortly to obtain permission to convert the line into an electrical one. There were very great advantages connected with this conversion, as they would not require an additional generating station. The progress made in connection with the conversion of their lines had been very satisfactory under the supervision of their engineers, Messrs. J. Dickinson & Co. They hoped by the middle of the summer the electric cars would be at work. Barcelona was especially suited for electric lines, as a great deal of the traffic was on sharp inclines, which caused excessive wear and tear and expense on all systems of traction except the electrical.

BORDEAUX TRAMWAYS AND OMNIBUS COMPANY (LIMITED).—The directors' report for the year 1897 states that, on the question of electric traction, after lengthy negotiations the directors succeeded in coming to terms with a committee of the Bordeaux Municipal Council specially appointed to deal with the subject. Since the end of the year, however, the Council has rejected the committee's report by a small majority. No further steps will, therefore, be taken by the Company in this direction for the present. The shareholders' meeting will take place in London on Wednesday next.

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BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 3s. per share (at the rate of 6 per cent. per annum), free of income tax, for the quarter ended Dec. 31 last, payable on Mar. 25. The transfer books will be closed from the 18th to the 24th inst. inclusive.

CAMBRIDGE ELECTRIC SUPPLY COMPANY (LIMITED).—The annual meeting of this Company was held last week at Cambridge. The Chairman (Mr. D. Munsey) moved the adoption of the report and congratulated the shareholders upon the success of the year's operations. The question of a reduction in the price of current was being considered by the directors. The motion was agreed to, and a dividend of 3½ per cent. was declared, making, with the interim dividend of 2½ per cent. already paid, 6 per cent. for the year.

COMMERCIAL CABLE COMPANY.—A quarterly dividend of 1¾ per cent. (being at the rate of 7 per cent. per annum) has been declared by this Company, payable on April 1 next. The transfer books will be closed from 21st inst. to April 1 inclusive.

COMPANIA TELEGRAFICO-TELEFONICA DE LA PLATA.—The receipts of this Company during the past year amounted to $336,165, and the expenditure to $266,400. Compared with the previous year receipts have increased 78 per cent., and expenses 34 per cent. The closing of the River Plate Telegraph Company's offices greatly benefited the Company. A dividend of 10 per cent. is now to be distributed, making, with the interim distribution of 8 per cent., a total dividend of 18 per cent. for the year.

DUBLIN AND BLESSINGTON STEAM TRAMWAY COMPANY.—At a meeting of shareholders the Chairman (Mr. Fletcher Moore, J.P.) referred to the steps taken by the Dublin United Tramways Company for the introduction of electric traction on the Dalkey, Clontarf and Rathmines Tramways. These experiments would, he said, enable the Directors of the Dublin and Blessington Company to ascertain the most suitable method of working their line.

EDISON-BELL CONSOLIDATED TELEPHONE COMPANY (LIMITED).—It will be seen from an abridged prospectus elsewhere that applications are invited for an issue of £85,000 Five per Cent. Mortgage Debenture Stock at par, and for 8,500 Six per Cent. Cumulative Preference Shares of £10 each in the capital of this Company, which is formed to acquire the letters patent for the United Kingdom, the Isle of Man, Australia, South Africa, South America, and India, and the trade marks for China and Japan, granted to Mr. Edison, Prof. Graham Bell, Dr. Chichester Bell, Prof. Tainter, and others, in connection with phonographs, graphophones, and similar appliances, &c. The prospectus states that there has been in the past obstacles in the way of the general adoption of the phonograph, more particularly the high prices of the machines, and the necessity for the supply of motive power by means of electric storage batteries. It is now proposed to meet any popular demand for the machine by introducing several new types calculated to bring the invention into general use, to simplify the machines, and to introduce a clockwork motor in place of the electric motor. We are ourselves users of the phonograph, and have always found the electric motors supplied with the machines work extremely well, and the charge made by the Edison-Bell Company of £1 per annum seems reasonable for so effective a supply of motive power. However it may be that the necessity for recharging and the obvious simplicity of the clockwork arrangement may be the means of bringing an extremely useful invention into more general use. The development which is now promised appears to be chiefly in the direction of popular entertainment, the Company evidently intending to cater for the many-headed. We ourselves incline to the opinion that the phonograph will ultimately find its most certain and permanent supporters in the commercial, legal and professional classes of the community. The total authorised capital of the Company is £110,000, with an additional £100,000 Mortgage Debenture Stock, beyond which no Debenture or other charge can be created in priority to Preference shares without the consent in writing of three-fourths of the Preference shareholders. The full prospectus can be obtained from the bankers or secretary of the Company, and intending subscribers are invited to inspect the machines at the offices, Edison House, Northumberland-avenue, London, W.C. The lists close on or before to-morrow (Saturday) at 2 p.m. both for town and country.

W. T. GLOVER AND CO.—This Company is about to join the ranks of limited liability undertakings. We understand that the prospectus will be issued in the course of a few days, when the public will be invited to subscribe for a portion of the Preference shares.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY (LIMITED).—The transfer registers of this Company will be closed from the 2nd to the 12th inst. inclusive, for the preparation of dividend warrants.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER COMPANY (LIMITED).—The report of the Directors for the year to Dec. 31 last states that the balance of profit and loss, after providing for debenture interest (£6,500), is £11,154. 14s. 9d., out of which the Directors propose to pay dividends at the rate of 6 per cent. for the year on the Preference and at the rate of 7 per cent. for the year on the Ordinary shares, absorbing £10,850, of which interim dividends amounting to £5,662. 10s. have already been paid. £304. 14s. 9d. is to be carried forward. The Company are pushing on with the construction and electrical equipment of the tramway from Laxey to Ramsey, a further distance of 10½ miles, connecting the two most important towns and districts in the island. The line is double throughout, and is expected to be open in time for the season's traffic.

NORTHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The ninth annual meeting of this Company was held at Northampton on Thursday last. The Chairman (Mr. F. H. Thornton) said that the year had been one of considerable development and progress, and also of some anxiety, caused by the engineers' strike, which prevented their having their new engine in working order. Last year they had sold 11,084 units, an increase of 29 per cent. They had been able to sell current cheaper, and this they hoped would help to popularise the electric light. They had had some difficulty with the gas company, but had secured a successful award from the arbitrator. The Directors looked forward to an extended use of electric current for power purposes, as electric motors had many advantages. There were several motors already in use in the town which had proved most successful. They had just fixed one new engine, and had ordered another. The Directors had had communications with the Corporation, who were desirous of buying the Company's undertaking, but such negotiations progressed very slowly. It would, he considered, be to the benefit of the town if the Corporation acquired the undertaking. As the Company had gone on for so many years without a dividend and without any Directors' fees, and had taken the whole risk, it would not be reasonable that the Directors should suggest to the shareholders that they should sell their undertaking except at a considerable premium. The Corporation had asked them to suggest a figure, and he supposed there might be a price at which it would be worth while to sell. Going ahead as they were, it would be necessary to issue fresh capital. Dividends of 6 and 5 per cent. on the Preference shares, and 2 per cent. on the Ordinary "B" shares was declared, and the issue of 4,290 Ordinary shares of £1 each, and Four per Cent. Debentures of £50 each, to the amount of £3,950, were approved.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed Thursday, 10th inst., as a special settling day for a further issue of 8,000 £5 fully-paid Ordinary shares (Nos. 32,501 to 40,500) of the Chelsea Electricity Supply Company (Limited), and 100,000 £1 shares, 5s. paid (Nos. 1 to 100,000), of the National Electric Free Wiring Company (Limited). The Committee has also ordered 17,400 Ordinary shares (Nos. 1 to 17,400) of Edmundsons' Electricity Corporation (Limited) and £97,800 Four and a-Half per Cent. First Mortgage Debentures (within Nos. 1 to 1,200) of the Halifax and Bermudas Cable Company (Limited) to be quoted in the official list.

VULCAN BOILER AND GENERAL INSURANCE COMPANY (LIMITED).—At the annual meeting of this Company last week a very satisfactory report was presented by the Directors, showing a gross revenue for the past year of £128,420, an increase of £18,500 over 1896. This Company has taken over the entire business of the late Boiler Insurance and Steam Power Company (Limited), and this business has shown a remarkable expansion during the past few years. The increasing connection in the London district has necessitated the taking of larger offices at 3, East-cheap, E.C.

WEST AFRICAN TELEGRAPH COMPANY (LIMITED).—Notice is given that the half-yearly interest on the £300,000 Five per Cent Mortgage Debentures of this Company, due March 1, is payable by the National Bank of Scotland, 37, Nicholas-lane, E.C., on presentation of the coupons.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended Feb. 25 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,396.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Feb. 26	3,332	- 38	...	...	...
Bristol Trams & Carriage	„ 25	2,290	+ 72	8	18,814	+ 3,092
City & South London Ry.	„ 27	1,065	+ 69	9	9,630	- 83
Dover Tramways	„ —	...	...	...	...	...
Dublin United (Southern)	„ 25	352	- 157	9	3,216	- 240
Liverpool Overhead Rly.	„ 27	1,300	+ 25	9	12,130	+ 714
Sheffield Tramways	„ 27	917	+ 33	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Feb. 23.	Price Wednesday, March 2.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 26. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	8/0	Central London Ordinary	10½ 11	10½ 11	2 14 1	June and December	10⅛	10⅜
143,106	10	1/9⅜	Do. (6s paid)	6½ 7	6½ 7	2 11 6	„ „	6⅛	6⅜
£680,000	Stock	1¾%	City and South London Railway Con. Ordy	66 68	67 69	2 14 4	January and July	67	65⅝
8,419	£10	5%	Do. 5% Perpetual Preference	15 16	15 16	3 2 6	„ „	..	..
£135,701	Stock	4%	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	..	..
54,000	10	2/6⅞	Waterloo and City Ordinary	13⅝ 14⅛	13⅝ 14⅛	2 2 1	June and December	14⅛	13⅝
37,500	10	5%	Liverpool Overhead Railway Ordinary	10⅛ 10⅜	10⅛ 10⅜	2 14 6	February & August	—	—
10,000	10	5%	Do. 5% Preference	15½ 16½	15½ 16½	3 1 6	„ „	—	—
125,000	Stock	4%	Do. 4% Debenture	108 110	108 110	3 11 5	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

PRESENT AMOUNT.	AMOUNT OF SHARE.	LAST DIVIDEND.	NAME.	PREVIOUS WEEK'S PRICE FEB. 23.		Price Wednesday, March 2.		RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS DONE DURING WEEK ENDING FEB. 26.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£925,960	Stock	19/6	Anglo-American	58	60	59	61	4 18 4	Feb., May, Aug., Nov.	60½	58½
£3,038,020	Stock	39/0	Do. Preferred	107	103	107½	108½	5 10 7	" "	109	107
£3,038,020	Stock	5/0	Do. Deferred	11½	12	11¾	12½	--	--	12	11½
£187,400	£100	4%	*African Direct Telegraph (Red)	100	104	100	104	3 16 11	January and July	--	--
£25,000	10	--	Amazon Telegraph	6	7	6½	7½	--	--	--	--
130,000	10	3/0	Brazilian Submarine	16⅝	17½	16⅝	17½	4 1 2	Mar., June, Oct., Dec.	17⅛	16⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	12	116	4 6 2	June and December	--	--
10,000,000	$100	$2½	Commercial Cable Capital Stock	187	192	187	192	4 3 6	Jan., Apr., July, Oct.	193	--
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	106	108	106	108	3 14 1	" "	107½	106½
16,000	10	6/0	Cuba Submarine xd	7½	8½	7	8	8 15 0	February and August	7½	7½
6,000	10	10%	Do. Preference 10 per Cent. xd	16	17	14½	15½	6 9 0	" "	14½	--
12,981	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	--	--
8,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	10⅝	10⅛
£80,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	--	--
60,710	£20	3/0	Direct United States Cable, 1877	10⅞	11½	10⅝	11½	5 15 7	Jan., Apr., July, Oct.	11 7/16	10⅛
400,000	£10	2/6	Eastern	18	18½	18	18½	3 10 3	" "	18⅜	17⅞
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	19	20	19	20	3 0 0	" "	19	--
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131	134	131	134	2 19 11	May and November	--	--
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	--	--
250,000	10	2/6	Eastern Extension	18⅞	19½	18⅞	19½	3 13 8	Jan., Apr., July, Oct.	18⅞	--
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	130	133	130	133	3 0 2	February & August	--	--
£125,700	£100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	99	103	99	103	4 17 3	January and July	--	--
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99	103	99	103	4 17 3	" "	--	--
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 16 2	February & August	--	--
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108¾	111¾	108¾	111¾	3 12 1	May and November	--	--
180,227	10	1/9	Globe Telegraph and Trust	12	12⅛	12	12⅛	3 16 0	Jan., Apr., July, Oct.	12⅛	12
180,042	10	6%	Do. 6 per Cent. Preference	17⅜	18⅛	17⅜	18⅛	3 5 9	" "	18⅛	17⅜
150,000	10	5/0	Great Northern of Copenhagen	27½	28½	28½	29½	3 7 9	January, April, July	28¼	--
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B" xd	101	104	100	103	4 17 1	March & September	--	--
17,000	25	12/6	Indo-European	52	55	52	55	4 10 11	May and November	--	--
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904. xd	108	111	106	109	5 10 1	March & September	--	--
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105	108	105	108	3 13 5	June and December	--	--
11,839	8	4/0	Reuter's	8	9	8	9	4 8 11	April and October	--	--
3,381	£100 Cert.	6%	Submarine Cables Trust	139	144	139	144	4 4 3	" "	143	140
15,609	10	6/0	West African Telegraph	4½	4¾	4½	4¾	5 0 0	" "	--	--
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.) xd	103	106	100	103	4 17 1	March & September	--	--
30,000	10	--	West Coast of America	½	1	½	¾	--	--	--	--
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	107	105	107	3 14 9	" "	--	--
88,321	10	1/0	West India and Panama	½	¾	½	¾	--	May and November	--	--
34,563	10	6/0	Do. 6 per Cent. 1st Preference	8	8½	8	8½	7 1 2	" "	8½	8⅛
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	--	--
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	1 8	4 12 2	January and July	--	--
64,256	15	3/0	Western and Brazilian	10½	10⅝	11½	12	2 10 0	May and November	10⅞	10½
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7⅛	8	7½	8	3 15 2	" "	7⅞	--
33,129	7½	1/6	Do. Deferred Ordinary	3½	3¾	4	4½	--	" "	3⅞	3 7/16
£382,230	--	4%	Do. 4 per Cent. Debenture Stock	105	107	106	108	3 14 0	June and December	03	--
£1,165,000	£1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	--	--
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.) xd	100	106	100	105	5 14 3	March & September	--	--
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3	3½	3	3½	5 14 4	August	--	--
224,850	10/0	2½d	Consolidated Telephone Const. & Maintenance	1/16	1/16	1/16	1/16	--	July	--	--
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	--	--
494,597	5	3/0	National xd	6¾	7¼	6¾	7	4 5 9	February & August	7 1/16	6¾
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref. xd	16	18	6	8	3 6 8	" "	16⅞	--
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid) xd	15	17	15	17	3 10 7	" "	--	--
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid) xd	6	6½	5¾	6½	4 0 0	" "	6¼	--
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104	107	104	109	3 4 0	June and December	106½	105
171,504	1	0/4	Oriental	⅜	½	⅜	½	6 13 4	April and October	--	--
58,000	5	5/0	United River Plate	4	4½	4	4½	5 11 1	July	--	--
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	106	103	107	4 14 2	June and December	--	--
			ELECTRICITY SUPPLY COMPANIES.								
£200,000	5	4½%	Birmingham Electric Supply (fully paid)	10⅝	10⅞	10¾		--	March	--	--
50,000	£10	14/0	City of London Electric Lighting (fully paid)	28½	29½	28½	29½	2 7 5	February & August	29	28½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17½	18½	17½	18½	3 4 10	January and July	18⅛	--
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	--	--
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp. xd	14	15	14	15	2 3 6	February & August	14 7/16	--
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	6½	--
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)						January and July		
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	11⅞	12½	11⅞	12	3 2 6	March	12	11⅞
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	115	117	115	117	3 17 5	June and December	--	--
£30,000	£10	--	County of London & Brush Prov. Ord. (fully paid)	15½	16	15½	16	--	--	15⅞	15⅝
20,000	£10	6/0	Do. 6% Cumulative Preference	15⅞	16½	15⅞	16½	3 13 10	March & September	16	--
10,000	£5	--	House-to-House Electric Lighting Supply Ord.	10½	11½	11	12	--	--	11½	11 7/16
10,000	£5	7%	Do. 7 per Cent. Preference	11½	12	11½	12	2 18 4	March & September	--	--
111,000	£5	--	London Electric Supply Ordinary	4½	4⅝	4½	4⅝	--	--	--	--
48,050	£5	--	Do. Preference	6⅞	7½	6⅞	7½	--	--	--	--
49,900	10	5/0	Metropolitan Electric Supply Ordinary	20	21	20	21	2 12 4	April and October	20½	20½
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	19½	20½	19½	20½	" "	" "	20⅜	20½
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	--	--
6,452	10	8/0	Notting Hill Electric Ordinary	19	20	19	20	2 0 0	March	19⅜	19
275,000	1	--	Rand Electric	1⅝	1⅞	1⅝	1⅞	--	--	--	--
£125,000	Stock	5%	River Plate Elec. Lt. Trust'n, Ltd., 5% 1st Mor. Deb.	90	95	90	95	5 5 3	--	93⅛	93½
150,000	$100	$2	Royal Electric Company of Montreal Shares	145	147	145	147	--	--	--	--
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 4 1	April and October	--	--
19,980	5	11/0	St. James and Pall Mall Electric Ordinary	18½	19½	18½	19½	3 14 4	February & August	19½	19
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	--	--
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	107	110	107	110	3 13 1	June and December	--	--
67,900	5	8/0	Westminster Electric Supply (fully paid)	18	19	17½	18½	3 4 10	March & September	18⅜	18⅛
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	5%	Brush Electrical Engineering	2	2⅛	2	2⅛	--	--	2 1/16	2
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	4 16 0	--	2⅜	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock xd	109	113	106	110	4 1 10	February & August	--	--
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 6 2	June and December	--	--
10,000	£10	--	British Aluminium Ordinary					--	--	--	--
20,000	10	--	Do. 7% Cumulative Preference					--	--	--	--
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	9	10	9	10	5 0 0	June and December	9⅜	--
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	110	113	110	113	4 0 0	" "	--	--
200,000	1	--	Castner-Kellner Alkali Co. (fully paid)	1	1½	1	1½	--	--	--	--
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	2½	2⅞	2½	2⅞	--	--	--	--
£82,850	100	--	* Do. 5% First Mortgage Debentures (red.)	86	91	86	91	5 6 5	January and July	--	--
99,261	5	1/6	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3	5 10 0	February & August	--	--
17,139	5	2/6	Do. (£5 paid)	4	5	4	5	5 10 0	" "	--	--
£200,000	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.)	103	105	103	105	3 16 2	June and December	--	--
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅜	2⅝	2⅜	2⅞	3 13 1	February & August	2 7/16	2⅛
16,343	9	7%	Do. 7 per Cent. Cumulative Pref.	3⅜	3⅝	3⅜	3⅝	4 3 4	August	--	--
91,196	1	10/0	Elmore's Patent Copper Depositing	½	½	½	½	--	--	--	--
12,500	10	6/0	Henley's Telegraph Works Ordinary	22½	23½	23	24	4 3 4	February & August	23½	23 1/16
3,000	10	7/0	Do. 7 per Cent. Preference	19	20	19	20	3 10 0	" "	--	--
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.) xd	112	117	110	115	3 18 3	" "	--	--
50,000	£10	15/0	India Rubber, Gutta Percha, &c., Works xd	22	23	21½	22½	4 8 11	" "	22⅜	22
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	103	107	104	108	3 14 6	March & September	--	--
£7,350	12	12/0	Telegraph Construction and Maintenance	39	42	38	41	4 7 10	March and July	39	--
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July	--	--
£22,500	£5	3/6	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	--	--
£22,500	£5	3/0	Do. 6% Cumulative Preference	6⅞	7½	7	7⅝	4 0 0	" "	7¼	--
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	106	108	106	108	3 18 6	May and November	--	--

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NOTES.

PROF. FLEMING'S lectures, no matter how elementary their subject, are always well worth attending, if only to witness the wonderful effects of the experimental drill to which his assistants have evidently been subjected. Experiments follow one another in rapid sucession, and there is hardly ever a failure. One might imagine the lectures had been several times rehearsed, for, in spite of his rapid delivery, the lecturer is never at a loss for a word. This rapid delivery has, however, its disadvantages, for besides taxing the intelligence of his non-technical hearers to the utmost, some of his many humorous observations slip by almost unheeded. For instance, in his second Tyndall lecture at the Royal Institution yesterday, there was hardly a smile when, whether intentionally or through an amusing *lapsus linguæ*, he told his assistant to "take that (soap) bubble away and fill it with oxygen."

THE first of the course of five Tyndall lectures on "Magnetism and Diamagnetism," delivered on the 3rd inst., was naturally of an elementary character. It dealt with the ferromagnetic group of bodies and their properties. The most noticeable feature was the use of the Heavisidian system of nomenclature—of the terms voltivity, fluxivity, magnetivity, retentivity, coercivity and gaussivity. The terms fluxivity for **B**, magnetivity for **I**, and voltivity for the "voltage per centimetre in any direction" may appear strange to some, though we are of opinion that they must be of considerable assistance to students. The assonance, however, between "gaussivity" and "coercivity" might cause confusion. Prof. FLEMING objects to "electromotive force," but he sanctions "police force" on the ground that it makes bodies "move on"; but does not electromotive force make current "pass along"? We may mention that—such is the force of habit—Prof. FLEMING inadvertently made use of the term "magnetic force" for "gaussivity" several times during his lecture. Some pretty experiments were shown yesterday in the second lecture (on "Paramagnetism"). The experiments, in which iron filings first placed themselves on end in the direction of the magnetic flux, and then, when the surface on which they rested was tapped, marched off across the lines of force to the points of greatest induction—or, shall we say "flux-density"—were greatly appreciated by the audience. The experiment of FARADAY, showing the attraction exerted by a magnet-pole on a soap-bubble filled with oxygen, was most successfully shown in the lantern; and a delicate variation of TYNDALL'S experiment, to demonstrate how a magnetically-neutral body can become diamagnetic when immersed in a paramagnetic medium, was performed with absolute success.

GREAT importance in their relation to electrical theory attaches to the researches recently made by Profs. ANDREW GRAY and J. J. DOBBIE, and described by them in a Paper on "The Connection between the Electrical Properties and the Chemical Composition of Different Kinds of Glass," recently read before the Royal Society. Systematic investigation of dielectrics is an avenue of research that leads by a direct road to a better understanding of the mechanism, so to speak, of electrical action; and, when the correlation of chemical composition and electrical properties is to be studied, few, if any, dielectrics can compare with glass for the purpose. In addition to being a homogeneous and well-defined chemical compound, glass possesses the immense advantage over the majority of dielectrics that its composition can be varied gradually and by known amounts between wide limits, as well as by the substitution of one element for another. Thus data may be obtained over a wide range of dielectrics, all related in a known chemical sequence, and the prospect of arriving at a law connecting the chemical constitution with the electrical properties is thereby enhanced. The researches embodied in the Paper referred to are described as "a first instalment of work the authors have undertaken with a view to determine, if possible, the circumstances which affect the

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conductivity and specific inductive capacity of glass." They are therefore incomplete, although useful results have been arrived at, and are set forth in an interesting table. If the authors succeed in arriving at the end in view they will have done far more than to ascertain the causes of the electrical properties of glass—they will have thrown valuable light on the theory of dielectrics in general.

In our issue of January 7th last we referred to a succession of four deaths from electric shock which had occurred in a German chemical factory where no greater electric pressure than 230 volts alternating was employed. The *Elektrotechnische Zeitschrift* in a leading article had expressed the opinion that the fatal pressure did not exceed 115 volts in any of these cases, but our contemporary did not publish the name of the factory or the precise nature of the processes carried on there. The German dailies appear to have made much sensational copy out of this article, not omitting to point to the fact that in the majority of installations a pressure of the order of 115 volts is used. The Hanover Electrical Society at a recent meeting discussed the harm such writing would do to the electrical industry, and resolved to protest to the Verband Deutscher Elektrotechniker that its organ, the *Elektrotechnische Zeitschrift*, should have published the article referred to, and called on it to take steps to obliterate the harmful effect caused by its publication. At the same time the Hanover Society has circularised other electrical societies in order to obtain their opinion on the matter.

The Frankfort Electrical Society, in considering the circular of their friends in Hanover, has agreed to differ from them entirely, holding that our contemporary is to be commended for calling attention to a hitherto-neglected source of danger. While agreeing with the Frankforters that accounts of such accidents should always be published in the technical Press, even if only as a warning, we think that too much care cannot be bestowed on the manner in which they are worded. We call to mind several cases nearer home where technical journals have published misleading particulars of this character, which inquiry would promptly have modified. Instead of withholding the name of the works at which the accident occurred, full particulars of all the facts and conditions which could in any way help to elucidate its cause should have been given, and more emphasis should have been put on the fact that this was essentially a "particular case" from which no general conclusion as to the danger from low-pressure shocks could be drawn. The tendency of the lay Press of all countries to make a sensation of any news item that partakes of the mysterious is well known, and should be reckoned with in such cases.

Patent Expiring.—The patent, No. 4,828, granted to J. [illegible]enheimer in 1884, for a form of telegraph post, expires on [illegible]th inst.

[illegible]terruptions and Repairs.—

	Date of Interruption.	Date of Repair.
[illegible]rus	Feb. 10. 1898 ...	—
[illegible]	Feb. 28. 1898 ...	Mar. 4, 1898.
[illegible]	Feb. 28. 1898 ...	—

[illegible]leers Royal Engineers Volunteers.—By kind [illegible]nel Josselyn the Corps has been able to commence squad drills at the headquarters of the 1st Middlesex Royal Engineers Volunteers in College-street, Chelsea. Technical drills, which count towards efficiency, will be commenced at the end of the present week.

Errata.—In the last line of a letter from Mr. Walter J. Murphy, on p. 301 of our issue of December 24th, $s \propto \frac{1}{\sqrt{f}}$ should be substituted for $p \propto \frac{1}{\sqrt{f}}$. In another letter from Mr. Murphy, on p. 334 of our issue of December 31st, lines 8, 10 and 13 of the second column, *read* "earth current" *for* "electric current."

Telephone Lines and Thunderstorms.—The German Postal Authorities have instituted an interesting inquiry into the influence exercised by telephone lines on the frequency of thunder claps. Observations have been made at 140 places with telephonic communication, and at 560 places without same. A comparison of the results show that, while under the latter circumstances an average of five detonations occur during a thunderstorm, yet where telephone lines are present, this number is reduced to an average of three, and the intensity of the flash also appears to be considerably lessened.

Will.—The will of the late Major Alexander Wood, managing director of the Western and Brazilian Telegraph Company and the Amazon Telegraph Company, who died on January 24th, has been proved by the executors, Mr. John Alexander Wood (the son) and Mr. Charles Aubrey Smith, the value of the personal estate being £11,704. 17s. 8d. gross, and £7,221. 13s. 8d. net. The testator gives to his son, Mr. Robert Gordon C. Wood, and his daughter, Mrs. Isabel Mary Scott-Smith, the silver service presented to him by the staff of the Western and Brazilian Company. The residue of his personal estate is divided between all his children.

Breakdown at Yarmouth Electric Supply Station.—In reply to our inquiries as to the rumoured breakdown at the Yarmouth electric supply station, we learn from Mr. A. Ranken, the Corporation electrical engineer, that on Saturday night one or both of the boilers at work primed badly, and the rush of water blew off the tops of the high-pressure cylinders of two engines before the staff could reach the stop-valves. The engine supplying the public lamps had to be shut down also to save it from a like fate. Supply to the public lamps was resumed an hour later, as well as to a portion of the private lighting, and since 11 p.m. on the same night the station has been running as usual.

Obituary.—We regret to announce the death of Mr. Radcliffe Saunders, a member of the old-established firm of J. B. Saunders and Co., telegraph engineers and electricians, Penarth, near Cardiff, which took place unexpectedly on Sunday last. Mr. Saunders was ill only a few days, and up to the time of the attack had been actively engaged in his professional duties at Cardiff. His death removes a well-known figure from the commercial world of South Wales, and serves to recall the pioneer part played by the firm in the introduction of electric lighting in passenger trains, and in the extended adoption of the latest discoveries in electrical science to railway telegraphy, with which branch of the electrical industry the firm have for many years been closely identified.

Royal Society.—The following Papers were down for reading yesterday: "On the Rotation of the Plane of Polarisation of Electric Waves by a Twisted Structure," and "On the Production of a 'Dark Cross' in the Field of Electromagnetic Radiation," by Prof. J. C. Bose; "An Extension of Maxwell's Electromagnetic Theory of Light to include Dispersion, Metallic Reflection, and Allied Phenomena," by E. Edser; "On the Relative Retardation between the Components of a Stream of Light, Produced by the Passage of the Stream through a Crystalline Plate, cut in any Direction with Respect to the Faces of the Crystal," by J. Walker; and "On the Relation between the Diurnal Range of Magnetic Declination and Horizontal Force, and the Period of Solar Spot Frequency," by W. Ellis.

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Village Lighting.—We briefly mentioned in our last week's issue that an electric light station had been formally opened in Mardy (South Wales). Mardy is a little village at the extreme end of the Rhondda Vach Valley, and four miles from the Ferndale gas-works. Considerable protest having failed to reduce the price of gas below 4s. 6d. per 1,000 cubic ft. a local electric light company was formed, with the baker as chairman and the butcher as secretary; £2,000 being subscribed in £1 shares. Messrs. Crompton and Co. were given the contract for the complete plant, which consists of a steel locomotive boiler, a duplex feed-pump, a compound engine of the vertical type, a shunt-wound dynamo capable of furnishing 168 amperes at 220 volts, a battery of accumulators and a booster for increasing the voltage to charge the latter. At present the lamp connection corresponds only to about half the maximum load that the plant could deal with. The house-wiring has been carried out by the Mardy Electric Light Company itself.

The Cable Fleet.—The cable steamer "John Pender," after completing cable repairs between Delagoa Bay and Mozambique, and while proceeding to the latter place, encountered a heavy cyclone which almost cleared her decks and caused more or less injury to fifteen of the crew. She is now under orders to proceed to Cape Town to refit sufficiently to return home. In the meantime the "Amber" was promptly despatched to Zanzibar to take the "John Pender's" place on the East Coast of Africa, the "Electra" moving up to the Red Sea to replace the "Amber," and the "Chiltern" proceeding to the Mediterranean station. On the West Coast the "Great Northern" is on her way to Cape Town and the "Duplex" is at Sierra Leone. Thus within five days arrangements, involving the movements of six vessels, were carried out to provide for repairing ships being at all the usual stations on the coasts of Africa, a result only possible with a great network of cables and interchange of ships between the associated companies.

Electric Power Supply from Central Stations.—On Saturday last Mr. Addenbrooke read an interesting Paper, with the above title, before the South Staffordshire Institute of Iron and Steel Works' Managers. In it the scheme of the Midland Electric Corporation for power distribution was referred to generally, but practically no fresh particulars of it were disclosed. The capital and working costs of coal-derived and water-derived power were first compared item for item. Dynamos, switching arrangements, motors and cables would cost more or less the same in both cases, the cost of turbines, turbine-pits, sluice-gates, &c., might be set against that of the steam engines, but while the boiler plant would cost some £4 per horse-power, the necessary outworks for a water-power plant would come to considerably more. On the other hand, the depreciation on the turbines would be a little less than on steam engines, and the depreciation of the boiler plant would exceed that on the outworks, but, taking account of the extra cost of the latter and occasional damage by floods, the difference would probably not exceed a couple of shillings per annum per horse-power either way. The difference in annual cost of power supplied on a large scale was practically the cost of the coal and its handling. This Mr. Addenbrooke estimated at £2. 10s. per indicated horse-power per annum in that district. Our opinion that gas engines working with producer gas may ultimately displace steam engines is endorsed by Mr. Addenbrooke, who estimates that it will be necessary to wait 10 or 15 years for this to occur.

By this means the coal bill may be cut down to half, and possibly enough residuals may be extracted from the gases before use to almost pay the cost of the coal. Coal-derived power would then be as cheap as water-power. . . . . Even then, however, I am afraid I do not see much opening for blast furnace gases. If the investigations I have made are correct, it seems to me it will be cheaper for a central station to make its own gas. As a matter of principle also, it seems to me that if there is a waste product in a trade it is better, if possible, to use it in the same or a similar trade, instead of employing it in something totally different, when the two may interfere with each other.

Finally, the author shows that the technical part of the scheme cannot be regarded as experimental. It had paid numbers of manufacturers to instal their own electric plants, and to work them from a small private central station. As an example, Messrs. Siemens Bros., in their large works at Charlton, have a central station containing over 1,500 H.P. of engines, cables transmitting the power to each separate department. So far as the transmission of currents over long distances at high pressure is concerned (and Mr. Addenbrooke mentioned 5,000 volts as "the pressure which it will probably be desirable to use" in that district), there is nothing untried about the scheme, and there would, moreover, be no need to go outside existing practice in the design of the generating station. As regards the cost of transmission—

At the voltage at which the primary mains will be worked the cost of a cable to convey 1,000 H.P., laid complete, will not exceed £1,000 per mile, or £1 per horse-power capacity; a cable for 600 H.P. about 25s. per horse-power; and a cable for 300 H.P. about 42s. per horse-power.

Nothing has yet been settled about the system of distribution, Mr. Addenbrooke being unwilling to come to any final conclusion until absolutely necessary, as experience is rapidly accumulating as to the advantages and disadvantages of various methods and their relative cost. A great deal of consideration has been given to the basis on which current is to be sold to consumers. It has been determined to supply both light and power on the demand meter system. In their agreements with the local authorities, who have so far come to terms with the Midland Electric Corporation, the following are the rat s for power supply, which are not to be exceeded:—Threepence per unit for the first hour's use per diem taken on the maximum demand in any quarter, the number of first hours being taken as 78, *i.e.* six days per week for 13 weeks; 0·825 of a penny for each subsequent hour's use. It is also proposed to supply motors on hire, the Midland Corporation keeping them in repair and replacing them when defective from fair use. The Corporation will keep a stock of spare parts of the different sizes, and in this way a manufacturer will get almost the security of duplicate plant without having to pay for it.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 11th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On Dynamical Illustrations of Certain Optical Phenomena," by Prof. J. D. Everett, F.R.S.; (2) "On Properties of Liquid Mixtures," by R. A. Lehfeldt.

SATURDAY, March 12th.

INSTITUTION OF ELECTRICAL ENGINEERS.

10:30 a.m. Students' visit to the stations of the Metropolitan Electric Supply Company. Applications to join the party should be made at once to the Students' Hon. Sec.

MONDAY, March 14th.

SOCIETY OF CHEMICAL INDUSTRY.

8 p.m. Meeting of the London Section in the Chemical Society's Rooms, Burlington House. Paper to be read: "Electrical Industries at the Foyers Waterfalls," by R. W. Wallace.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture I., "The Thermo-Chemistry of the Bessemer Process," by Prof. W. N. Hartley, F.R.S.

WEDNESDAY, March 16th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Polyphase Motors," by E. E. Tasker.

THURSDAY, March 17th.

INSTITUTION OF CIVIL ENGINEERS.

11 a.m. Students' visit to the ventilating, heating, lighting and drainage arrangements of the Houses of Parliament.

8 p.m. Special Meeting, when the Sixth "James Forrest" Lecture will be delivered by Prof. W. Boyd Dawkins, on "Geology in Relation to Engineering."

ROYAL INSTITUTION.

8 p.m. Tyndall Lecture III., "Recent Researches in Magnetism and Diamagnetism," by Dr. J. A. Fleming, F.R.S.

SATURDAY, March 19th.

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' visit to the works of Messrs. Easton, Anderson and Goolden (Limited), Erith. Train 10:2 a.m. from Charing Cross. Applications to join the party must be made at once to the Students' Hon. Sec.

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday noon.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Resistance of Magnetised Films.—The fact that the paramagnetic metals—iron, cobalt, and nickel—have a different electric resistance according as the specimens examined are magnetised or not was first observed by Lord Kelvin. The variation is an increase when the resistance is measured parallel to the lines of magnetic force, a decrease when perpendicular to them. J. C. Beattie describes some experiments which had for their object the investigation of the manner in which the resistance varies in films of cobalt, nickel, and iron transversely magnetised. Kundt having shown that in such films the Hall effect is proportional to the magnetisation, some simple relation might be expected. The method employed by the author consisted in measuring for any one film the Hall effect and the resistance perpendicular to the lines of magnetic forces, and seeing whether any simple relation existed between them. The films were deposited on platinised glass by electrolysis. It was found that the variation of resistance due to magnetisation was greatest in nickel and cobalt, and least in iron. The lowest field strength at which the variation can be observed is 1,000 C.G.S. units for nickel, 2,000 for cobalt, and 6,000 for iron. In cobalt films the variation of resistance is proportional to the square of the Hall effect, and hence also to the square of the magnetic field. In nickel the variation of resistance differs very considerably according to the specimen used, and after first use it usually is higher than the square of the magnetisation. In iron it is lower.

[Beattie, *Phil. Mag.*, March, 1898.]

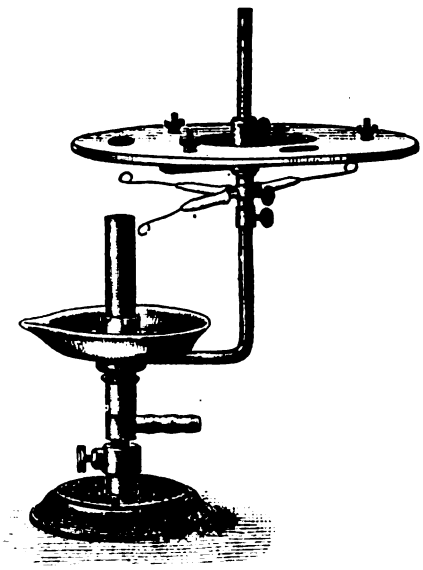
Conductivity of Liquid Films.—Some time ago Koller found that with certain liquids the thinnest films had the highest resistance. This somewhat resembles Wiedemann's discovery of the extreme resistance of the dark cathode space, and the observation that under certain conditions short spark gaps have a higher resistance than long ones. G. B. Bryan has studied this remarkable effect in detail, with all kinds of precautions. Koller himself obtained the films by placing a gilt brass plate on the bottom of a vessel and another plate upon it separated from the first by feet of glass of various thicknesses, and filling the vessel with water, benzol, turpentine and other liquids. Bryan used a screw instead of glass separators; but in the first apparatus used an error in adjustment was introduced by the fact that the upper plate rotated with the screw and was not always parallel with itself. He therefore devised an improved apparatus in which the upper plate did not rotate, and the plates could easily be removed to be cleaned, and could be replaced without interfering with the adjustment. The plates were scraped up to a good surface plate, and alternating currents of 200 $\sim$ per second were used. With this improved apparatus it was found that for dilute solutions, alcohol and aniline, the conductivity is the same for all thicknesses within the limits of the experiments. In other words, these liquid films obey Ohm's law. Koller's contrary results are probably accounted for by impurities, by unevenness of his plates, and by polarisation due to the continuous currents he used.

[Bryan, *Phil. Mag.*, March, 1898.]

Ultra-Violet Light and Röntgen Rays.—J. Zeleny compared the action of ultra-violet light with that of Röntgen rays as regards the effects of their discharging power on the gas in the neighbourhood of the discharged body. The light of an arc lamp was concentrated upon a freshly-cleaned negatively-charged zinc plate. Air was blown through a tube containing the zinc plate into a metal chamber filled with glass wool and connected with an electrometer. The electrometer showed a continuously increasing charge, but such charge was completely stopped, as in the case of X-rays, by inserting another plug of glass wool in the tube in front of the metallic chamber. The amount of free electrification conveyed by the gas is less in the case of X-rays than in the case of ultra-violet light, probably owing to a difference in the mode of discharge.

[Zeleny, *Phil. Mag.*, March, 1898.]

An Improved Sodium Burner.—C. Pulfrich, of Jena, describes a new arrangement for obtaining a broad and steady sodium flame which promises to be of great utility in spectro-magnetic and other observations. It is somewhat similar to that devised by Reed, and consists of a circular plate of asbestos (*see* Fig.) with several holes, circular and elliptical. The flame and the height of the plate are adjusted until the flame just fits into



one of these holes, and saltpetre or sodium bromide is piled up about the rim. The asbestos plate is easily removed, so that the flame can also be used with platinum loops in the ordinary way.

[Pulfrich, *Zeitschr. für Instr.*, February, 1898.]

Electric Car Disturbances.—The United States Naval Observatory is situated on Georgetown Heights, in the suburbs of the City of Washington, on a spot selected by a commission appointed for the purpose. The purchase of this site, which is irregular in shape, and contains nearly 70 acres, was made in 1882. One of the principal requirements of the commission was a site which should probably remain free from disturbances due to the proximity of a city and the effects of traffic. The electric railway had not then been perfected, and no more desirable site could have been selected. Three Kew instruments and one Mascart vertical-force needle were mounted in January, 1894. There are two lines of electric railway passing on parallel lines in a north-westerly direction on either side of the observatory grounds. The main line passes within 1,400ft. of the magnetic observatory. The disturbance due to this railway first showed itself in a blurring or broadening of the curve traced by the vertical-force needle, but it was not sufficiently serious to destroy the value of the record. The disturbance remained about the same until the spring of 1897, when it gradually assumed larger proportions, and began to show itself also in the horizontal force and declination, the increase in disturbance being attendant upon a very heavy increase in the traffic of the road. Magnetic values are published to the millionth of a dyne, and it was found that a single car on the Glen Echo branch of the Tennallytown Road increases the vertical force by 75×10^{-6} dynes. Occasionally, when the trolley wire broke and short-circuited the line, there was a decrease of some $1,500 \times 10^{-6}$ dynes. The only other magnetic observatory in North America, that of Toronto, has had to be abandoned, owing to similar disturbances. "It thus appears," says the Superintendent at Washington, Commander C. H. Davis, "that the use of powerful electric currents for commercial purposes has destroyed the usefulness of the only two magnetic observatories on the North American Continent . . . A remedy could possibly be reached by making it evident that the grounding of powerful electrical currents is either wasteful and extravagant, or is working an injury to other commercial enterprises."

[Davis, *Terr. Magn.*, December, 1897.]

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Time Variation of Terrestrial Magnetism.—Adolf Schmidt writes a review of V. Carlheim-Gyllensköld's pamphlet on the magnetic condition of the earth expressed as a function of the time. Gauss had shown that the earth's entire magnetic force could be referred to a potential of internal forces alone. His analytical representation forms the simplest and surest basis for all further theoretical investigations. One step, however, remained to be taken after him—to express likewise the magnetic condition of the earth as a function of the time. Carlheim-Gyklleusköld deserves the credit of being the first to undertake and complete a solution of this problem, and his paper must be henceforth classed among the fundamental works on terrestrial magnetism. The difficulty in the way of a determination of the earth's magnetic potential at remote periods lies in the fact that no early intensity observations are extant. But the author devised an improved method of determining the potential from declination and dip measurements alone, beginning with Hansteen's, of 1710. As regards the physical causes of the earth's magnetism, the author finds that the variations in the earth's magnetic condition can be referred to the inductive action of an external magnetic field, which may be produced by the earth's inductive action in case the upper layers of the atmosphere are conducting and lag behind the earth's rotation, so as to have a relative motion from east to west.

[SCHMIDT, *Terr. Magn.*, December, 1897.]

RECENT PRACTICE IN AMERICAN ELECTRIC RAILWAY GENERATING PLANT.

The rapid development of electric street railway traction in America has been paralleled by not less remarkable progress in the construction of generating plant for electric railway power stations. It is not our purpose in this article to enter into the particulars of that progress, nor to discuss technical details, but rather to invite attention to the types of machinery depicted in the accompanying illustrations, a glance at which will indicate the magnitude and importance to which railway generator building in America has now attained. The illustrations, in the present instance, relate to machinery manufactured by the Walker Company, of Cleveland, one of the three large concerns in the United States that divide between them practically the whole of this class of work. We hope to give in a future issue a similar account of the newest types of machinery made by the other two companies.

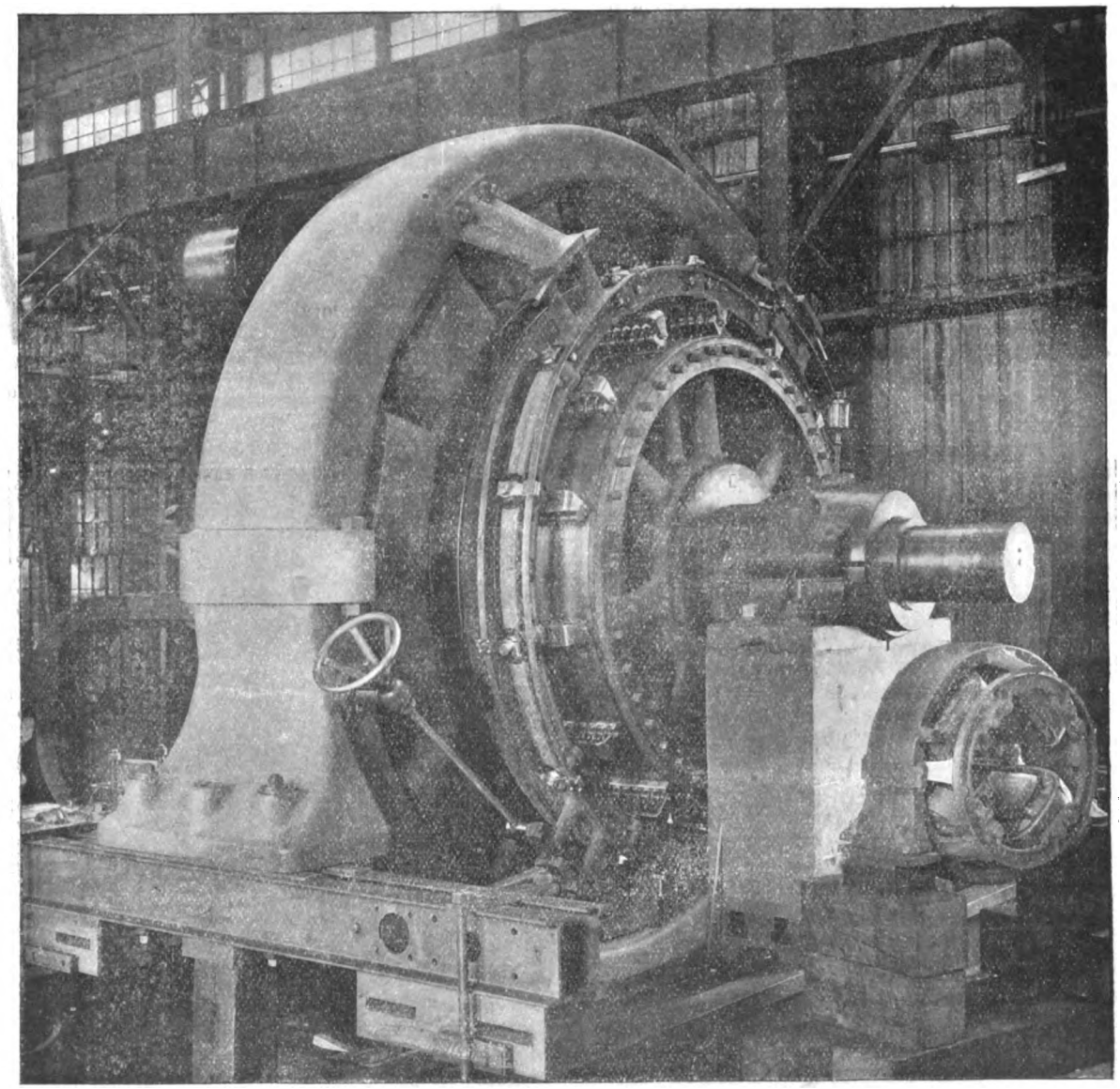

FIG. 1.—1,500-kilowatt "Walker" Generator for the Power House of the Kansas City Electric Tramways.

One of the largest and latest dynamos built for traction work by the Walker Company is that shown in Fig. 1. This machine was built for the power house of the Metropolitan

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RECENT PRACTICE IN AMERICAN ELECTRIC RAILWAY GENERATING PLANT.

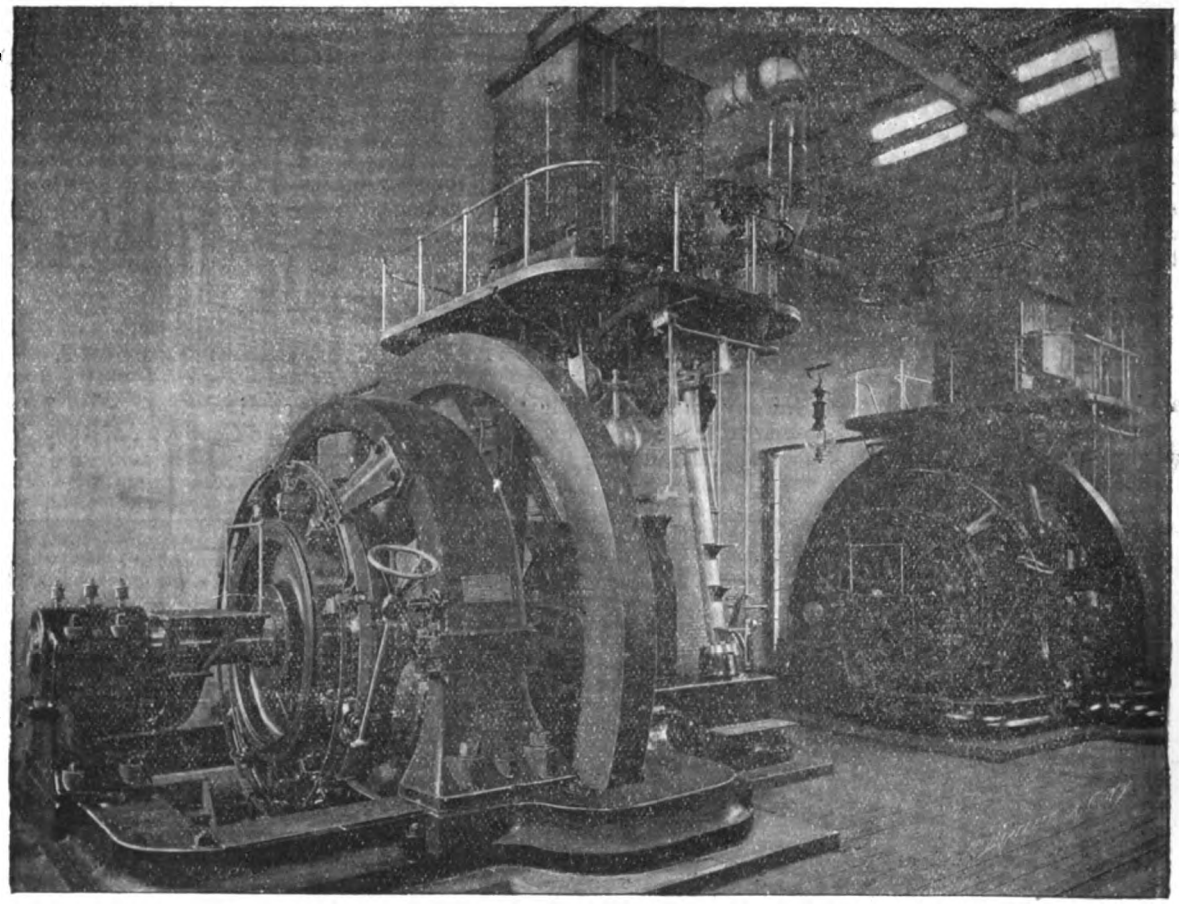

FIG. 2.—Railway Generators at Brooklyn Bridge Power Station.

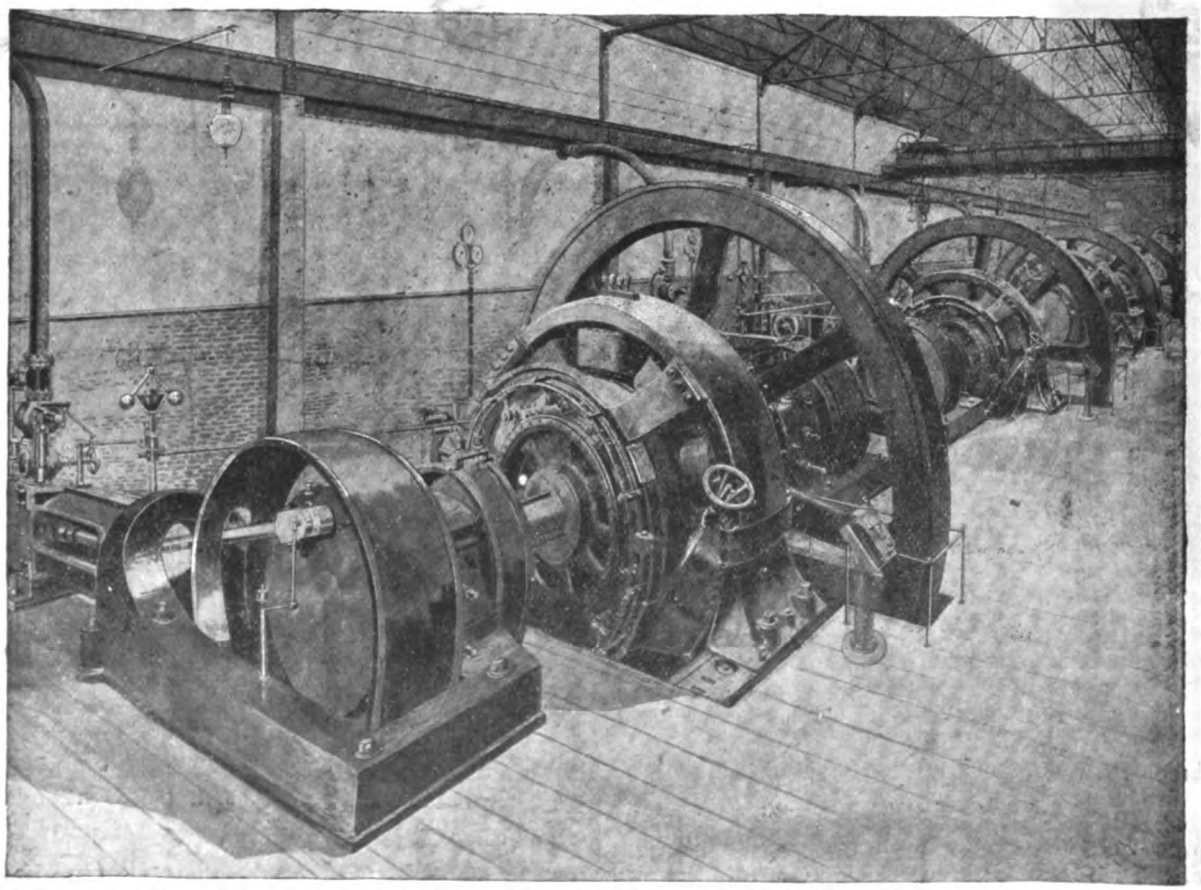

FIG. 3.—Interior of Detroit Electric Tramway Power Station.

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RECENT PRACTICE IN AMERICAN ELECTRIC RAILWAY GENERATING PLANT.

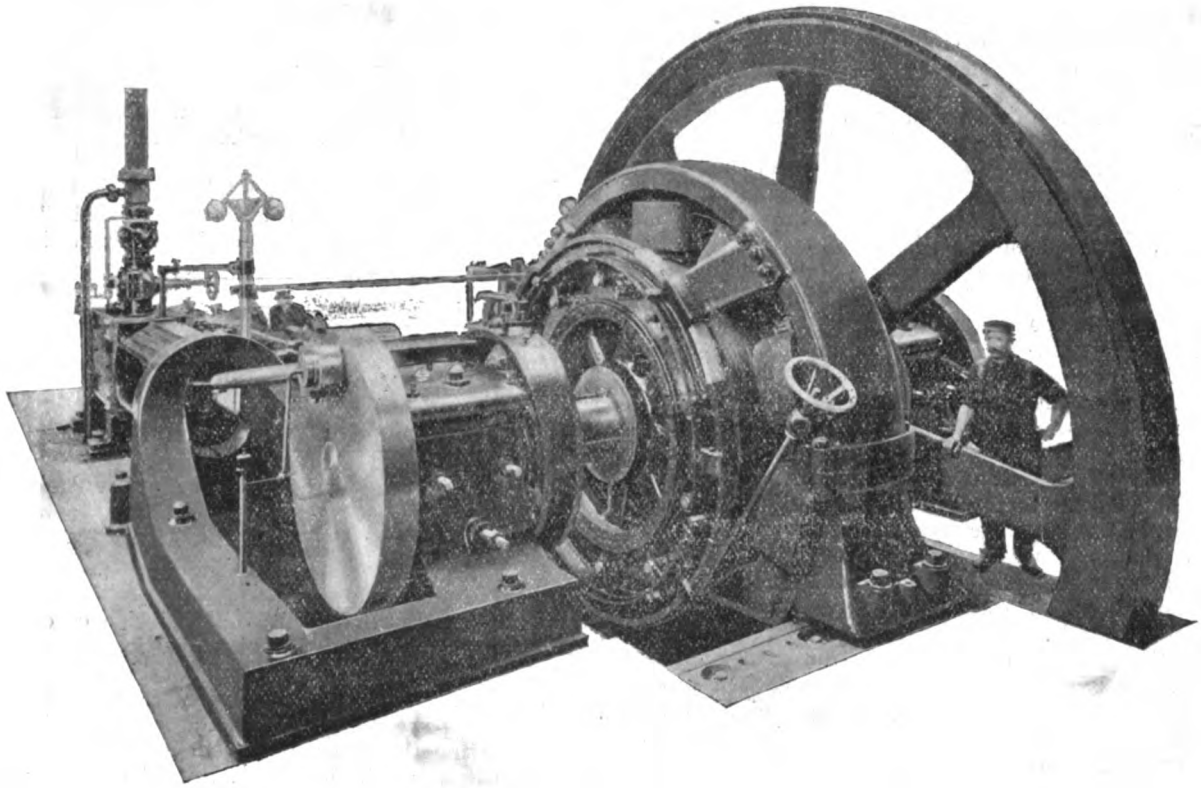

FIG. 4.—Direct-Coupled "Walker" Railway Generator and Horizontal Steam Engine.

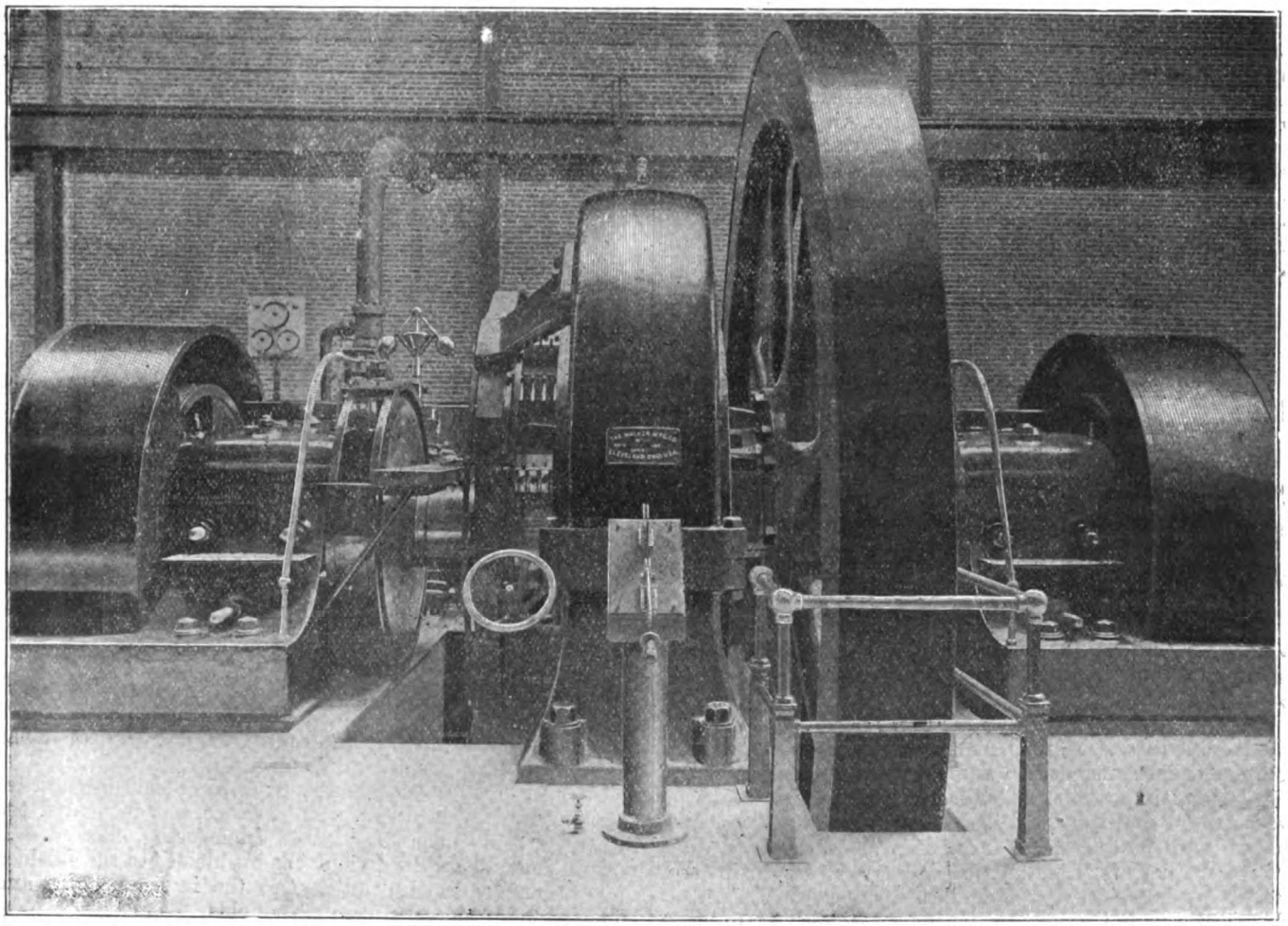

FIG. 5.—Direct-Coupled "Walker" Railway Generator and Horizontal Cross-Compound Steam Engine.

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Street Railway Company at Kansas City, Mo., and will develop 1,500 kilowatts. It is shown as photographed in the erecting shop, but has recently been taken to Kansas City, where it is running direct-coupled to an Allis horizontal tandem compound steam engine. The plant is designed as an extension, and will work in conjunction with the General Electric Company's generators erected some time ago. The station operates 68 miles of track and nearly 90 motor cars.

A different class of generating plant is that shown in Fig. 2, which illustrates two of the Walker generators at the power station of the Brooklyn Bridge railway. The trains on this line are ordinarily worked by cable grip, but are shunted at the termini by means of electric motors, and electric traction is also employed on emergency for hauling the trains across the bridge. The direct-coupled vertical type of steam-driven generating plant is not commonly met with in the United States, horizontal engines either direct-coupled or rope-geared to the dynamos being more usual. In the older and less up-to-date stations one sees nothing but rope-geared or even countershaft-driven dynamos, and even in some of the more modern traction plants rope gearing has been adopted; but the tendency generally is in the direction of horizontal engines direct coupled to the dynamos. A popular type consists in a cross-compound engine with the generator and flywheel placed intermediate between the high and low-pressure halves of the engine, as shown in Fig. 3, which gives a view of the traction power station at Detroit. This type is to be seen at many of the power stations in the United States, and except that it occupies a rather larger amount of floor space than other types, is a serviceable and satisfactory arrangement. Other views of a similar arrangement are shown in Figs. 4 and 5. An equally or perhaps more popular type is the horizontal tandem compound engine direct-coupled to the generator, the flywheel being at the end of the crank shaft opposite from the dynamo. The tandem arrangement, by the way, is coming into use in traction-power stations on this side of the Atlantic; at the new power house to be built at Dublin they will be used, and at the new station at Coventry the old single-cylinder engines are to be compounded by the addition of tandem low-pressure cylinders.

American railway generators are almost exclusively built for continuous-current direct transmission, though there are instances of the use of polyphase plant for traction purposes. The pressure for which the machines are designed varies from 500 to 550 volts for ordinary tramway work up to 600 to 700 volts for high-speed and elevated lines. Usually the generators are compound wound and are over-compounded about 10 per cent.

ON MAGNETIC SHIELDING.—IV.

BY PROF. H. DU BOIS.

(*Continued from page 514.*)

Internal and External Shielding.

§ 25. In the preceding discussion the "shielding ratio," g, as defined in § 8, denoted the ratio $H_e/(H)_i$ of the external uniform field to the field subsisting within the inner shell. It thus afforded a measure for the *internal shielding* against outside disturbances at a distance sufficient to allow of the disturbing field being considered uniform within the range of the sheaths. We now have to consider the case of *external shielding*, *i.e.*, the protection of surrounding space against disturbing causes within the sheaths; generally speaking, we may suppose the latter to be produced by any electromagnetic appliance.

In order, however, to discuss the shielding we have to consider specific cases. If, in the first place, the effect proceeds from one or more magnetic "sources" *or* "sinks," shielding is in general impossible. To illustrate this, suppose one or two north (or south) poles to be placed at or near the centre of a spherical multi-lamellar (as in Fig. 7)—a case not at all a mere mathematical fiction, for it may be approximately realised by introducing a long thin magnet, or, better, a solenoid, through a small hole in the sheaths, so as to bring its end near the centre. The undisturbed field of a single pole is simply radial; on applying the sheaths the lines of force pass radially through the shells without being in the least interfered with. This may be easily verified by a two-dimensional filings-picture for the corresponding cylindrical case. The source (or sink) must then consist of a linear north (or south) pole, such as is more or less realised near one of the ends of a somewhat short cylindrical magnet. The radial pictures obtained in this way with or without a sheath are almost identical. It is hardly necessary to illustrate this very simple case.

Neither does external shielding take place in the case of a single current along the axis; the "axial field," with its circular lines of force, is concentric with the cylindrical shells,

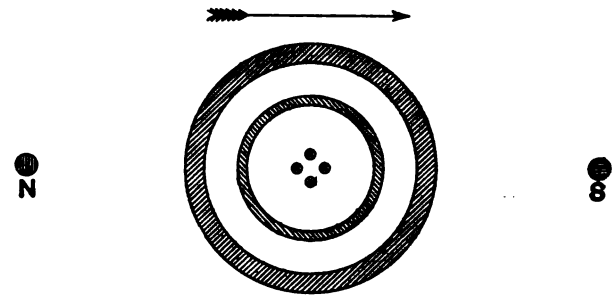

Fig. 7.

and is in no way interfered with either inside or outside the sheathing (compare § 27). The above particular cases will be reverted to in connection with "dynamical shielding."

§ 26. Essentially different phenomena occur with sources *and* sinks of equal power placed within the sheath. The lines of force connecting the two will now in general choose a less resistant path through the shells, instead of spreading disturbance outward; the surrounding space will, therefore, be shielded. We will only treat the simplest case inversely corresponding to a uniform external field. The latter may be supposed due to a source N, and sink S, placed at a sufficient distance apart. In the case of cylindrical shells a linear source and sink at right angles to the plane of the figure (Fig. 7) have to be substituted for these. Now, by the

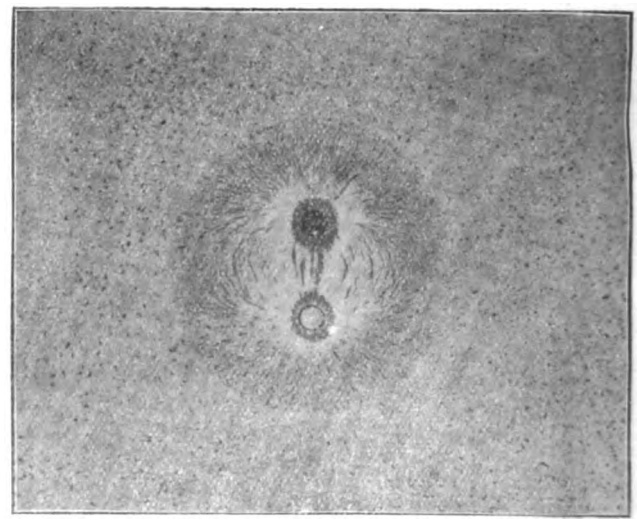

Fig. 8.—Shielded Linear Source and Sink.
(● North Pole; O South Pole.)

theory of reciprocal radii, the inverse of the above with regard to a certain mean radius of the shells simply consists of a source and sink pair near the centre, supposed linear in the case of cylindrical shells.

The effect is illustrated in Fig. 8; a thin shield, of diameter equal to about thrice the polar distance, has prevented the filings in the surrounding space from being affected. If now we denote by k the ratio of the unshielded to the shielded force at any external point due to the internal source and sink, the following general equality holds

$$k = g. \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

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Thus for a given sheathing arrangement the internal and external shielding ratios are simply equal. A proof of this theorem has been given by Poisson and Stefan for spherical and cylindrical uni-lamellars respectively. Prof. Rücker (*loc. cit.* p. 101) furnishes a demonstration for spherical multi-lamellars, which also applies to fields represented by zonal harmonics of higher order. The working out of a corresponding proof for cylindrical multi-lamellars would offer no difficulties; for the latter case experimental evidence will be forthcoming in § 31. Moreover, it will be seen in a subsequent article that this reciprocity of the shielding effect may be indirectly proved by certain dynamical considerations amounting to a *reductio "ad perpetuum mobile"—i.e., ad absurdum.* In the statement of the above theorem the permeability of the internal and external medium is tacitly assumed to have the same value, which in practice is, of course, always equal to unity. An internal source and sink is also formed by a closed current; for spherical shells by a small circular current flowing round the centre, for cylindrical shells by a down-flowing and up-flowing branch parallel to the axis, represented in the usual way in Fig. 7.

§ 27. Before proceeding to the experimental part of our subject a few lines may be devoted to the question of the alleged purely "tangential shielding," mentioned in § 3. As this problem is still considered debateable by several electricians, the writer must postpone a discussion of all the *pros* and *cons* in the controversy, and he will only state that, in his opinion, such an effect does not exist. He considers that the results of the physicists named in § 3, as well as certain ancient myths, have been sufficiently explained or disproved by Drs. Silvanus Thompson, Ascoli, Beck, Kirstädter, and himself.

Experimental Investigation.

§ 28. A number of preliminary experiments were made with eight Swedish wrought-iron cylinders, intended for use on iron-clad galvanometers ($r = 4{\cdot}7$cm., $R = 5{\cdot}7$cm.; height $b = 14$cm.). These had been welded, turned, and annealed. The shielding ratio was simply determined by finding the ratio of the squares of the frequencies of a small suspended magnet freely subjected to the earth's field, or placed in the middle part of the shield. The results were irregular (g being of the order 10 to 20), owing to intrinsic polarity of the shields, which, even when occurring in a slight degree, considerably modifies the weak-shielded field. This may be more or less eliminated by placing the shield in several azimuths. Heterogeneity of the material, especially near the welded bevelled joint, also causes irregularities of distribution. This was expressly excluded in the theoretical treatment (*see* § 6). The shielded field was found to be sufficiently uniform (1) in planes normal to the axis, as far as the suspended magnet could be moved from the centre without having its period appreciably influenced by the neighbourhood of the iron, and (2) along the axis over the middle part of the cylinders. The influence of the open ends on the shielding will be discussed in § 34.

§ 29. The simple method of oscillations thus proving insufficient, except for rough measurements, a combination of it with the method of deflection was resorted to, constituting a near approach to the actual circumstances in most shielded apparatus. The suspended magnet consisted of steel wire bent to the shape of a very small fork, the prongs of which were only a few millimetres apart, so as to keep their own lines of force as much as possible between them.* Another somewhat heavier fork, whose height and azimuth was adjustable along and around the axis, was placed inside the shield, so as to give a directing field of intensity and azimuth variable at will. This could therefore always be made to exactly reproduce the earth's field, notwithstanding the shielding and polarity occurring when the cylinder was put in place. The criterion for the identity of the directing torque in both cases was the equality of the azimuth and period of the suspended magnet; if the period proved somewhat different from that occurring in the earth's unshielded field, a correction was easily applied. A deflecting magnet was placed east or west, and the ratio of the deflections with or without the shield was then simply equal to the internal shielding ratio g. The deflecting field never exceeded 0·05 C.G.S. unit, and was therefore well within the range of constant permeability; its effect was simply superimposed on the distribution resulting from the earth's field, intrinsic polarity, and from any inducing effect that the directing magnet might possibly have on the shield.

In order also to determine the external shielding ratio, the linear source and sink of § 26 was realised with sufficient approximation by a number of very small magnets, each of moment **M**, placed at intervals of 1cm. across the axis of the cylinder, as *e.g.* in Deprez's "fish-bone" galvanometer. The force exerted by such a system at a distance x, small compared with its length, may be shown to be

$$H = \frac{2M}{x^2},$$

x being measured at right angles to the axis, and either parallel or normal to the direction of the magnets. The fish-bone was placed vertically east or west of the magnetometric arrangement. The ratio of the deflections obtained with and without a shield, as before, is now equal to the external shielding ratio k, as defined in § 26. The small magnets were so weak that the force they exerted on the iron of the narrowest shield was still within the range of constant permeability.

§ 30. Most of the experiments were made with three cylinders, consisting of 4, 5 or 6 layers of soft transformer sheet, closely wrapped together; the average thickness of the three plates, cut from the same sheet, was 0·045cm. The cylinders were 30cm. in height, so that the middle part was kept entirely clear of the disturbance due to the ends; the other geometrical data are given in the following table:—

No.	d	r_m	r	R	$\frac{r}{R}$	q	m	w
	cm.	cm.	cm.	cm.				kg.
1	0·270	2·420	2·285	2·555	0·896	0·803	0·197	1·03
2	0·180	4·170	4·080	4·260	0·959	0·920	0·080	1·22
3	0·225	6·290	6·175	6·400	0·965	0·931	0·069	2·35

r_m, r and R denote mean, inner and outer radii, respectively; $q = r^2/R^2$; $m = 1 - q$ (*see* § 7), and w is the weight; d stands for the aggregate thickness of the layers. It may be shown, from equation (I*B) in § 16 that the influence of the intervening films of air and oxide is practically negligible.

§ 31. The three cylinders were first separately tested, but an independent *simple* method of measuring their average initial permeability was somewhat difficult to apply. This constant was therefore first calculated from the experimental value of the shielding ratio by assuming the truth of equation (5*A) of § 16; this gave the values $\mu = 199$, 160 and 177 for the three cylinders respectively. Their agreement may be considered sufficient for a material such as transformer iron, which even when of a good brand shows variations of thickness and quality. For the three possible bi-lamellar combinations g was then measured, and the result compared with the theoretical value calculated from equation (II*A) of § 16. Instead of μ^2, the product of the permeabilities found for the two component sheaths was substituted, this being equivalent to adopting the geometrical mean permeability. The shielding ratio was also determined for the tri-lamellar formed by combining all three cylinders. The following table gives a synopsis of the principal results:—

—	No.	Calculated.			Observed.		
		μ	Product.	g	g	k	γ
Uni-lamr.	1	$\mu_1 = 199$	...	...	10·8	10·9	...
	2	$\mu_2 = 160$	...	...	4·2	4·4	2·8
	3	$\mu_3 = 177$	...	...	4·0	4·2	3·5
Bi-lamellar.	(2, 3)	$\sqrt{\mu_2\mu_3} = 168$	$g_2g_3 = 16{\cdot}8$	12·1	11·4	13·0	6·3
	(1, 3)	$\sqrt{\mu_1\mu_3} = 188$	$g_1g_3 = 43{\cdot}5$	38·4	35·6	...	...
	(1, 2)	$\sqrt{\mu_1\mu_2} = 179$	$g_1g_2 = 45{\cdot}0$	32·8	31·2	31·0	...
Tri-lamr	(1, 2, 3)	$\sqrt[3]{\mu_1\mu_2\mu_3} = 179$	$g_1g_2g_3 = 181{\cdot}0$	...	71·2	...	...

* If too many lines of force of the suspended magnet oscillate to and fro through the solid shield considerable damping occurs, and in an eccentric position the period is also independently affected in a way difficult to correct for.

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§ 32. The agreement of the observed and calculated values of g (fourth and fifth columns) leaves little to be desired, considering the nature of the material operated with. The theoretical values of g are placed beside the products (g_2g_3), &c., forming the first term in equation (II.*A) in the third column of the table. A comparison of the third and fourth columns therefore shows the amount by which the resultant shielding ratio remains below the ideal value corresponding to simple multiplication of its factors (compare § 14). The sixth column contains the external shielding ratios k, determined as described in § 29; these are seen to agree with the values for internal shielding, and thus furnish experimental evidence for the identity of the two ratios, discussed in § 26.

In the last column a few measurements are given of the ratio γ relating to the external shielding against the effect of a magnet about one-third the length of the cylinder, with its axis coinciding with that of the latter instead of perpendicular to it. This case is not amenable to calculation by the two-dimensional methods followed above. It is of some empirical interest, *e.g.* as representing the shielding of a motor car running through an iron tunnel, if the electromotor's field be parallel to the track. This ratio γ is seen to be of the same order as g or k, though considerably less. As

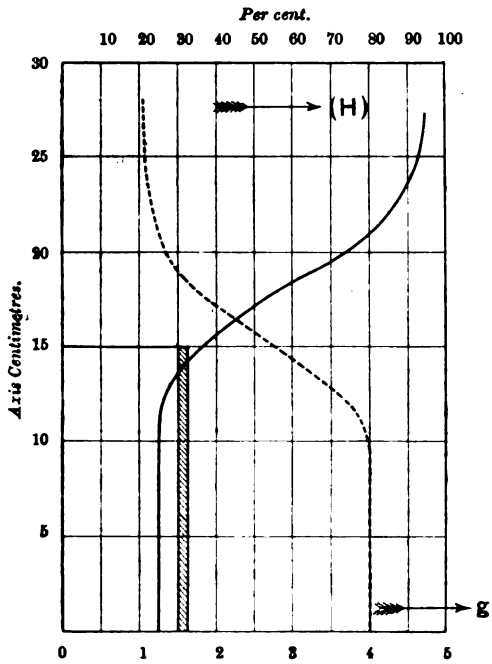

Fig. 9.

regards an electromagnetic system, whose axis encloses an oblique angle with that of the cylindrical shield, the components parallel and perpendicular to that axis have to be considered. The experimental results in the above table ($g_1 = 10{\cdot}8$, $g_2 = 4{\cdot}2$, $g_3 = 4{\cdot}0$) were already approximately illustrated by Fig. 3 (*vide* § 20), referring to a fixed sheath ($g_1 = 11$) and a variable cylinder supposed to expand ($g_2 = 4$). Two particular positions of the latter (marked ⊙ in Fig. 3) nearly correspond to the actual cylinders, Nos. 2 and 3 now investigated.

§ 33. Numerous experiments were made to check the method used. The shielding ratio was found always to remain the same for a given cylinder, notwithstanding the somewhat rough magnetic treatment to which it was occasionally subjected by accident; in fact, the cylinders showed intrinsic polarity after the experiments, whereas the sheet-iron had originally been remarkably free from it. The azimuth of the cylinders relatively to the disturbing field exerted no influence on the shielding, not even when the position of the generatrix coincided with the two ends of the sheet wrapped up in a spiral (which were, of course, made to overlap).

One of the thick wrought-iron cylinders of § 28 was uniformly wound with wire, by means of which a *circular* field of several C.G.S. units could be excited. Besides the corresponding circular magnetisation, this produced considerable polarity, owing to the welded joint and general want of homogeneity. Notwithstanding this, and the high permeability corresponding to the circular field, the shielding ratio proved practically unaffected by it. This result lends support to the assumption, made throughout, that shielding against moderate disturbing fields depends, within due limits, upon the constant permeability for small increments or decrements of force superimposed upon any condition of magnetisation.* This is of immediate applicability to the shielding of apparatus such as galvanometers, where the coils and directing magnets exert an appreciable influence on the sheaths.

§ 34. Hitherto the cylinders were understood to be of infinite length, the influence of the ends being thus eliminated. In order to test how far this assumption is justifiable in the case of cylinders of finite length the field was determined along the axis of several of the cylinders as far as shielding was still perceptible. Fig. 9 represents the result for cylinder No. 3, one-quarter of which is shown in shaded section; the full-drawn curve shows the value of the shielded field (H) on the axis expressed in percentage of the impressed field; the dotted curve represents reciprocal values, *i.e.*, the shielding ratio g. It will be seen that the distance, over which the influence of the open end extends inward is about equal to the radius. We may hence infer that the shielding in the central part of a sheath, whose length is three or four times the radius, does not differ from that which would occur in an infinitely long cylinder, as stated in § 7. For shorter cylinders it is less, according to Stefan, in the approximate ratio of b to $\sqrt{4R^2 + b^2}$, where b denotes the height, and the root the diagonal of meridian section.*

(To be continued.)

* Lord Rayleigh, *Phil. Mag.* (5), Vol. XXIII., p. 245 (1887).

* This result is given by the late Prof. Stefan (in the Paper mentioned in § 1) without proof, and is probably empirical.

ON THE MANUFACTURE OF LAMPS AND OTHER APPARATUS FOR 200-VOLT CIRCUITS.†

BY G. BINGSWANGER BYNG.

In the progress of electrical industry manufacturers have become accustomed to sudden demands arising from a discovery or a successful experiment, and I purpose to deal with apparatus which manufacturers are called upon to make to meet the requirements of the latest innovation—*i.e.*, the distribution at a potential of 200 to 230 volts. Central station engineers have thus arranged their three-wire system, relying upon makers to successfully alter lamps and minor fittings incidental to such a change. Their expectations have been fulfilled in a measure only. The ultimate success of the high-pressure system will depend largely upon the verdict of the consumer, and he will give it in its favour only if his fittings, in points of efficiency, economy, safety, convenience, and appearance, approach the standard which he can obtain by means of the lower voltage system. It is therefore of importance that the central station engineer should assist the manufacturer to arrive at such perfection. His instructions, so far, have hardly gone beyond the demand to supply him with fittings to conform in appearance to the 100-volt system. It is true each central station has issued rules; but they are of little help to the manufacturer, and their very disconformity shows that there is neither unanimity nor correlation of ideas between the engineers in charge. What is wanted is to have a thorough interchange of opinion of engineers, contractors and manufacturers. The latter would then know theoretically how far they may satisfactorily depart from the present practice, and thus save much time and money in adventitious experiments; and this also might tend to produce some degree of standardisation—much to be desired in the interest of all who have the success of the new system at heart. With this object in view I bring this Paper before you, and I think I can best serve the purpose by describing the chief appliances now upon the market, or under manufacture at my works, pointing out the existing deficiencies, and giving you my views upon the attainment, as far as possible, of higher perfection.

Incandescent Lamps.

Most important in connection with this subject is the incandescent lamp. The lamp manufacturers have been compelled to supply 200-volt lamps at a given candle-power and efficiency, in the same size bulbs as are used for 100-volt lamps. With flashed carbon

† Paper read at the Institution of Electrical Engineers on Feb. 24, 1898.

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the manufacturers meet with the great practical difficulty of properly disposing their long thin 200-volt filament in the same space as their shorter and thicker 100-volt filament, and therefore most of them solve this problem by resorting to a filament of much higher specific resistance than would be given by the flashing operation.

Unflashed Filaments.—Such a lamp is ready to the maker's hand by simply taking his ordinary carbon filament as it exists before being flashed—that is to say, before it is reduced by a fresh layer of carbon being deposited on the surface of the original filament. The higher specific resistance of an unflashed carbon enables one to easily get over the difficulty of size of bulb, as such a filament will give the necessary resistance by taking a shorter length. Such filaments have also a greater emissivity, owing to the darker and rougher nature of their surface than that of flashed filaments; consequently they require a less amount of surface by candle-power, and therefore the mass of an unflashed filament, at a given candle-power and efficiency, is less than that of the flashed filament. The filaments of high-voltage lamps largely used to-day are, therefore, in other words, faster converters of energy into heat and light than flashed filaments of the same candle-power and efficiency, although the watts supplied to each be the same.

On comparing the behaviour of such 200-volt lamps with that of 100-volt lamps, the roughest of tests shows that there is a far more rapid falling-off of candle-power during life with the former than the latter. At the same time, the efficiency of an unflashed lamp decreases in a given number of hours by a far greater percentage than is the case with the flashed lamp. Mr. Robertson has made a series of life and efficiency tests on high-voltage lamps. They show that in the average unflashed 200-volt 16-c.p. lamp the percentage loss of candle-power in 600 hours is about 42 per cent., and the average drop of efficiency is about 35 per cent.

These two quantities seem to cover the chief practical merits desirable in an incandescent electric lamp—*i.e.*, the lamp which has the best percentage retention of original candle-power during its life, together with the best average percentage retention (or increase) of original efficiency during its life. These tests show that these most desirable points, which have been worked on diligently for the last 13 years, have had to be thrown on one side in order to bring about the possibility of using the same-sized bulb for a given candle-power at 200 volts as at 100 volts.

Tests of the behaviour of unflashed high-voltage lamps show that such lamps sometimes increase in candle-power during the first 100 hours or so. This also happens with badly-carbonised or badly-flashed 100-volt lamps (noted by Prof. Ayrton in some of his recent lamp tests), owing to the initial lowering of their resistance in consequence of their not having been properly carbonised in the first instance; and this is often accompanied by a great alteration in the character of the surface (emissivity) of the filament. The carbonising or baking process is therefore still going on in the lamp, and the two above-mentioned changes coming together mask the fact that a great deterioration of the filament has taken place; but a period is quickly reached when this fact is no longer masked. This period is when there is no further decrease of resistance; but the surface deterioration still goes on, and thus soon brings about a large pecentage fall of candle-power, and on the slightest increase of voltage there is now a tendency to increase resistance. These changes seem to be initially, owing to the fact that the (unflashed) high-specific resistance carbon is far more volatile than is the case with a good flashed carbon.

A microscopical examination of a flashed and unflashed filament after each have been running 500 hours shows that the surface of the flashed filament is still quite smooth and shiny, whereas the surface of the unflashed filament has become very dull, sooty, and often full of small pit-holes. These pit-holes and soot form a large increase of surface, which therefore increases the emissivity of the filament, and consequently lessens its candle-power, as the watts supplied keep the same. The property of an unflashed filament becoming so rapidly less efficient (increasing in watts per candle-power) acts as a preservative, because the increased emissivity lowers the temperature. This lowering of temperature decreases both the tendency to volatilise and also to further great change of resistance. This power of self-preservation leads to such a filament giving some satisfaction to the general public, for the latter is satisfied when it obtains a good average, or sometimes an excessively long-life lamp; but this is very false economy, as it is only purchased by a very great falling-off in actual efficiency.

Mr. Robertson's experience with carbon filaments seems to point to the fact that *it is impossible to obtain a carbon filament of high specific resistance without its being accompanied by at least the defect of greater volatility.* In other words, the lowest specific resistance carbon is the best, because it is less liable to evaporation, and therefore it gives the best retention of original candle-power and efficiency, and it is also mechanically stronger. The specific resistance of many of the present types of 200-volt lamps is about 3,500 to 5,000 microhms per cubic centimetre, whereas it is easy to obtain flashed carbons whose specific resistance is as low as 2,400 microhms per centimetre; and even as low as 300 is possible, but not practicable.

Gases.—Another important consideration to bear in mind as to whether the high or low specific resistance carbon is the best, is that the high specific resistance filaments retain their occluded gases in a far more persistent degree than is the case with the low specific resistance flashed filaments. It is probable that the occluded gases arising from the carbonisation of the filament are, by means of the flashing process, driven off to a large extent; and, in addition, the more dense and impervious nature of the flashed surface prevents the filament from absorbing the gases during its subsequent handling or treatment. This absorption is a property possessed by all carbon bodies in some proportion, varying with their density. This greater power of unflashed carbon to absorb gases, and to retain what it has absorbed, than is possessed by flashed carbon, leads in many instances to sudden deterioration of the vacuum in a finished lamp, accompanied by short-circuiting as soon as the pressure and the condition of the residual gases in the bulb has reached its most conductive point. The consensus of opinion at the present day of the average types of high-voltage lamps undoubtedly points to the fact that a large percentage are expected to short-circuit as soon as they are put up, and I have heard several engineers say that they expect about one in twelve to go in this way.

From these causes, and others relating to the treatment of filament pointed out above, there seems to be no doubt that the average 200-volt lamps have a shorter life than 100-volt lamps. The above experiences have led Mr. Robertson to design all high-voltage lamps that are not restricted by size with well-flashed carbon filaments, and such lamps compare favourably with lower voltage lamps.

Horizontal Burning.—Another question which is very important in considering 200-volt lamps is that of horizontal burning, and contractors should take special notice of this. There is no doubt whatever that almost all the present-day 200-volt lamps are only suitable for burning in a vertical position. As soon as any other position is adopted defects become prominent. The long thin filament soon drops on to the bulb and cracks it. Also electrostatic attractions, owing to higher voltage, cannot be resisted by the long thin filament, and this is an additional cause of the filament approaching the bulb. The effect of electrostatic attractions on long thin filaments is even noticeable with lamps burning in a vertical position. Such lamps have to be designed with the object of making their filaments more rigid, and to be thus able to withstand the effects of gravity and electrostatic attractions exerted by the charge on the bulb; and this is the chief point which makes high efficiency 200-volt lamps so difficult to produce. There is, therefore, a tendency, in trying to avoid the defects just mentioned, to make 200-volt lamps as low in efficiency as possible.

Leading-in Wires.—Another fault that exists with the bulk of the present forms of high-voltage lamps is, that, owing to the same size bulb being retained, no greater separation can be given between the leading-in wires of the lamp. This is a special difficulty with high-voltage lamps which contain two filaments, as, in this case the same size cap is used, and four wires are passed through the sealing point instead of two, and they are therefore more crowded together. This question of distance apart of leading-in wires is a vital one, both in the manufacture of the lamp and in its after-use. In the case of unflashed carbons this becomes a still greater defect, owing to small distance combined with probably greater gaseous emanation. The higher the voltage, the sooner are these defects made manifest. Even with 100-volt lamps there is, under certain conditions, a tendency for current to jump across from pole to pole, owing to the remanent gases in the bulb attaining a high state of conductivity. The greatest conductivity of the remanent gases which lead to sudden short-circuiting appears to be when the pressure is about 0·01mm. But, by reason of a continued discharge taking place in all lamps, there seems to be a tendency for the residual gaseous molecules to arrange themselves in a straight path between each pole. Through such a path discharge will take place even in a better vacua than 0·01mm. This leakage current (sometimes called the "Edison effect") which leads to short-circuiting is very prominent during manufacture of high-voltage lamps, and to avoid it greater care is required as the voltage increases.

If the size of a bulb for a high-voltage lamp is to be restricted to the present dimensions, there is no doubt that the best lamp would still be that which has a single filament, were it not that other vital questions step in. Electrostatic effects also increase with the voltage, and several most promising patterns of lamps, from all other points of view, have had to be put on one side on this account.

As to the best forms of cap for high-voltage lamps, preference will naturally be given to those in which the poles can be kept furthest apart. If a B.C. or E.S. cap were on a larger scale, there is no doubt that considerable benefit would accrue. The simplest holder, with the least moving parts and for always making the best contact, is undoubtedly the Edison screw, which, in the cases of

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excessive vibration, can be made with a locking device. The slightest want of insulation in the cap between the poles eventually leads to a large leakage current between them or the cap and one of the poles, and in many cases this is suddenly established to such a large degree as to result in the complete fusion of the lamp-cap, and sometimes the holder. In such cases a non-metallic lamp-cap seems to offer great advantages, and has, in my experience, removed complaints on this score.

Standard Voltage.—From a lamp-maker's point of view a fixed standard of voltage and efficiency would only lead to an increased cost in manufacture, and the present practice of varying efficiencies with voltages, running in the case of low-voltage lamps from 95 to 120, and in the case of high-voltage lamps from 200 to 230, tends to keep the lamp at a lower cost than if these efficiencies or limits of voltage were more restricted. On the other hand, voltages which lie outside these limits are a source of great expense to the manufacturer. It would, therefore, tend to cheapen lamps if a standard of voltage were adopted which lay exclusively between the above or even smaller limits, but at varying efficiencies.

Combination Filaments.—In order to get over the difficulty of size of bulb, &c., many filaments (beyond the unflashed pure carbon filament in order to obtain any advantage which might be derived from the "luminescence" of the rarer earths is apparently greater than 5 watts per candle-power; and, as above stated, it has been found impossible to so evacuate a lamp as to leave any of the "luminescent" bodies incorporated with the filament at temperatures higher than 5 watts per candle-power, the object sought for is consequently defeated.

From the above it seems that, with our present knowledge, the best form of 200-volt lamp is that which has a well-flashed low specific resistance pure carbon filament in a large bulb, with a well-insulated moisture-proof cap allowing the poles to be placed at a reasonable distance apart. It should consist of a single filament, and be so disposed in the bulb that it can withstand the disturbing effects of gravity and electrostatic charges on the bulb. I wish to mention here that my co-director, Mr. Robertson, has given me great assistance in the remarks I have made upon lamps.

Switches.

I come now to the matter of adapting switches, wall plugs, ceiling roses, lampholders, and minor fittings. I do not apprehend any difficulty in changing existing types from the present standard of use to conform to the higher standard, yet maintaining the same

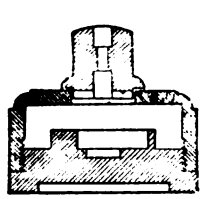


Fig. 2.

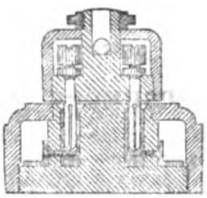
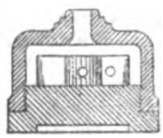


Fig. 4.



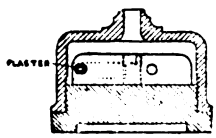


Fig 3.

Fig. 5.

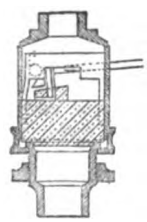


Fig. 6.

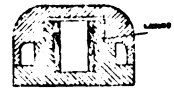


Fig. 7.

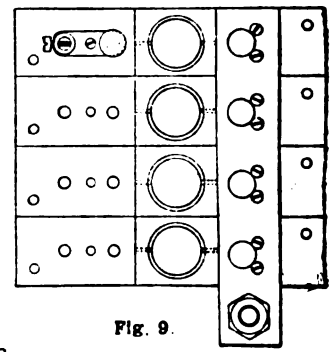


Fig. 9.

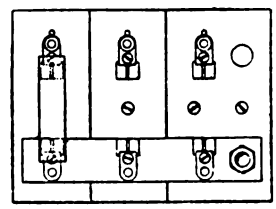


Fig. 8

High Voltage Fittings.

Fig. 2.—Double Break Switch.
Fig. 3.—Ceiling Rose.
Fig. 4.—Wall Plug.
Fig. 5.—Ceiling Rose, with Lined Cut-Out.
Fig. 6.—Key Socket.
Fig. 7.—China Cut-Out, with Lined Chamber.
Fig. 8.—Cut-Out Board, with Spring Clips for Hollow China Fuse-Holders.
Fig. 9.—Cut-Out Board, with lined Chambers.

derived from cellulose in some form) have been introduced which have a high specific resistance. This can only be obtained by using a less dense form of carbon than has hitherto been found most satisfactory in low-voltage lamps.

A form of high-specific-resistance filament that has been tried is where the carbon has been admixed with various oxides, borates, and silicates of the earths. In addition to mixtures, electrolytic and chemical deposits of these bodies on the surface of carbon have also been tried; but, although it is a simple matter to obtain baked carbons containing these bodies either incorporated with the carbon or on the surface thereon, it is quite another matter to obtain a finished lamp containing these bodies in a form to be of any practicable use. The difficulties met with are apparent as soon as the lamp is incandesced while undergoing exhaustion. If such lamps be incandesced to a temperature exceeding about 5 watts per candle-power, there is a gradual separation by evaporation of these bodies from the carbon, and their resulting deposition on the surface of the lamp bulb. The temperature of incandescence of the appearance and size, and, when sufficiently in demand, approximately the same cost. The chief alteration will be in the increased break, and better insulation of the two poles. In smaller articles, such as combined switches and lampholders, the difficulty, if any, is more apparent. A discussion bearing upon the subjects involving the use and construction of double-pole switches, length of break, standardisation of terminals, position of fuses, the carrying capacity of contacts, &c., would be, to my mind, of great value.

Without enlarging upon the subject of switches to an undue extent, I will show some specimens of different types I find to be satisfactory in practice.

Fig. 1 is a switch to take the place of the ordinary link or tumbler switch, and Fig. 2 is an ordinary double-break china switch. You will notice the formation of the china base, and the separation and action of the metallic parts, which are arranged to produce a long break and perfect insulation, so that an arc cannot be maintained if established, nor can a shock be communicated to the operator. The remaining Figs. are drawings of wall sockets

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and ceiling roses, &c., to illustrate my further remarks under this heading. It is not necessary to go deeply into the subject of fixtures such as electroliers, pendants, &c., but in connection therewith I wish to refer to the question whether it is advisable to recommend the use of two or more low-voltage lamps in series on a 200-volt circuit. Within my own experience, I know of several installations fitted originally with 200-volt lamps that have, by reason of greater expense for current, and an inferior light, been rewired for two 100 lamps in series, with satisfactory results. It is within the province of manufacturers to materially assist wiremen by designing fittings specially adapted to series wiring, such as series holders, ball fittings, brackets, or electroliers with arms in multiples of two; and such a practice might be extended with advantage to many other details.

The question of fuses for higher voltage requires more careful investigation, and would repay thorough discussion. Central-station engineers agree to differ upon the various points of efficiency, as evidenced by the different rules issued for our guidance. Some lay stress upon increasing the length of fuse wires, others insist upon ventilation holes, and in some cases the height of covers are to be increased. But there is no unanimity between them, and none of these rules, in my opinion, indicate the right direction. I have made some extensive experiments, and believe that the results are of interest to the profession generally.

When a circuit is opened by the disruption of a fuse the combined metallic vapours and hot air produced by the high temperature of the resulting arc may extend and maintain it so as to bridge over the terminals, which, melting and becoming volatilised, feed the arc, and rapidly increase the temperature. I find, in practice, that under these conditions the china base supporting the fuse and terminals is easily volatilised also, and not only contributes towards the maintenance of the arc, but is ruptured as if by explosion, tending to set fire to any inflammable surroundings. This rupture has hitherto, I believe, erroneously been attributed to the expansion of

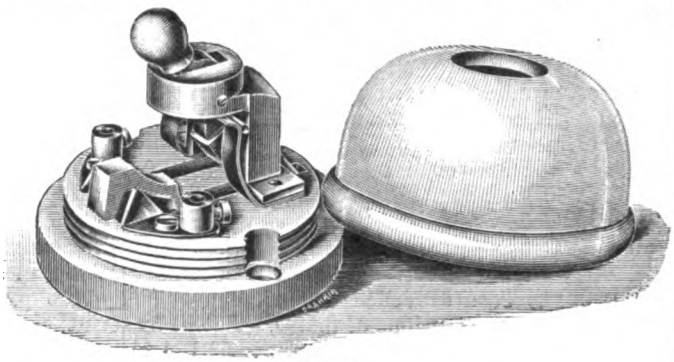

FIG. 1.

air confined by the cover; hence the ventilation holes, which, according to my opinion, are useless. The same experiments tend to prove the fallacy of using a long fuse wire, with the concomitant disadvantages of finding space for it, and also difficulty in renewal; and I feel sure that full efficiency may be attained with a short fuse.

My deductions from the aforesaid experiments are that:—(1) It is essential to arrange a fuse wire so that it will break at a definite part of its length, *i.e.*, approximately the centre; and (2) the arc formed on breaking the fuse must be so confined that it cannot be maintained so as to damage the terminals, base, or cover.

I will now describe how I have carried out these essential points in china cut-out boxes, which are the general type of fusible cut-outs used in house installations in this country. These fuses are arranged on china bases, or in groups upon cut-out boards, and their carrying capacity varies from 1 to 100 amperes. In all these I provide what I call a "fuse chamber"—*i.e.*, a round china wall forming a central hole, from ½in. to 1in. in diameter—and this is pierced with two holes near to the terminals, which are fixed upon the base outside the wall. The wire is threaded through the holes from one terminal to the other, passing through the fuse chamber. Both ends of the fuse wire are supported by a material which is a better heat conductor than air, whilst it is free in the central fuse chamber. Thus the same current raises the temperature of the fuse wire within the fuse chamber more rapidly than at the supported ends, therefore the disruption takes place there, and the resulting arc is enclosed. I find, however, that china as an isolator is not sufficient, because of its tendency to volatilise under the high temperatures—a fact I have already mentioned. Therefore I line the interior of the chamber with another material which is a better heat conductor and less liable to fracture, and I find that ordinary plaster-of-paris is most convenient for this purpose, although several other substances may be equally efficient.

Fuses constructed on this principle require but a short length of wire, and are perfectly safe on high voltages, and the general appearance and size does not differ to any great extent from those now in common use. The principle once established of surrounding part of the length of fuse wire with a substance that is a better conductor of heat than air, we can easily construct any other type of fuse upon the same principle. Fuse wires enclosed in glass tubes filled with plaster or cement, but with a free central space for fusion, for instance, fulfil the same conditions. I find that such fuses have been patented by Mr. Mordey in 1890. The mere fact of enclosing a fusible wire in a non-conducting refractory filling would not fulfil the essential functions of a perfect fuse as I have described, without a clear space at or about the centre for disruption. Mr. Mordey describes such a space in his specification, but it is for the purpose of observation only, and it is not clear from the tenor of the specification that the inventor had this purpose of the localisation of fusion in mind. Mr. Miller, of Kensington, has also altered the ordinary Edison fuse by substituting thin copper wire, and partly filling the centre with asbestos fibre. So far as localising the point of disruption and confining the arc, this fuse acts very well, although copper or alloyed fuses are not perfect under any circumstances, by reason of the maintenance of a dull red heat under normal load.

(*To be concluded.*)

THE RUSHMORE MULTI-VOLTAGE DYNAMO.*

After a number of years of study and experiment, Mr. S. W. Rushmore, of the Rushmore Dynamo Works, Jersey City, N.J., has perfected a method of working ordinary multipolar generators, whereby a simple machine with single armature winding, single commutator, &c., may be made to deliver its entire output at a single voltage in the usual way, or be connected to a number of independent circuits and the voltage on each circuit independently varied from 0 to maximum without the least mutual interference. By the new method a machine will supply as many circuits as there are pairs of poles, and the voltage is varied by varying the excitation of the poles acting on the different parts of the armature. Each pair of brushes with the corresponding section of armature and pair of field poles constitute, as it were, an independent machine, and each may supply a separate circuit; or they may be connected in groups to meet the requirements of the different circuits to be supplied.

A four-pole two-circuit machine, now on exhibition at the Rushmore Works, is operated in connection with a special switchboard for showing all its various applications. When brushes of the same sign are connected together on a single circuit, the machine will deliver its entire output in the usual way. To show how the machine will fulfil all the conditions of a feeder and main system, one pair of brushes is connected to a water rheostat taking 125 amperes at 110 volts, while the other pair is connected to the same rheostat through two smaller rheostats corresponding to the resistance of a feeder. The voltage is then raised on the second pair of brushes to as high as 150 volts to deliver 125 amperes more to the main rheostat, thus overcoming a drop of 40 volts on the feeder. In another experiment the machine carries one-half the full load on one pair of brushes at 110 volts, while the other pair is connected directly to the brushes of a separately excited elevator motor, and the motor is started and stopped and run at any speed and in either direction by varying the E.M.F. supplied to it by the dynamo; and although this variation is all the way from 0 to maximum in sudden jerks, there is not the least interference with the lights on the other pair. In connection with storage batteries the machine may run in parallel with the cells at full load, and at light load one or more of the pairs of brushes may carry the load while other pairs are connected to the battery, and the voltage increased to any amount required for charging, thus doing away with boosters and wasteful resistances.

The same machine was shown in operation as a motor dynamo taking current at one pair of brushes and running at constant speed, and delivering current from the other pair, the voltage on the second or dynamo pair being varied from 0 to maximum by a rheostat in the corresponding field circuit, thus having all the advantages of a motor driven dynamo with better efficiency and without the extra cost of two machines.

The brushes are fixed and there is no sparking, even though the current exceeds 50 per cent. overload over the whole range of voltage.

The principle on which the machine operates is similar, in some respects, to that of the Rushmore multi-circuit arc dynamo,† which consists in collecting the current from the armature in such a manner that the armature flux does not affect the strength of the poles under which current is directly collected. This is shown in Fig. 1, which illustrates diagrammatically the course of the armature flux in a four-pole machine with ring armature, with current taken from one pair of brushes only, the field flux being omitted. In

* Abstract of an article in the *Electrical Engineer* of New York.

† See *The Electrician*, November 5, 1897, pp. 34 and 40.

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the diagram it is assumed that the total armature flux is four lines. It will be seen that two of the lines will circulate across the pole under which the current is directly collected, while the other two lines will pass through pole N′ in a direction opposing the field lines, then around the field ring and through pole N″ in a direction to assist in its magnetisation, thus completing the circuit. In this manner the effect of current in the armature through brushes *a* and *b* is to weaken pole N′ and to a like amount strengthen pole N″, while poles S′ and S″, under which current is directly collected, are unaffected. When the loads on both pairs of brushes are equal, the distorting influence due to one current is equal to and neutralises that due to the other, and there is then no interference, and the machine acts exactly the same as if operated in the usual way on a single circuit.

With a lap wound drum armature the distribution of the armature flux is more complex, as the current collected from a single pair of brushes passes before both poles of each pair. All the poles in a

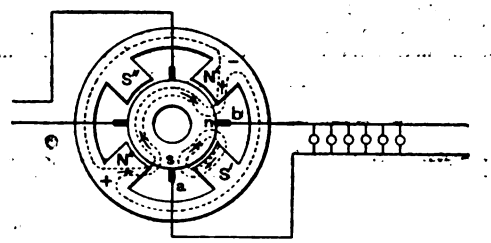

FIG. 1.

four-pole machine are affected, but as the current from each pair of brushes strengthens one of its poles as much as it weakens the other, there is no interference, and thus the only difference in the machine is that the armature must be of the multi-circuit or lap wound type.

ELECTRICITY WORKS ACCOUNTS.

This week we publish statements and analyses of the accounts of the Dover Electricity Supply Company (Limited), and of the Notting Hill Electric Lighting Company (Limited).

Dover Electricity Supply Company (Limited).

Of special interest and importance are this year's accounts of the electric supply system at Dover, as they mark the influence of a tramway load upon a station which formerly did little, if anything, else than generate current for lighting. The invigorating effect is unmistakable and most pronounced, even though the supply of power for the Corporation tramways has existed only during the last four months of the year, and represents only 11½ per cent. of the total energy sold. When the concern shall have had a whole year in which to benefit by the tramway load, an even greater improvement will almost indubitably be realised. This branch of the supply—the actual revenue from which is unfortunately not separately stated in the accounts—has exerted considerable influence in the improvements indicated both in a rise in the revenue per unit sold, and in a decided fall in practically every cost that can be reduced by a magnified load-factor. As regards revenue, an improvement of 50 per cent. in the receipts from supply per unit sold has raised the total revenue per unit sold by about 22 per cent., the aggregate receipts having risen 85 per cent., from £2,839 to £5,249. As regards expenditure out of revenue, there has been a substantial fall of 18·7 per cent. in the total cost per unit sold. This has been chiefly effected by a reduction of 10 per cent. in the generation costs and of no less than 44 per cent. in the "fixed charges" pertaining to management and property—the natural effect of an improved load-factor. Curiously enough the cost of fuel per unit has slightly augmented.

In previous years the accounts of the Dover Electricity Supply Company have presented a somewhat gloomy aspect, showing not only a deficit on the balance of the revenue account, but also heavy fixed interest charges, including a 6 per cent. charge on a loan capital of £25,000. Against such a past record considerable headway must be made before the accumulated deficit can have been wiped off and a surplus be available for distribution to the shareholders. But rapid strides are being made in that direction, and already a deficit of £456 against the revenue account has been converted into a working profit of £1,778 for the year, which is a change amounting to over 4 per cent. on the mean capital expended. A further change for the better has been the redemption of the £25,000 loan, carrying 6 per cent. interest, by the creation of £25,000 Debenture Stock bearing 4½ per cent. interest, the whole of which has been taken up. Still, a balance on the wrong side of the previous account equal to 6·68 per cent., and interest chargeable equal to 3·38 per cent., or an aggregate charge of 10·06 per cent. of the mean capital expended, leave much yet to be done, the present deficit standing at 5½ per cent. Notwithstanding all this it would not surprise us if a dividend were to be declared next year on the accounts for the present year's working.

Notting Hill Electric Lighting Company (Limited).

It is gratifying to scan the accounts for the past year of the Notting Hill Electric Lighting Company, which differs from the companion accounts in this respect—that whereas the latter show a transition from a more to a less unprofitable state, the Notting Hill accounts indicate a substantial advance upon the former prosperous condition. This is shown in the most convincing manner possible by the dividend of 6 per cent. on the Ordinary shares as against 4 per cent., a balance of about £18 being carried forward, as against £4. A remarkable feature in the working of this concern is the low percentage ratio of expenditure to revenue. In the previous year this figure stood below 45 per cent., but in the last accounts it is shown to have been reduced to 41 per cent. Thus the working profit for the year is considerably greater than the total expenditure. Another striking feature is the low proportion of the total costs represented by the works-costs. Indeed, the generation and distribution of electricity involved an expenditure of only 47 per cent. of the total costs, the remaining 53 per cent., for "Management and Property Charges," representing a somewhat unusually large proportion, the most prominent item being that against "Salaries," which includes Directors' fees amounting to £650, this item amounting to 1·11d. per unit sold.

The authorised capital of this concern is £150,000, comprising 550 Founders' shares at £10, 2,998 £10 Six per Cent. Preference shares, 6,452 £10 Ordinary shares and 1,000 £100 Four per Cent. Mortgage Debentures, the whole having been received with the exception of £40,000 debentures. A sum of £14,079 has been expended out of capital during the past year, chiefly on extensions of mains. It will be seen that the balance of capital account represents £3,184 over-expended. In view of this fact, and the necessity for an immediate outlay of about £7,000 on new mains and machinery, an addition to capital of £14,150 is required; and this it is proposed to raise by the issue of debentures at £107. 10s., covering £11,000, and the absorption of the £3,340 now standing to the "Renewal and Depreciation" account. If the additional capital is raised in the manner proposed the entire sum set apart as a reserve against contingencies, &c., will have been appropriated to the ordinary capital account, a risky proceeding which it is difficult to find justification for. Hitherto the depreciation and reserve fund has been accumulating at the steady, if not altogether rapid rate of £1,000 per annum. "The policy of the Board," we are told by the Chairman, "is to increase this fund to such a point that the Company shall be in a position to bear the strain of any breakdown. . . . without inflicting a loss of dividend upon the shareholders." But if the fund is to be virtually wiped out of existence there will be up-hill work in re-starting it and bringing it up to the proper mark in future, and the shareholders will have to forego more than the customary £1,000 per annum for the purpose. In our opinion this fund ought to be a real and permanent affair, not a mere matter of book-keeping, and the accumulated sums appropriated to it ought to be held, or, better still, invested, against no other charges than those specifically related to the purpose of the fund. The day may not yet have arrived when the benefit of such a fund will be felt, but it is coming; and for some electric supply concerns it is nearer than would seem to be indicated by the indifferent manner in which the depreciation fund is nurtured. The best of mains and machinery will not last for ever, and there is much that will last a shorter time than seems to be generally allowed for.

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	DOVER.	NOTTING HILL.
Undertaking Worked by	Dover Electricity Supply Company (Limited).	Notting Hill Electric Lighting Company (Ltd.).
Date of Commencement of Supply	1895.	1891.
System of Supply	High-pressure alternate-current sub-stations[a]	Continuous 3-wire battery system.
Chief Engineer	A. A. Whitlock.	George Schultz.

YEAR ENDED DECEMBER 31st.	DOVER 1896.	DOVER 1897.	NOTTING HILL 1896.	NOTTING HILL 1897.
QUANTITIES—				
Units generated	207,027	317,190	252,690	378,206
„ **SOLD (TOTAL)**	154,200	234,074*	230,787	354,969
„ sold to consumers	66,216	128,334	230,787	354,969
„ sold for public lighting, &c.	87,984	78,624	—	—
„ used on works	5,578	9,037	7,370	8,500
UNITS SOLD PER 8 C.P. LAMP CAPACITY	14·0	13·4	11·5	17·7
Maximum supply demanded	154 kilowatts	289 kilowatts[e]	235 kilowatts	310 kilowatts
Number of public lamps	31	40	nil	nil
Connections to mains in 8-c.p. lamps	7,904	10,137	25,000	31,000
CAPACITY OF PLANT IN 8-C.P. LAMPS	11,000	17,500[e]	20,000	20,000
CAPACITY OF PLANT IN KILOWATTS	325	525	600	600

CAPITAL—	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£75,000	£231	£75,000	£143	£150,000	£250	£150,000	£250
Share	50,000	154	50,000	95·3	100,000	167	100,000	167
Loan (including Debenture charges)	25,000	77·0	25,000	47·6	50,000	83·3	50,000	83·3
RECEIVED (TOTAL)	49,278	152	49,300	93·9	96,840	161	110,000	183
Share	24,278	74·8	24,300	46·3	96,840	161	100,000	167
Loan (including Debenture charges)	25,000	77·0	25,000	47·6	nil	—	10,000	16·7
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	25,722	79·0	25,700	49·0	53,160	88·6	40,000	66·7
Share (unissued)	25,700	79·0	25,700	49·0	nil	—	—	—
Share (uncalled)	22	—	nil	—	3,160	5·27	—	—
Loan (including Debentures)	nil	—	nil	—	50,000	83·3	40,000	66·7
REPAID (TOTAL)	nil	—	nil	—	—	—	—	—
RESERVE OR SINKING FUND	—	—	—	—	} 2,340	3·90	3,340	5·57
DEPRECIATION FUND	—	—	—	—				
EXPENDED (TOTAL)	50,904	157	62,836	119·8	99,105	165	113,184	189
Lands and buildings	13,342	41·1	13,418	25·6	18,345	30·5	18,295	30·5
Plant	14,797	45·5	16,199	30·9	20,022[a]	33·7	20,906[a]	34·9
Mains	16,758	51·6	17,814	33·9	52,638	87·7	64,408	107
Miscellaneous	6,007	18·5	15,405	29·4	8,100	13·5	9,575	16·0
BALANCE OF CAPITAL ACCOUNT	−1,626	−5·00[b]	−13,536[f]	−25·8[f]	2,265[b]	3·78	3,184[b]	5·31

REVENUE—	Total.	Per unit sold.	Total.	Per unit sold.	Total.	Per unit sold.	Total.	Per unit sold.
TOTAL	£2,839	4·42d.	£5,249	5·38d.	£8,553	8·89d.	£11,626	7·86d.
Revenue from supply	1,724	2·69d.	3,965[g]	4·07d.	7,366	7·66d.	10,231	6·92d.
„ meters, &c.	77	0·12d.	114	0·117d.	398	0·414d.	519	0·351d.
„ public lighting	950	1·48d.	1,095	1·123d.	nil	—	nil	—
„ sale of lamps, &c.	59	0·092d.	50	0·051d.	513	0·533d.	573	0·387d.
„ miscellaneous sources	29	0·045d.	24	0·025d.	276	0·287d.	303	0·205d.
EXPENDITURE OUT OF REVENUE—								
TOTAL COSTS	£3,296	5·13d.	£4,070	4·17d.	£3,816	3·97d.	£4,771	3·22d.
WORKS COSTS	2,384	3·71d.	3,303	3·38d.	1,719	1·79d.	2,252	1·52d.
Generation of electricity	*2,107*	*3·28d.*	*2,874*	*2·95d.*	*1,680*	*1·75d.*	*2,222*	*1·50d.*
Fuel (including cartage, &c.)	1,040	1·62d.	1,631	1·67d.	683	0·71d.	982	0·664d.
Oil, waste, water, stores	87	0·135d.	93	0·095d.	174	0·181d.	138	0·093d.
Wages at station	791	1·23d.	813	0·834d.	414	0·430d.	485	0·328d.
Repairs and maintenance at station	158	0·246d.	259	0·266d.	409	0·425d.	618	0·418d.
Distribution of electricity	*151*	*0·235d.*	*257*	*0·264d.*	*39*	*0·040d.*	*30*	*0·020d.*
Wages, &c.	134	0·209d.	136	0·139d.	} 39	0·040d.	30	0·020d.
Repairs, renewals of mains, &c.	17	0·026d.	121	0·124d.				
Public lighting	*126*	*0·196d.*	*172*	*0·176d.*	*nil*	—	*nil*	—
Attendance	—	—	55	0·056d.	—	—	—	—
Renewals	—	—	117	0·12d.	—	—	—	—
MANAGEMENT AND PROPERTY CHARGES	912	1·42d.	767	0·787d.	2,097[c]	2·18d.	2,519[r]	1·70d.
Royalties	—	—	—	—	*nil*	—	*nil*	—
Rent, rates, taxes	*114*	*0·177d.*	*115*	*0·118d.*	*264*	*0·274d.*	*394*	*0·266d.*
Management	*798*	*1·24d.*	*652*	*0·669d.*	*1,623*	*1·69d.*	*1,978*	*1·34d.*
Salaries	454	0·706d.	320	0·328d.	1,349[d]	1·40d.	1,640[k]	1·11d.
Stationery, &c.	83	0·129d.	38	0·039d.	41	0·043d.	57	0·038d.
Establishment charges	235	0·336d.	232	0·238d.	90	0·094d.	115	0·078d.
Law charges, &c.	26[e]	0·040d.	31[h]	0·0318d.	144[e]	0·150d.	166[m]	0·112d.

FINANCIAL RESULTS—	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded
WORKING PROFIT FOR YEAR	−£456[d]	−0·92%	£1,778	3·13%	£4,737	5·17%	£6,854	6·46%
Sum carried to Depreciation Fund	nil	—	nil	—	} 1,080[f]	1·18%	1,050[n]	0·99%
Sum carried to Reserve or Sinking Fund	nil	—	nil	—				
Net interest on loans (incl. Debenture charges)	1,627	3·28%	1,923	3·38%	37[g]	0·040%	155	0·146%
BALANCE FROM LAST ACCOUNT	−1,711[d]	−3·45%	−3,795[d]	−6·68%	+137	0·150%	+4	0·004%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	—	—	—	—	3,894	4·25%	5,657	5·33%
Deficit	*3,795*	*7·66%*	*3,179[i]*	*5·59%*	—	—	—	—
ORDINARY DIVIDEND PAID	—	—	—	—	4%	—	6%	—

	DOVER 1896.	DOVER 1897.	NOTTING HILL 1896.	NOTTING HILL 1897.
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	116%	77·6%	44·6%	41%
Expenditure per kilowatt capacity	£10·13	£7·75	£6·36	£7·95
REVENUE PER KILOWATT CAPACITY	£8·73	£10	£14·25	£19·4
Expenditure per 8-c. lamp capacity	6s. 0d.	4s. 8d.	3s. 10d.	4s. 9d.
REVENUE PER 8-C.P. LAMP CAPACITY	5s. 2d.	6s. 0d.	8s. 6d.	11s. 7d.
Price charged for lighting, per unit	7d.	7d. − 3½d.	8d.	8d. − 4½d.
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ELECTRICAL MANUFACTURE AT A PROFIT.

The concerted action of the leading firms of electrical plant manufacturers in this country, in conjunction with the Municipal Electrical Association, of which we give detailed information in the annexed article, is a direct attempt to elevate the electrical manufacturing business of Great Britain to a profitable level, from the depths of the profitless, and sometimes even worse than profitless, abyss to which it had sunk during recent years. The conditions under which engineering work is carried out in this country differ in several respects from those of many continental countries and the United States, but in none more emphatically than in the almost absolute power vested in the consulting engineer. In all important engineering undertakings, whether civil, mechanical or electrical, it has been our national custom to place both the drafting of the initial scheme and the surveillance of the contract works in charge of an individual professing to be an unbiassed and competent expert. Rarely has sterling reputation for excellent work obtained for a British manufacturing firm emancipation from the dictates of the consultant; and, except where firms have directly acquired control over the undertaking, we know of no instance of an electrical firm having been engaged to carry out any works of importance other than through the medium of a consulting engineer. It is the consulting engineer who, in the first instance, drafts the specification of the work to be done, and therein imposes the conditions under which it is to be performed; whose advice, having the authority of an expert, really decides between the competing firms; and who, in the past, has been practically the sole arbiter in regard to the interpretation of the specification, during the performance of the contract. He it is, in fact, who, in the majority of cases, has the power of actions which make all the difference between an anticipated profit and a realised dead loss

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for the contractors. In the olden and golden days of British engineering, when to be a consulting engineer generally implied the possession of a hoary head and many decades of experience, and when the number of individuals engaged in this work was more commensurate than now with the aggregate of work to be done, there was a high code of honour, by which both engineers and contractors were safeguarded from the ruinous rate-cutting so disastrous in later times. To have accepted work at fees one-half or one-third of the normal figure would have been scorned; and to have drawn up a specification that would have admitted of successful competition by unscrupulous tenth-rate contractors, would have been considered still more reprehensible.

But in recent times competition has altered the face of custom. To-day the number alike of aspirants to the profession of consulting engineer and of competitors in the ranks of engineering manufacturers has augmented out of all proportion to the increment of work to be done—substantial though this latter has been—and the struggle for existence has grown so keen, that the survival of the fittest has been by no means always the survival of the best. On the one hand, youthful and inexperienced men have sought to wrest from the leaders of the profession the patronage of those about to employ contractors, partly by undertaking to perform their duties for ridiculously low remuneration, and partly by earning a reputation for draughting sharper specifications and securing lower tenders than the more experienced and reputable engineers have the conscience to do. On the other hand, firms have sprung into existence whose policy it has been to tender for lower prices than those for which the work could be carried out in a fair and honourable manner; work being done either at a loss, for advertising purposes, or an ill-gotten profit being realised by recourse to shoddy material and scamped workmanship. We do not mean to assert that all contracting work and all consulting advice have been of this evil character; far otherwise, indeed, has it been. But the free existence of these two classes of unscrupulous competitors has become increasingly a menace to the existence of the legitimate members, and has already wrought much harm by reducing the scale of prices to such a pitch that it has been difficult or impossible for honest firms to carry on a profitable trade.

To remedy this unfortunate state of affairs a number of the leading firms have formed themselves into a defensive alliance, known as the Electrical Engineering Plant Manufacturers' Association, having for its main object the introduction of more rational and less irksome clauses into engineering specifications. Leading consulting engineers and the Municipal Electrical Association were approached, with the result that a number of standard clauses for insertion in such specifications have been drawn up and approved. Without wishing to employ the term in any invidious or unfriendly sense, we may refer to this alliance as a species of ring, or "combine," as they term it in America; but the non-aggressive and self-protective character of the organisation must justify its formation in the eyes of all right-minded individuals. The question arises, however, as to whether the organisation is an effective one. Frankly, we may say we do not know of any better way in which its promoters could have sought to attain their ends; but it is none the less evident that the strength of the combination is secured only by the moral support employers of engineers and of contracting firms may bestow in the future. It is devoutly to be hoped this bulwark will be sufficient to safeguard the movement against the "outside" consultant and the tenth-rate contractor; and, furthermore, we trust that the praiseworthy effort of leading engineers and manufacturing firms to elevate the industry to a profitable level will afford no encouragement to those who do not hesitate to import inferior foreign plant at cheaper prices. But though we trust and hope, we can see in the constitution of this "combine" no guarantee that such shall not be the case. Much, very much, however, will have been secured if the adoption of these standard clauses by leading consulting engineers and firms of manufacturers revives again something of the code of honour and the *esprit de corps* of former days; if, in other words, it should once more come to be regarded as derogatory to the profession of a consulting engineer to encourage inferior work because at a lower price, or to practise unfair competition by undertaking work that does not really pay. From foreign competition honourably carried out on the lines of standard British practice we have nothing to fear; against such, whenever it may come, we can hold our own. But the foreign competition that is a parasite upon legitimate British trade, fostered by those who betray their country by adopting unprofessional and dishonourable practice, is an insidious foe, which can only be subdued by the creation of a healthier and broad-minded patriotic feeling.

STANDARDISATION IN ENGINEERING SPECIFICATIONS.

For some time past the question of the conditions appearing in specifications, as commonly issued by consulting engineers and local authorities for electrical plant, has been receiving the attention of electrical engineers in this country. A very general feeling has been found to prevail that the regulations which commonly govern the execution of buildings and similar works do not satisfactorily apply to electrical contracts, where the conditions of supply, execution, test, and subsequent use differ widely from the comparatively stereotyped procedure in the former case. Electrical manufacturers and contractors on their side complain that the conditions of electrical specifications in the past have placed them too unreservedly at the mercy of the purchaser's engineer; while consulting and municipal electrical engineers in many cases disapprove of the excessive responsibilities which they are called upon to bear under such specifications, and of being forced into occupying a judicial position which properly pertains to the law courts or to independent arbitration. The result of general ventilation of the subject in the Press and electrical engineering circles has led to its being taken in hand by the two organised bodies, representative of the respective interests of the contractor and the purchaser, viz.: (1) The Electrical Engineering Plant Manufacturers' Association, and (2) the Municipal Electrical Association.

These associations recently appointed representative committees to meet in conference and thoroughly discuss the subject, with a view, if possible, of agreeing upon a model specification to serve as a basis for future guidance. Their labours have already resulted in the settlement of certain standard clauses upon a number of points, in respect of which there has been much divergence of opinion and friction in the past; and it will no doubt prove possible, as it is clearly desirable, to add to these in future and as occasion offers until an agreed standard specification is available which will cover all the essential contingencies of electrical contracts. These clauses are now published in the hope that they may be generally accepted by consulting engineers and local authorities as an equitable adjustment, at the hands of thoroughly qualified experts representative of the interests of buyer and seller, of past differences and sources of dispute; and that they may be embodied in future specifications for electrical plant.

The committees have so far confined themselves to dealing only with what may be described as the commercial conditions usually appearing in electrical specifications, and have left the purchaser's engineer free to specify the character of plant he considers desirable and the technical conditions which it is to

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fulfil. A feeling has, however, been steadily growing that some efforts should be made in the direction of standardisation, as far as possible, of the technical features of electrical specifications; thereby enabling the purchaser to buy more cheaply, to obtain early delivery, and to secure freedom from the inevitable risks attendant upon new designs and patterns; while the manufacturer would reap the advantages consequent upon specialisation and repetition in manufacture. It is accordingly greatly to be hoped that it may prove possible, as time goes on, to extend the scope of the present foundation of a standard specification, until all the essential features of a contract, based on experience and equitable compromise, are included, and so ensure a satisfactory outcome both for the intelligent buyer and the honest contractor.

Subjoined we give the full text of the approved standard clauses for adoption among the general conditions of specifications for electrical engineering plant, together with the names of the engineers and engineering firms constituting the committees:—

Drawings.—The contractor shall, at his own expense, supply to the purchaser (n) copies of the drawings necessary for the erection of the works under the contract, but shall not be called upon to furnish constructional details further than in the opinion of the engineer are required for the purposes of the contract. If the contractor shall be called upon to supply additional copies of the drawings, they shall be paid for at a fair price to be arranged. The engineer shall, in addition, have the right at all reasonable times to inspect any drawings of any portion of the plant contracted for at the works of the manufacturer.

Powers of Engineer to Reject Materials or Vary Works.—The engineer may from time to time, during the execution of the contract, vary, increase, or reduce the contract works, and may order any work or portion of work executed, or partly executed, to be removed or altered; and the difference of cost occasioned by any variation, addition, omission, removal, or alteration as aforesaid shall be added to or deducted from the contract price as the case may require, and the amount of such difference shall be ascertained and determined in accordance with the rates specified in the schedule of prices set out in the schedule to the contract so far as the same may be applicable, and where the same are not applicable, then according to such rates or prices as shall be fair and reasonable; such prices in case of dispute shall be referred to arbitration, as herein provided. No addition shall, however, be made to the contract price in respect of any such variation of or addition to the said works, unless the instructions for the same shall have been given by the engineer in writing, nor unless such instructions shall state that the matter thereof is to be the subject of an extra charge. A decision of the engineer to reject materials, or require workmanship which is in his opinion defective, to be amended, shall be obeyed by the contractor. If the contractor shall so desire, and of such desire shall give notice in writing to the purchaser within 72 hours after receiving notice from the engineer, the question involved in any such decision of the engineer may be submitted to arbitration, as herein provided. The contractor shall not under these circumstances cease to proceed with the execution of the contract, to the prejudice of the purchaser.

Date of Completion of Works and Penalties.—The contractor shall within a period of [time to be inserted here] from the date of the order of the engineer to commence the contract works (and time shall in this respect be of the essence of the contract) complete the whole of the contract works, and make good all damage done to the roads, buildings, or other property of the purchaser, and fill up all holes and trenches which may have been dug, and level any mounds or heaps of earth that may have been made, and reinstate all works, property, matters, and things disturbed or damaged, and deliver up to the purchaser the said works complete to the satisfaction of the engineer; and in case the contractor shall make default in performing and observing the provisions of this clause within the period hereinbefore limited, or within any extension of the same period which may be granted under the powers herein contained, the contractors shall and will pay to the purchaser on demand as ascertained and liquidated damages, and not as a penalty, the sum of £n* for each and every week which shall elapse between the expiration of the period limited by this clause or any extension thereof which may be granted as aforesaid, and the actual performance and observance by the contractor of the provisions of this clause, unless the execution of the contract works shall have been delayed by an unreasonable strike of workmen, by excessive inclement weather affecting the work of the contractor, or by any circumstances over which the contractor shall have no control; provided that no such damages shall accrue as payable by the contractor to the purchaser after the time when the plant is complete and ready to be set to work.

Power of Purchaser to use Works during Execution.—The purchaser shall have power to use any portion of the plant reasonably capable of use at any time during execution of the contract, and also pending any arbitration. In such case, however, the contractor shall be entitled to receive, by way of rental, a sum equal to 5 per cent. per annum upon the amount withheld in respect of any machinery put into beneficial use, and not paid for.

Payments.—During the progress of the works, and as soon as possible after the expiration of each month, the contractor shall be entitled to payment, on the engineer's certificate, of 75 per cent. of the value of the work executed on the site and plant delivered on the site during the month, until the balance of 25 per cent. of the value of the executed work retained by the purchaser is equal to 10 per cent. of the total value of the contract. Thereafter the contractor shall be entitled to monthly payments as before equal to 90 per cent. of the value of the remainder of the executed work, until the contract works are completed for continuous effective usage by the purchaser, whereupon he shall become entitled to one-half of the retention moneys. The remaining half of the retention moneys shall be payable n* months later. The purchaser shall, however, be entitled to retain such sum of money as, in the opinion of the engineer, fairly represents the prejudice to the purchaser arising out of incomplete or defective details, until the adjustment of such details to the satisfaction of the engineer. In cases where the contractor, although willing so to do, is unable to repair defects in certain parts of the contract works in consequence of the purchaser not being able to place such parts into his hands for the requisite time, owing to their being in use, the contractor shall be paid in full for such portion of the contract works on giving an undertaking, with security to the satisfaction of the purchaser if required, to remedy the defects so soon as the same can be placed in his hands for the purpose.

Certificates of Engineer.—The engineer shall from time to time issue his certificates in accordance with the clause relating to payments, and payment shall be made to the contractor at the earliest possible date. Certificates of the engineer, other than the final certificate, shall not be considered conclusive evidence as to the sufficiency of any work or materials to which they relate, nor shall they relieve the contractor from his liability to make good all defects as provided by the contract. The contractor when applying for a certificate shall, if required, furnish to the engineer an approximate statement of the value of the work executed and materials delivered, based on the original estimate. When the contract works shall be completed, as referred to in the clause relating to payments, the contractor shall be entitled to call upon the engineer for a certificate to that effect. In case of the refusal of the engineer to grant such certificate when called upon by the contractor so to do, this refusal shall be subject to appeal under the arbitration clause herein contained.

Maintenance and Limitation of responsibility of Contractor.—The contractor shall be responsible for, and shall effectually maintain and uphold in good and substantial condition, in accordance with the specification, fair wear and tear only excepted, all and every part of the contract works for a period of n months* from the date of completion of the contract as certified by the engineer.

Arbitration.—In case any dispute or difference shall arise between the purchaser, or his engineer on his behalf, and the contractor, either during the progress of the works, or after the determination, abandonment, or breach of the contract, as to the construction of the contract, or as to the reasonableness of any extra charge, or as to the withholding by the engineer of any certificate to which the contractor may claim to be entitled, then either party may within 72 hours, but not later, give to the other notice in writing of the existence of such dispute or difference, and such dispute or difference may be referred to arbitration, which arbitration shall be deemed to be a submission to arbitration, within the meaning of the Arbitration Act, 1889.

These clauses have been approved, on behalf of the Electrical Engineering Plant Manufacturers' Association, by R. Percy Sellon (British Electrical Engineering Company, Limited), R. E. B. Crompton (Crompton and Co., Limited), A. B. Blackburn (Electric Construction Company, Limited), S. Z. De Ferranti (S. Z. De Ferranti, Limited), A. Fowler (John Fowler and Co., Limited), and W. B. Esson (Johnson and Phillips); and on behalf of the Municipal Electrical Association, by A. H. Gibbings (President), C. H. Wordingham and A. Wright (Past Presidents), and A. Gay, G. Pearson, T. P. Wilmhurst and A. B. Mountain (Members of Council).

* N.B.—Under no circumstances to exceed 1 per cent. per week of the contract value.

* N.B.—Under no circumstances to exceed twelve months.

A METHOD OF DETERMINING MAGNETIC HYSTERESIS LOSS IN STRAIGHT IRON STRIPS.†

BY PROF. J. A. FLEMING, M.A., D.SC., F.R.S.

(Concluded from page 589).

Table I. embodies all the results taken with bundles of annealed transformer iron strip (Sankey's) of very different lengths and sections, and Table II. similar observations on rods of steel and hard iron: and it will be seen that the effective induction in the case of the iron strip is always found at a point in the bar or bundle which is very nearly 0·56 of the half-length of the bar from the centre. If therefore the secondary coil is placed at that spot and the secondary voltage then observed used to calculate the induction density, the value so obtained is that which corresponds to the true mean value of the varying hysteresis loss per unit of volume along the bar. In other words, if we suppose the bar magnetised by an alternating current uniformly and with a maximum induction density everywhere equal to that which it actually has under normal conditions at 0·56 of the half-length of the bar from the centre; then the hysteresis loss in such a bar would be equal to that found

† Paper read before the Physical Society.

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Table I.—*Summary of Experiments made to ascertain the "Effective Point" in bundles of annealed Transformer Iron Strips (Sankey's) when placed in a Uniform Alternating Magnetic Field.*

Reference letter to diagram.	L'ngth of specimen in cm.	Sectional area of specimen in sq. cm.	Induction at centre of bar, B. C.G.S. units.	Effective induction B_1. C.G.S. units.	Ratio of $\frac{B_1}{B}$	Distance of effective point from centre of bar.	Fraction of half length of bar from centre at which effective induction exists.
A_1	61	0·936	564	420	0·744	17·01	0·558
A_2	61	0·936	1,648	1,240	0·752	16·91	0·554
A_3	61	0·936	2,084	1,563	0·750	16·92	0·555
A_4	61	0·936	2,536	1,900	0·749	17·00	0·557
A_5	61	0·936	3,112	2,335	0·712	17·00	0·557
A_6	61	0·936	3,816	2,870	0·752	17·10	0·561
B_1	30	0·936	1,597	1,192	0·746	8·36	0·557
B_2	30	0·936	4,052	3,012	0·743	8·35	0·557
B_3	15	0·936	1,622	1,265	0·780	4·11	0·548
B_4	15	0·936	3,430	2,660	0·775	4·18	0·557
B_5	10	0·936	1,907	1,554	0·815	2·73	0·546
B_6	10	0·936	1,025	833	0·813	2·76	0·552
B_7	5	0·936	1,622	1,420	0·875	1·39	0·556
B_8	5	0·936	778	678	0·871	1·49	0·596
C_1	61	0·312	3,485	2,565	0·736	16·84	0·552
C_2	61	0·312	9,673	7,250	0·749	16·81	0·551
C_3	61	0·624	2,125	1,570	0·739	17·07	0·560
C_4	61	0·624	5,834	4,420	0·758	17·60	0·577

Mean of last column = 0·56.

Table II.—*Summary of Tests made, as in Table I., upon Steel and Hard-Iron Rods.*

Reference letter to diagram.	Length of specimen in cms.	Sectional area of specimen in square cms.	Induction in centre of bar, B. C.G.S. units.	Effective induction B_1. C.G.S. units.	Ratio of $\frac{B_1}{B}$.	Distance of effective point from centre of bar in cms.	Fraction of half-length of bar from centre at which effective induction exists.	Nature of bar.
C_6	61·0	0·970	4,499	3,525	0·783	6·90	0·58	Round bar of silver steel $\frac{7}{16}$in. in diameter.
D_2	32·0	0·178	5,997	4,784	0·798	9·80	0·61	Round rod of silver steel $\frac{3}{16}$in. in diameter.
D_3	32·0	0·534	5,555	4,244	0·764	9·31	0·58	Three similar pieces of steel.
D_4	20·45	0·645	4,746	3,587	0·756	6·67	0·65	Bundle of 60 iron wires of hard iron of rectangular section.
D_5	20·45	0·645	2,545	1,912	0·751	6·76	0·66	

in the bar as it is. In all cases where induction density values are given, these are to be understood as being the maximum values during the cycle unless otherwise stated. The frequency of alternations used was 80.

We have therefore in this useful fact regarding the distribution of induction in iron strips in a uniform magnetic field the foundation of a quick method of determining the hysteretic constant of a sample of iron. If the iron sample, taken in strips, is placed as above in the interior of the long magnetising coil, and if a sensitive wattmeter, suitable for use with alternating currents, is connected therewith, we can measure the total power taken up in the iron and in the copper of the coils when any known alternating current is passing through the magnetising coil. If then the iron strips are withdrawn and another measurement of the same kind made with the current passing through the magnetising coil adjusted to the same value as in the first case, this last reading gives us the wattmeter-reading corresponding to a known power taken up in the copper of the magnetising coils. Hence the first wattmeter-reading gives us the iron loss, together with the copper loss, and the second reading gives us the copper loss alone. The iron loss gives us the true mean value of the hysteresis loss in the iron, assuming the iron is so well laminated that eddy-current loss is practically absent. The above-mentioned law as to the distribution of the induction enables us, then, to assign the corresponding value of the maximum induction density. Unless this can be done, the mere mean hysteresis loss measurement is no practical use.*

The operation of making the mean hysteresis measurement is effected by a sensitive mirror bifilar electrodynamometer. This was constructed in the following way: The fixed or series-coil consists of 90 turns of No. 16 S.W.G. cotton-covered copper wire wound in five layers on a rectangular block of wood. The movable coil, or shunt-coil, consists of a rectangular coil of 20 turns of No. 24 S.W.G. wire, the turns being fastened together with silk and shellac. This movable coil embraces, without touching, the fixed coil, as in a Siemens dynamometer. The movable coil is suspended by a bifilar suspension consisting of two silver wires 0·002 of an inch in diameter and 37cm. long, fixed about 3mm. apart. These wires are attached to the ends of the suspended coil, and serve to convey the shunt-current in and out of the coil. The movable coil carries a concave silver mirror, by means of which a sharp image of an incandescent lamp filament is formed upon a scale at a fixed distance of 100cm. from the mirror. A torsion head carries the upper ends of the bifilar suspension, and serves to adjust the zero. In series with the shunt coil is a high non-inductive resistance of 1,000 ohms. The resistance of the thick-wire fixed coil of the wattmeter is 0·133 of an ohm, and the resistance of the shunt coil and suspension, without the associated inductionless resistance, is 11·7 ohms.

When such a bifilar wattmeter is employed to measure electrical power it can be shown that the deflections of the movable coil, when not large, are strictly proportional to the power passing through the wattmeter, so that each scale division has an assignable power value, which in our case was almost exactly 0·01 of a watt per millimetre of scale. The arrangement of circuits was then as shown in the diagram. The long magnetising coil above described was connected in series with the fixed coil of the wattmeter, and also with a sensitive electrodynamometer or ammeter suitable for measuring small alternating currents of about an ampere or less in value. The shunt coil of the wattmeter was joined across the ends of the long coil. Suitable resistances beyond controlled the current. The process of measurement was then as follows:—A bundle of straight iron strips was fitted with the secondary coil at the effective point—viz., 0·56 of the half-length of the bar from the centre. The bundle was slipped into the magnetising coil, and an alternating current sent through the coil of such a magnitude (generally about 0·2 of an ampere) as to give an induction density of not more than about 6,000 C.G.S. units at the effective point. The wattmeter deflection was then read. To interpret this reading the iron strips were removed from the coil, and another wattmeter measurement made on the copper coil alone. As the removal of the iron sends up the current strength by decreasing the inductance of the circuit, it is necessary to readjust the current to the same value as before, and to know that value in amperes. The resistance of the coil being known, and also the current passing through it, we can calculate the power being taken up in the copper coil alone for this standard current, and hence know the power in watts producing the observed wattmeter deflection. The wattmeter is therefore calibrated on the copper circuit of the magnetising coil, and from the known copper loss in this coil and the proportionality of its deflections we are enabled to assign at once the value in watts of its deflection when used to measure both the iron loss and copper loss together when the iron strip is inserted in the coil.

If the induction is carried up as far as 4,000 or 5,000 C.G.S. units at the effective point, and if the strips have a thickness over 0·01in., then it becomes necessary to apply a small correction for the eddy-current loss set up in the iron. This can be at once done by using the following simple practical formula given by the author* for this loss in rectangular sectioned strips. If t is the thickness of the strip in *mils* (1 mil = 0·001in.), n is the frequency of the current, and B is the maximum value of the induction density during the cycle at any point on the bar, then it can be shown that the eddy-current loss in watts per cubic centimetre at that point in the rectangular or sectional strip is closely given by the expression—

$$\left(\frac{B}{10^8} nt\right)^2,$$

and hence for a given frequency and thickness the eddy-current loss per pound of iron is very quickly found from a simple parabolic curve representing ^{2} in terms of B. In all the above observations with the iron strip used, which was 12 mils thick, this correction has been applied, and it is sufficient for this purpose to take as B in the above formula the value B_1 of the effective induction. The eddy-current loss varies from point to point in the bar, being always proportional to the square of the maximum value of the induction density. Hence, properly speaking, the mean value of the eddy-current loss should be obtained by taking the mean square value of the induction all along the half-length of the bar, and using the mean square value instead of the B^2 in the formula above.

We have, however, found that the point on the half-length of the bar at which the actual induction has a value equal to the root-mean-square value, or to the square root of the mean of the squares of the distributed induction, is always very close to the point at which the 1·6th root of the mean of the 1·6th powers of the dis-

* Methods of measuring hysteresis loss by one observation of an instrument have been suggested by other observers; but the practical value of these methods has been very small, because the investigators have not shown how the corresponding maximum value of the effective induction is to be obtained. The rule above given supplies this deficiency.

* *See* "The Alternate Current Transformer," Fleming, Vol. II. p. 490, for proof of this formula.

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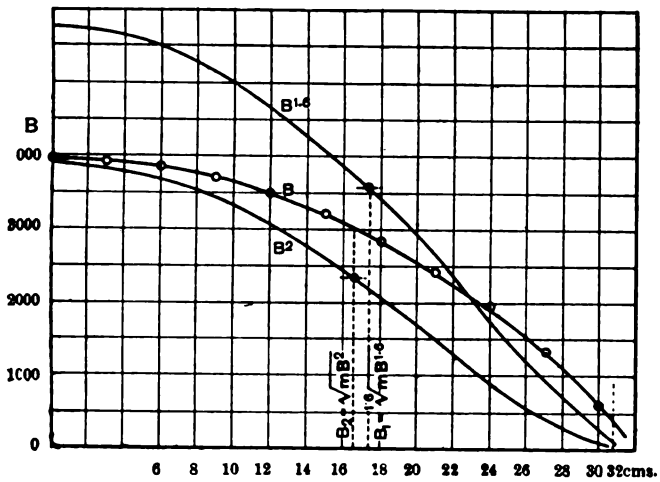
tributed induction is found. In other words, the induction at the effective point is the induction corresponding to the mean eddy-current loss as well as to the mean hysteresis loss. This is shown by the curves given in Figs. 4 and 5, in which the curve marked B is the curve of variation of the maximum value of the induction-density along the half-length of a bundle of iron strips, and the curves marked $B^{1\cdot6}$ and B^2 represent (to different scales) the variation of these powers of B. In a bar 5 centimetres long (*see* Fig. 5), the points where the actual induction had a value equal to $\sqrt{m \cdot B^2}$ and to $\sqrt[1\cdot6]{m \cdot B^{1\cdot6}}$ were only separated by a fraction of a millimetre. Hence by another curious coincidence we are enabled to apply the proper correction for the eddy-current loss by taking the square of the effective induction B_1 and putting its value into the expression

$$\frac{B_1^2 n^2 t^2}{10^{1\cdot6}},$$

where n is the frequency and t the thickness of the strip in mils.



Distance from centre of iron strip.

12 strips 61 cms. long.

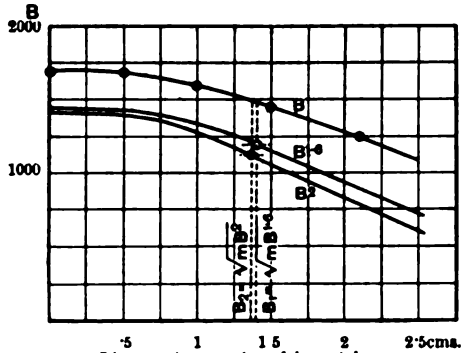
$B_1 = \sqrt[1\cdot6]{m B^{1\cdot6}} = 2{,}980$ $\frac{B_2}{B_1} = 1.026.$

$B_2 = \sqrt{m B^2} = 3{,}060.$

Position of B_1 is *17·2cms.* from centre, or 0·561 of half length.
Position of B_2 is *16·54cms.* from centre, or 0·542 of half length.

FIG. 5.

In order to put the method to a test, a very careful determination was made by the ballistic method of the hysteresis loss of a sample of the transformer iron strip used. A ring-coil was prepared, and a series of (B-H) cycles of magnetisation taken, and a hysteresis loop drawn, and from this loop it was found that for this iron the hysteresis loss was 0·25 watts per pound per 100 cycles per second, for a maximum value of the induction density equal to 2,500 C.G.S. units. Straight strips of exactly the same iron were then tested



Distance from centre of iron strip.

12 strips 5 cms. long.
B_1 is at 0·552 of half length from centre.
B_2 is at 0·546 " " "

FIG. 6.

by the method here described, which for shortness will be called the "straight coil" method; and the results of these tests with the iron in different conditions of hardness are shown in the Tables III., IV. and V. It will be seen that the results of the "straight coil" test with the wattmeter, as given in Table III., gave exactly the same mean value for the hysteresis loss of the strip when not bent and unbent, as did the calculations made from the ballistic test, viz., 0·25 watts per pound per 100 ∽ per maximum induction density of 2,500. The difference in the time of taking the tests is, however, immense. A very minutes suffices to take the wattmeter tests, and the necessary calculations can be made in a comparatively short time. Many dozens of tests of irons can be made by the straight coil method in the time occupied by one ballistic test.

Table III.—*Hysteresis Test by "Straight Coil" Method of Annealed Transformer Iron Strip. Six strips used (new) 61cm. long, 2·54cm. wide, and 12 mils thick.*

Voltmeter scale-reading in mm.	Effective induction density, B_1.	Wattmeter scale-reading. Iron in.	Wattmeter scale-reading. Iron out.	Total iron loss in watts per lb.	Eddy-current loss in watts per lb.	Hysteresis loss in watts per lb. at 80 ∽.	Hysteresis loss in watts per lb. at 100 ∽ and 2,500 B.	Mean hysteresis value.
303·0	6,719	87·6	17·5	1·247	0·245	1·002	0·257	0·25 watts per lb. per 100 ∽ per 2,500 B.
225·3	5,702	66·0	15·3	0·9027	0·176	0·727	0·243	
131·8	4,284	40·0	7·8	0·5747	0·099	0·476	0 251	
95·1	3,623	43·0	8·1	0·4377	0·071	0·367	0·251	

Table IV.—*Hysteresis Test by "Straight Coil" Method of Transformer Iron Strip. Same strips used as in Table III., but once bent and unbent.*

Voltmeter scale-reading in mm.	Effective induction density B_1.	Wattmeter scale-reading. Iron in coil.	Wattmeter scale-reading. Iron out of coil.	Total iron loss in watts per lb.	Eddy-current loss in watts per lb.	Hysteresis loss in watts per lb. at 80 ∽.	Hysteresis loss in watts per lb. at 100 ∽ and 2,500 B.	Mean hysteresis value.
56·9	2,786	19·0	4·2	0·303	0·042	0·261	0·273	0·28 watts per lb. per 100 ∽ per 2,500 B.
128·8	4,244	39·0	8·4	0·635	0·098	0·537	0·288	
204·0	5,424	58·1	12·4	0·948	0·160	0·788	0 285	
273·0	6,346	76·0	15·9	1·247	0·219	1·028	0·289	

Table V.—*Hysteresis Test by "Straight Coil" Method of Transformer Iron Strip, the same quality as in Tables III. and IV., but bent and unbent several times. Twelve strips used 30cm. long, 12 mil. thick, cut from the same pieces used for the ballistic galvanometer tests*

Voltmeter scale-reading in mm.	Effective induction density, B_1.	Wattmeter scale-reading. Iron in coil.	Wattmeter scale-reading. Iron out of coil.	Total iron loss in watts per lb.	Eddy-current loss in watts per lb.	Hysteresis loss in watts per lb. at 80 ∽.	Hysteresis loss in watts per lb. at 800 ∽ and 2,500 B.	Mean hysteresis value.
374·5	3,778	135·7	105·1	0·539	0·078	0·461	0·296	0·28 watts per lb. per 100 ∽ per 2,500 B.
281·4	3,219	101·4	78·1	0·415	0·057	0·358	0·297	
199·5	2,672	71·2	54·8	0·277	0·038	0·239	0·268	
111·6	1,964	42·1	32·9	0·160	0·0215	0·139	0·252	
71·1	1,625	57·0	43·1	0·125	0·017	0·107	0·282	
50·4	1,314	39·2	29·9	0·083	0·011	0·072	0·261	

Table VI.—*Hysteresis Test by "Straight Coil" Method of Transformer Iron Strips. Twelve new annealed strips used, never bent. Wattmeter standardised by Potentiometer and Continuous Currents.*

Voltmeter scale-reading in mm.	Effective induction density, B_1.	Wattmeter scale-reading. Iron in.	Wattmeter scale-reading. Iron out.	Total iron loss in watts per lb.	Eddy-current loss in watts per lb.	Hysteresis loss in watts per lb. at 80 ∽.	Hysteresis loss in watts per lb. at 100 ∽ and 2,500 B.	Mean hysteresis value.
497·0	4,742	90·6	26·0	0·517	0·118	0·399	0·178	0·21 watts per lb. per 100 ∽ per 2,500 B.
338·8	3,576	63·6	17·1	0·340	0·069	0·271	0·190	
267·0	3,136	50·7	14·7	0·295	0·053	0·242	0·210	
204·9	2,715	39·8	11·7	0·232	0·038	0·193	0·210	
130·8	2,138	51·6	14·6	0·154	0·025	0·129	0·208	
110·3	1,957	44·0	11·9	0·133	0·022	0·111	0·205	
77·1	1,628	31·0	8·7	0·093	0·016	0·070	0·191	
49·5	1,295	21·1	6·1	0·062	0·010	0·052	0·187	
398·5	3,913	71·0	17·5	0·466	0·083	0·383	0·234	
282·0	3,223	100·9	25·1	0·334	0·056	0·278	0·230	
200·5	2,679	73·2	18·1	0·242	0·039	0·203	0·226	
100·0	1,950	42·9	11·0	0·118	0·021	0·097	0·181	
77·2	1,627	61·4	16·1	0·103	0·016	0·087	0·217	
49·2	1,302	41·2	11·7	0·067	0·010	0·057	0.203	

N.B.—The method of standardising the wattmeter by use as a dynamometer employing a continuous current as above does not give such consistent or accurate hysteresis determinations as when it is standardised on a known copper resistance with known alternating currents.

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Table VII.—*Hysteresis Test by "Straight Coil" Method on Hammered Transformer Strip (unannealed). Six Strips used, 61cm. long, 2·54cm. wide and 12 mils thick.*

Voltmeter scale-reading in mm.	Effective induction density, B_i.	Wattmeter scale-readings. Iron in.	Wattmeter scale-readings. Iron out.	Total iron loss in watts per lb.	Eddy-current loss in watts per lb.	Hysteresis loss in watts per lb. at 80 ∽.	Hysteresis loss watts per lb. at 100 ∽ and 2,500 B.	Mean hysteresis value.
114·0	3975	54·5	23·5	0·562	0·086	0·476	0·284	0·290 watts pr lb. per 100 cycles at 2,500 B.
160·0	4737	72·9	30·2	0·778	0·123	0·655	0·297	
206·0	5138	90·5	37·5	0·959	0·161	0·802	0·280	

Calibration Table of Wattmeter.

C^2R.	Wattmeter deflection.	Watts per mm.
0·1875	20·9	0·00897
0·3263	36·9	0·00884
0·1195	13·3	0·00898

Table VIII.—*Hysteresis Test by "Straight Coil" Method of 18 Strips of Iron of inferior quality. Length 61cm., width 0·63cm., thickness 26·5 mils.*

Voltmeter scale-reading in mm.	Effective induction density, B_i.	Wattmeter scale-reading. in mm. Iron in.	Wattmeter scale-reading. in mm. Iron out.	Total iron loss in watts per lb.	Eddy loss in watts per lb.	Hysteresis loss in watts per lb. at 80 ∽.	Hysteresis loss in watts per lb. at 100 ∽ and 2,500 B.
83·4	2054	51·9	23·7	0·319	0·110	0·209	0·360
136·0	2644	79·7	34·1	0·517	0·183	0·334	0·360
176·0	3028	101·0	42·8	0·659	0·239	0·420	0·386

Calibration Table of Wattmeter.

C^2R.	Wattmeter deflection in mm.	Watts per mm.
0·272	30·0	0·00908
0·381	41·4	0·00920

There is another method by which the bifilar wattmeter can be calibrated, but which is not so generally convenient as that above described. If the shunt and series coilsof the wattmeter are joined up in series with each other, so as to form a dynamometer, and if a known current I is passed through these coils, causing a deflection θ in the movable coil; then when the instrument is used as a wattmeter with a total shunt-resistance R (including the added non-inductive resistance) the true power corresponding to a deflection θ is I^2R watts. Hence, from a curve showing the deflection given by various currents, we can at once determine the constant of the instrument, when used as a wattmeter, with given shunt resistance. If this standardisation is taken with continuous currents, then it is necessary to eliminate the effect of the earth's field by taking right and left deflections. The curve connecting square of current strength and the deflections of the movable coil is nearly a straight line, in the case of the bifilar wattmeter. Standardising our wattmeter in this way with a continuous current, we then made another set of hysteresis measurements, with 12 strips of perfectly new annealed transformer strips (Sankey's), with the results shown in Table VI. Two other sets of observations for hammered and hardened iron are given in Tables VII. and VIII. As a matter of fact, in the above experiments in the observations given in Tables III., IV., V., VII. and VIII., the wattmeter was standardised by sending known and measured currents through the coppr coil and obtaining a wattmeter constant by finding the deflections corresponding to known copper losses in the copper coil. Thus are found the following figures, when using the wattmeter to measure power taken up in the magnetising coil alone :—

Known copper loss (C^2R) calculated from observed current and coil resistance in watts.	Scale-deflections of wattmeter in millimetres.	Watts per millimetre of scale-deflection of wattmeter.
0·398	39·1	0·0102
0·292	28·9	0·0101
0·197	19·0	0·0103

In the case of the observations given in Table VI. we employed the method of determining the wattmeter constant by passing known currents through its coils joined up in series and used as a dynamometer, and from the curve showing relation of $(\text{current})^2$ to deflections we could at any moment find the wattmeter constant.

The method described above has this great advantage, that the test can be made on fairly large samples of iron, and it can be made with an alternating current having any desired and practical form factor. The iron is tested under conditions which are exactly similar to those under which it will be used in transformer manufacture, and, in fact, the straight magnetising coil and iron sample constitute an open circuit transformer of very small power factor. The above-described method effects a great saving of time in comparison with the ballistic method, whilst at the same time it is an absolute method and does not depend upon comparisons with other iron samples of supposed known hysteretic value. In converting hysteresis losses from one maximum induction-density B to another by the aid of Steinmetz's law, it is useful to have the arithmetic values, for different values of B, of the ratios of $B^{1·6}$ to $2{,}500^{1·6}$; since B = 2,500 C.G.S. units is generally taken as the standard induction-density in reference to hysteresis determinations.

Table IX.—*Showing the Values of the Ratio of* $B^{1·6}$ *to* $2{,}500^{1·6}$.

B.	$\frac{B^{1·6}}{2{,}500^{1·6}}$	B.	$\frac{B^{1·6}}{2{,}500^{1·6}}$
1,000	0·231	5 500	3·531
1,500	0·442	6,000	4·058
2,000	0·700	6,500	4·614
2,500	1·000	7,000	5·193
3.000	1·338	7.500	5·795
3,500	1·713	8,000	6·430
4,000	2·118	8,500	7·085
4,500	2·563	9,000	7·764
5,000	3·031	9,500	8·466
		10,000	9·190

Table IX. gives these ratios with sufficient accuracy for all practical work. Thus, for instance, if the value of the hysteresis loss in an iron has been determined at a maximum induction-density during the cycle of 5,000 units, and we wish to know the value at 2,500 units, the observed value has to be divided by 3·031 to obtain the required result.

A PORTABLE ELECTRIC RAILWAY.

A description of a practical form of temporary light railway, made by the firm of Arthur Koppel, is described in the *Zeitschrift für Elektrotechnik* and accredited to "Mittheilungen über Gegenstände der Artillerie-und Geniewesens." The rails have the usual profile and are about 2½in. in height, resembling those customarily employed for such work. Each portable section is made up of the two rails fixed on a number of sleepers, five for instance. Some of these sections are made with the addition of an inverted U-shaped iron yoke, as shown in Fig. 1, to carry the trolley-wire, the sections

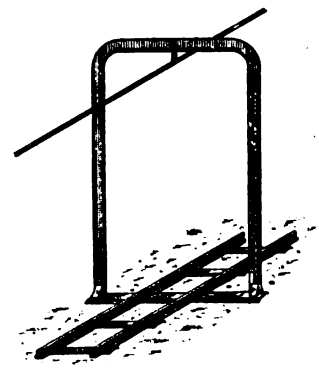

Fig. 1.

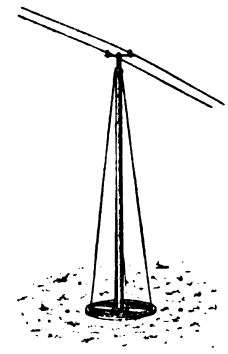

Fig. 2.

with these yokes being placed about 80ft. apart on straight stretches of track, and of course closer together on curves. Each of these adds about a hundredweight to the weight of the section in question. The two feeders from the generating station are carried either on poles sunk in the ground in the usual manner, or on standards shown in Fig. 2, which is self-explanatory. A simple car has been designed for the purpose of erecting the trolley-wire. The drum carrying the wire is supported on trestles on this car, and is run off over a pulley on a level with the trolley-wire supports, this pulley being mounted in bearings at the top of a double ladder on the car. The car itself is fastened to the rails while the wire is being run off, to allow of the necessary strain being put on the wire before the car and ladder are removed.

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CORRESPONDENCE.

GLOW-WORM RADIATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice on p. 616 of *The Electrician* of March 4 a statement by Mr. E. Fournier d'Albe to the effect that the electric world was startled last December by a discovery made in Japan that glowworms emitted a radiation like X-radiation. As I made a similar communication to Section A of the British Association in 1896, founded partly on work of my own done in Worcestershire in August, 1896, and partly on work done in Paris by M. Henry, I should be obliged by your making this correction.—Yours, &c., DAWSON TURNER.

Edinburgh, March 7, 1898.

COMMUTATION OF CONTINUOUS-CURRENT DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to Mr. Housman's letter on the above subject, it is remarkable that he should put forward such a complicated statement as is contained in his last letter as a "simple proof" that his views are correct. By arguing in a similar way Mr. Housman might readily prove that an alternator in which both exciting and inducing coils were stationary could give no current—if he left the inductor out of account! The teeth on a projection armature cause considerable oscillation in the armature field, and this effect enters very largely into the commutation problem.—Yours, &c.,

Glasgow, March 9, 1898. W. B. SAYERS.

SPARKING IN CONTINUOUS-CURRENT DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your editorial comments in your issue of February 11th, on my Paper entitled "Sparking: its Causes and Effects," you credit me with claiming that the part played in commutation by the varying resistances of the segment surfaces under a brush was a new idea put forth by me for the first time. You misunderstood my Paper in this, as I thought that was a well-recognised element in commutation, and my idea in describing these operations was to serve as a basis for what came after. What I did claim as new was "that the real injury is done before the segment leaves the brush," and the gist of this idea is contained in the analysis showing how the current must be distributed between the contact surfaces under a brush so as to develop the least amount of energy and to distribute this energy uniformly. If this idea is not new it is at least new to me, and the quotation made by you from Mr. Housman's remarks on the subject, which I had not before seen, does not appear to me to exactly cover the point although it comes fairly close to it. That someone may have anticipated me on this point is possible enough, but I venture to think that the idea was here for the first time analysed and explained systematically.

Thanking you for your commendation of the Paper as a whole.—Yours, &c. THORBURN REID.

Feb. 23, 1898.

COST OF STEAM, GAS AND ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my address, to which you refer in your impression of the 25th ult., I speak of the cost of coal or coke and of gas as fuel, and correspondingly of the total cost of electricity as fuel delivered to the tramcars, not merely of the cost of fuel consumed in generating that current. As far as I know, this cost, including every cost connected with lighting stations, is over 2d. per unit in all stations, with only two or three exceptions, and in most stations much more than this. Clearly it costs something more than this before the car gets it, for interest and depreciation on cost of buildings, plant and conductors have to be added. The cost per unit generated under better load factor conditions in tramway stations, and delivered by overhead wires, is somewhat less, but the works-cost alone is not the total cost of current delivered to the car.

Where the cost of coal or of gas is mentioned, that cost means the total cost delivered to user, not the cost of raising the coal to the pit's mouth, or the cost of making the gas. The cost of carriage of coal and the cost of delivery through miles of costly gas mains have to be paid by some one—the user, and the cost of stations and the corresponding costs of electricity must be taken into account also. Let me repeat that, although I urge this, I admit that there are cases where electricity is best, even at the higher cost.

The gas cars to which I referred carry 42 passengers; the new cars, like the Serpollet cars, carry 50 passengers and haul one trailer when necessary.—Yours, &c.

Outer Temple, March 9, 1898. W. WORBY BEAUMONT.

THE IMPERIAL WIRE-GAUGE TABLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Perhaps you will permit me to call attention to some errors which exist in Mr. Cheesman's "Table of Relative Dimensions, Lengths, Weights and Resistance of Pure Copper Wire," published as a Supplement to *The Electrician* of Jan. 28, 1898? The numbers in column 17 ("Metres per ohm") are apparently deduced from those in column 15 ("Feet per ohm,") by dividing by 3·048 instead of by multiplying by 0 3048, the number of metres in 1 foot. The values given in column 17 are consequently about 7 per cent. too high, and to correct them they need to be multiplied by 0·929. Similarly, the numbers in column 16 ("Ohms per metre") should be multiplied by 1·076 to make them approximately correct. Again, in column 18 ("Ohms per lb.,") the value given for No. 15 wire should be 0·1253 instead of 0·15792.—Yours, &c.,

March 2, 1898. T. MATHER.

We forwarded a copy of Mr. Mather's letter to Mr. Cheesman, who now writes that, by some unaccountable oversight, he reversed the constants when calculating the "ohms per metre" and "metre per ohm" columns in his Table of Imperial Board of Trade Wire Gauge, and that this error will necessitate the substitution of the following figures for those appearing in the Table:—

Ohms per metre.	Metres per ohm.	Ohms per metre.	Metres per ohm.	Ohms per metre.	Metres per ohm.
16	17	16	17	16	17
0·00013383	7471·8	0·0052280	191·28	0·39531	2·5297
0.00015541	6431·6	0·0064543	154·94	0·47419	2·1038
0.00017928	5577·7	0·0081687	122·42	0·57928	1·7263
0·00020913	4781·9	0·010669	93·727	0·72360	1·3820
0·00024178	4135·9	0·014522	68·860	0·93942	1·0759
0·00027628	3619·5	0·020912	47·820	1·2374	0·80815
0·00031873	3137·4	0·025817	38·734	1·4522	0·68860
0·00037177	2689·9	0·032675	30·605	1·7283	0·57862
0·00043923	2276·7	0·042678	23·432	2·0912	0·47820
0·00052688	1898·0	0·058089	17·215	2·5817	0·38734
0·00062164	1608·7	0·069130	14·466	3·2675	0·30604
0·00074447	1343·2	0·083648	11·955	4·2678	0·23432
0·00090764	1101·8	0·10327	9 6835	5·8089	0·17215
0·0010802	925 79	0·12440	8·0395	8·3648	0·11955
0·0013070	765·11	0·15275	6·5466	13·070	0·076511
0·0016136	619·74	0·18090	5·5280	23·236	0·043037
0·0020422	489·67	0·21761	4·5955	33·459	0·029887
0·0024866	402·16	0·24865	4·0217		
0·0030935	323·26	0·28686	3·4861		
0·0039531	252·97	0·33459	2·9877		

In column 18, opposite No. 15 gauge, *read* 0·1253, *instead* of 0·15792.

In the footnotes to the table, third line from bottom, *read* $R = \frac{21 \cdot 584}{d^2}$, *instead* of $R = \frac{20 \cdot 0535}{d^2}$.

ELECTROLYTIC BLEACHING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A copy of *The Electrician* for January 21st, containing an abstract of a thesis by me, also a criticism on the same, has recently come into my hands. I will begin by agreeing with you. It is a highly-debatable point as to whether electrolytic bleaching can compete with existing chemical methods on equal terms. It is debatable for many reasons, but not because theoretical calculations do not show that it should be able to compete very successfully where power is

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reasonably cheap. It is but natural to take the Hermite system as a guide in devising the experiments; for has it not been over the Hermite system that so much conflicting data has been published, and so much said *pro* and *con* when attempts were made to apply it on a commercial scale?

I made no experimental comparisons of the relative bleaching powers of the ordinary chemically-prepared bleach and that prepared electrolytically, but an investigation as to the relative costs of bleaching by the two methods would hardly be fair or complete which did not at least refer to the work done by others in this connection. I used the arsenious-acid test throughout for determining the amount of available chlorine, thus putting the comparisons on equal terms with bleaching powder.

I did not attempt to approach the subject from a chemical standpoint at all. To me it seems that the subject is purely a chemical one or equally an electrical one, depending entirely upon the results sought and the method of going about it.

As to the experimental work, it was simply a question of determining the amount of power required to produce a gramme of chlorine under various conditions of solution density, temperature and current density—a most important matter which can only be arrived at by experiment. Theoretical chemistry may serve as a guide in devising experiments and interpreting results, but it cannot directly divulge the facts.

Certainly a maximum concentration will be reached, at which point the hypochlorite is reduced at the cathode as rapidly as formed, but where is the limit? Concentrations of practically ten grammes of available chlorine per litre were obtained by me, and the limit was by no means reached, notwithstanding the fact that it has frequently been stated that such high concentrations were impossible. If results of any systematic investigation of considerable scale for the same purpose have been published, I have been unfortunate in overlooking them.

The conclusions given do not and could not well contain more than a suggestion of the results found in my extensive series of experiments. The full data are given in the thesis, but only typical curves and a small portion of the experimental results are given in the abstract published by you.

It *is* "pleasing to have physical proof of the correctness of one's data and reasoning," and further, it seems to me essential to know something definite about the quantitative effect of temperature since it has such a large influence upon the useful output.

The only claim my seventh conclusion has to individuality is this: that it entirely disagrees with statements made by Andreoli and others to the effect that it is impossible (using Hermite's solution) to reach a concentration greater than three grammes per litre; and, besides, it shows clearly "how poor a result a much-extolled method may give" when improperly handled.—Yours, &c.,

M. C. BEEBE.

Madison, Wis., Feb. 22, 1898.

[Owing to the great length of Mr. Beebe's letter we have been obliged to omit certain passages, which, however, are not material to the main points of his argument.—ED. *E.*]

BOOKS RECEIVED.

"Transactions of the American Society of Civil Engineers." Vol. XXXVIII. (New York: published by the Society.)

"A Pocket Dictionary of Electrical Words, Terms and Phrases." By E. J. Houston. Fourth edition. (New York: American Technical Book Company.) Price $3.

"The Standard Electrical Dictionary." By T. O'Conor Sloane. Second edition. (London: Crosby Lockwood and Son.) Price 7s. 6d.

"The Official Gazette of the United States Patent Office." No. 8, Vol. 82. Published by authority of Congress. (Washington: Government Printing Office.)

"*Journal* of the Institution of Electrical Engineers." No. 132, Vol. XXVII. Edited by W. G. McMillan. (London: E. and F. N. Spon.) Price 2s. 6d.

Index to Vol. XXVI. of the "*Journal* of the Institution of Electrical Engineers." (London: E. and F. N. Spon.)

LEGAL INTELLIGENCE.

Vestry of St. Mary, Battersea, v. the County of London and Brush Provincial Electric Lighting Company (Limited).

This case was heard by Sir Francis Jeune in the Chancery Division on Wednesday.

Mr. R. BRAY, Q.C., for the plaintiffs, said the question his lordship had to decide was whether the defendants, a company which had obtained a Provisional Electric Lighting Order, had a right to lay their pipes in streets in the parish of Battersea. There was a road called Trinity-road, part of which was in the parish of Battersea and a part in the parish of Wandsworth, the parish of Wandsworth being within the area of supply of the defendant Company, whereas the area of supply of the parish of Battersea was within the area of supply of the Battersea Electric Lighting Order.

His LORDSHIP: I suppose it depends upon the Provisional Order of the defendant Company?

Mr. BRAY said it did. In October, 1895, the defendants broke up the pavement and laid their pipes in a certain portion of Trinity-road. Although that was not the point in dispute at the present moment, a letter was written to Mr. Morse, the solicitor of the Company, on October 29, 1895, complaining of this, and saying that the Company had no right to do what they had done. On October 31st the defendants replied expressing their regret at what had taken place, and that their sub-contractors had laid a cable within the Battersea parish without any authority from them. The Company in that letter asked to be allowed to keep the cable where it was. The Vestry, however, replied that the Company could not keep the pipes there, and that they must take them up, and accordingly the Company took them up. That was the beginning and the end of that dispute. Matters went on until September, 1896, when the defendants began to lay down their pipes at another point of Trinity-road, or rather on the left of the offshoot, Cockerton-road. The dispute was whether that road or point was in the parish of Wandsworth or Battersea. The plaintiffs did not take any notice of that, not seeing the necessity of fighting at that moment, and evidently the defendants' feeling emboldened by that circumstance on October 18, 1896, proceeded at ten o'clock on a Sunday night to lay seven pipes under the pavement of the road which was undoubtedly in the parish of Battersea. After that had been brought to the notice of the Vestry, a letter was written on Nov. 19, 1896, to the defendants, requiring them to take up so many of the pipes as were in the parish of Battersea, and to restore the pavement within seven days. The defendants replied that they could not admit that they were acting without authority, or that they were not entitled to do what they had done. The learned counsel said that the simple question to be determined was whether the defendants were right or wrong, and that question depended upon the construction of a number of statutes and the Provisional Order. The Provisional Orders were based on the powers in the Electric Lighting Acts. There was no need to trouble his lordship with the Act of 1888, but it was necessary to point out that by the Act of 1882, section 12—this Act being a general Act applying to all Provisional Orders—the provisions of the Lands' Clauses Act and the Gas Works' Clauses Act of 1847 applied with respect to the breaking-up of streets for the purpose of laying pipes. In the Interpretation Clause of the latter Act the word "gas" meant and included "electricity," so that the limits of the special Act meant the area of supply as defined by the Provisional Order. Section 8 of the Gas Works' Clauses Act, 1847, provided that before proceeding to break up any street, &c., a three days' notice should be given of intention to do so, so that the power so conferred was to do it within the limits of the special Act. By the provisions of the Electric Lighting Order Confirmation Act of 1882 the area of supply was the whole of the area included in the first schedule, and it would appear that that was the district of the Board of Works for the Wandsworth District, and that was not included in the Battersea Parish. The section the defendants relied upon was Section 6:—"The undertakers shall not at any time after the commencement of this Order supply energy, or except for the purpose of this Order, erect or lay down any electric lines or works beyond the area of supply provided certain things were done." That did not extend the power to break up streets, but it would enable the undertakers, if they could get the consent of the Vestry or of private owners therein, to carry their pipes under their ground, but it did not give them an absolute roving right to go through the parish. What the plaintiffs complained of was that the defendants had no business to put the pipes where they had at all, and certainly not without having given the plaintiffs three days' notice of their intention to do so.

His LORDSHIP: That is the beginning, middle, and end of it, is it not?

Mr. BRAY replied that that was so, and that there was the right in such a case to ask for a declaration and an injunction.

Mr. CRIPPS, Q.C., in answer to his lordship, said that one of his points on behalf of the defendants was as to the construction of Section 6 of the Act of 1832, and the other that it was not a case for a mandatory injunction if the defendants were held to be in the wrong, but merely a case for damages.

Mr. BRAY, continuing, asked his lordship to take particular notice of the following summarised statement of facts: In October, 1895, the defendants laid down pipes in Trinity-road, in the parish of Battersea; on October 29, 1895, complaint by the Vestry; on October 31, 1895, an apology by the defendants, and a request for a licence; on November 18, 1895, the Vestry say the pipes must be removed, and they were removed; September 3, 1896, the defendants request again to be allowed to lay down their pipes, but Vestry refuse again on September 16th; September 28th, pipes laid down in Trinity-road, on the north side of the junction with Cockerton-road and Trinity-road; on October 18th, at 10 o'clock at night, without any notice whatever, pavement in Trinity-road broken up and pipes laid down; November 19th, complaint by Vestry; November 23rd, defendants' answer: "We have got authority to do it."

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His LORDSHIP: I suppose the area in question is a street repairable by the local authority?

Mr. BRAY said it was.

Mr. CHAPMAN CHUBB, following on the same side, said that an electric lighting company had no more power to break up the pavement than private persons, except by powers expressly conferred. The defendants had no more right to break up the streets than they had to go into a person's garden and lay down their pipes. To succeed, his learned friends on the other side had to contend that Section 6 of the Act of 1882 gave the Company this power.

Mr. CRIPPS said he thought the arguments depended upon legal principles, even if the defendants had been unscrupulous, which he did not think was a fact. He should first contend that it was not a case for a mandatory injunction at all, even assuming that the defendants were in default.

His LORDSHIP: The alternative would seem to be a perpetual action for damages.

Mr. CRIPPS said that the Courts had always drawn a distinction between the rights of private owners and the rights of local authorities in such cases. Where the rights of private people had been infringed the proper remedy might be by a mandatory injunction, but this course was not always followed in the case of public bodies. The learned counsel cited to his lordship a number of cases bearing on the subject. The Company have all rights along Trinity-road North and South, except the little bit in question, which affected not alone three houses, but all the Company's rights to the South, and to avoid the piece in question he was told would involve going round 1,440 yards, at a prohibitory cost of £5,000.

His LORDSHIP said the question of law involved was very interesting, and he never liked to stop counsel, but he confessed he should have thought the Company might very well recognise the plaintiffs' rights, and take a licence from them, or something of that kind. He certainly thought that the plaintiffs' rights ought to be recognised.

Mr. CRIPPS said he would be willing to take that attitude, because his clients did not wish to assume an antagonistic position.

Mr. BRAY said he could not act at present in the way suggested, as the Vestry would have to be consulted first.

Ultimately counsel on both sides agreed to an adjournment for a month, to enable his Lordship's expression of opinion to be submitted to the Vestry.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

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"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

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NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set,

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. WADE. *In the Press.*

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshal. and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

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"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net 2s. 9d. post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is *now ready.* Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898, and contains about 150 additional pages over last year's book. Supply houses will find the book very reliable and complete for circularising.

Tenders Invited.—The Electric Lighting Committee of the County Borough of Salford are prepared to receive competitive plans and estimates from architects for the erection of a new electricity generating station. Some additional particulars are given in an advertisement elsewhere, and all further information may be obtained from the electrical engineer (Mr. C. Turner), Walness-road, Salford, after the 14th inst. Sealed plans and estimates, addressed to the Chairman of the Committee, must be delivered at the office of the town clerk (Mr. Samuel Brown), Town Hall, Salford, by 9 a.m. on Friday, the 25th inst.

——— The Edinburgh Town Council require tenders for certain additions and extensions to the electric lighting installation at the City Chambers. Some particulars are given in an advertisement elsewhere, and plans, &c., can be obtained at the office of the resident electrical engineer (Mr. F. A. Newington), 5, Dewar-place. Tenders must be sent to the town clerk (Mr. Thomas Hunter, W.S.), City Chambers, Edinburgh, by the 22nd inst.

——— The Plymouth Corporation invite tenders for the supply of alternating-current electricity meters for the twelve months ending March 31, 1899. Specification, &c., may be obtained by bona fide meter manufacturers or their authorised agents on application to the borough electrical engineer (Mr. John H. Rider), East-street, Plymouth, and tenders must be delivered to the town clerk (Mr. J. H. Ellis), Town Hall, Plymouth, not later than March 23. Further particulars are given in an advertisement elsewhere.

——— The Leyton Urban District Council require tenders for the supply and erection of two dynamos, one continuous-current

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balancing transformer, two gas engines and connections, and switchboards, at the electricity works at Leytonstone. Manufacturers only can tender. Plans, &c., can be obtained at the office of Mr. H. Collings Bishop, electrical engineer, Cathall-road, Leytonstone, after the 21st inst., and tenders have to be sent to the Town Hall, Leyton, Essex, by Monday, April 4. Mr. R. Vincent is clerk to the Council. An advertisement on another page gives some further particulars.

Tenders Invited.—The Great Central Railway Company (M.S. and L.) require tenders for the supply of certain stores and materials for the twelve months ending April 30, 1899. Tenders to Mr. Oliver S. Holt, secretary, London-road Station, Manchester, by 10 a.m. on Tuesday the 15th inst.

——— The Visiting Committee of the Wilts County Asylum, Devizes, require tenders for the supply and delivery at their new engine house of two 40-kilowatt continuous-current belt-driven dynamos. Tenders to Mr Joseph T. Jackson, office of clerk to the Visiting Committee, Devizes, by noon of 21st inst.

——— The Corporation of Blackpool invite tenders for the supply and erection of plant at their electricity works. Particulars of and tenders to Mr. T Loftos, Town Hall, Blackpool, by 10 a.m. March 22.

——— The Wallasey Urban District Council invite tenders for the supply of (*a*) engine, alternator and exciter; (*b*) two Lancashire boilers and one water tube boiler; and (*c*) condensing apparatus. Tenders to Mr. H. W. Cook, Church-street, Egremont, by 4 p.m. March 17.

——— The Watford Urban District Council require tenders for generating plant, switchboard and connections; overhead travelling crane; conduits and mains; transformer sub-stations, switch gear, electric lamps and posts, &c., &c. Tenders to Mr. H. Morton Turner, Council Offices, Watford, by noon of March 16.

——— The Darwen Corporation invite tenders for the supply of steam engines and dynamos, steam and exhaust pipes, &c.; accumulators, switchboards, &c.; underground mains, arc lamps, and pillars. Tenders to the Town Clerk's office by noon 28th inst.

——— The Derby Corporation invite tenders for wiring their Lunatic Asylum and premises at Rowditch. Tenders to the Town Clerk by the 24th inst.

——— The Horse Committee of the Bournemouth Corporation invite tenders for motor vans for the collection of house refuse, &c. Tenders to the Borough Engineer by April 4.

——— The Southgate District Council require tenders for an installation of electrical communication for Fire Brigade purposes. Tenders to Clerk by Monday next.

——— The Committee of Visitors of the Lancaster County Asylum require tenders for the supply of electrical goods, &c., for twelve months to April 3, 1899. Tenders by 16th inst.

——— The Council of the City of Hawthorn (Victoria) invite tenders for the supply and erection (or supply only) of boilers, water heater, pumps, engines, dynamos, switchboard, mains, submains, transformers, meters, arc lamps, insulators and testing instruments; for the supply of poles and their erection and for the running of the electric lighting plant for three years. Tenderers have to supply drawings. All particulars can be obtained of the Agent-General for Victoria, 15, Victoria-street, Westminster, London, S.W. Tenders have to be sent to the Mayor of the City of Hawthorn, Victoria, Australia, by five p.m. of Friday, June 24th next.

——— The Public Works Department at Fribourg, Switzerland, require plans and estimates for the projected electricity station at Hauteraine. Water-power is to be used, and the station is to have a capacity of 6,000 H.P. A premium of £120 will be awarded to the three best schemes sent in. Estimates and plans must be in by April 30.

——— The small towns in Spain are moving forward. The Municipal Council of Zafra (Badajos) require tenders for the lighting of the streets for 20 years. About 200 10-c.p. incandescents will be required. Tenders to the Council by 29th inst.

——— The Municipal Authorities of Santoña (Santander) also require tenders for the electric lighting of the streets for a period of 20 years. 120 10-c.p. incandescents and four 6-ampere arcs swill be required, the latter to be employed from June to Sept. Tenders to the Council by 21st inst.

Tenders Accepted.—At the meeting of the Bradford Town Council on Tuesday it was decided to accept the tender of Messrs. Cole, Marchent and Morley for another set of condensing plant at the electricity works at £1,679.

——— The Belfast Town Council have accepted the tender of Messrs. Thomas Parker (Limited) for the supply of a steam dynamo (to be suitable for both lighting and traction) at £2,646.

——— The Canterbury Town Council have accepted the tender of Mr. A. J. Brewster for the erection of electricity station buildings, at £4,032, and for boiler seatings, flues, &c, at £910.

Tenders Accepted.—The Free Library Committee of the Swansea Corporation recommend the acceptance of the tender of Mr. Ganz for the supply of six electric timepieces for the library and one for the exterior of the building, at a cost of £84. 14s.

——— The General Purposes Committee of the Carlisle Corporation have accepted the tender of Messrs. J. and W. Baty for the erection of electricity supply station buildings, at £7,402. The tender of Messrs. E. and W. H. Haley for the supply of cast-iron pipes has also been accepted.

Appointment Vacant.—The Co-operative Wholesale Society, 1, Balloon-street, Manchester, require an electrical and mechanical working engineer to take charge of plant, &c., of large works near Manchester. Applications to the Committee by 14th inst.

Business Notices.—The British Thomson-Houston Company inform us that increase of business has necessitated the taking of further premises at 26 and 27, Bush-lane, Cannon-street, London, where new show-rooms have been opened. This address is the headquarters of the Company's supply department, under the management of Mr. A. J. Ireland.

——— Messrs. Crompton and Co. inform us that they have closed No. 35, Queen Victoria-street, at which address they have hitherto carried on the sale of electrical cooking and heating appliances, and that this branch will be carried on at Arc Works, Chelmsford. In future the trade only will be supplied with their electric heating and cooking appliances, but the name and address of the nearest agent from whom these goods can be obtained can be had on request.

——— Messrs. J. C. Lyell and Co., of 55, Victoria-street, London, S.W., inform us that increase of business during the past year has necessitated the taking of additional offices, and that the whole building of 55, Victoria-street, is now occupied by the firm, who are about to open several new departments.

Bankruptcies.—In the bankruptcy of Trehearne, Son and Crump, electrical engineers, 155, Fenchurch-street, London, E.C., the first meeting of creditors will be held on 16th inst., and the public examination on April 5, at Bankruptcy-buildings, London.

——— The public examination of John Dewhurst, electrician, 52, North End-road, Kensington, took place on Wednesday at the London Bankruptcy Court. Debtor stated that he had carried on business for thirteen years, and ascribed his failure to having paid an excessive amount to buy out a former partner and to loss by embezzlement on the part of a traveller. The examination was concluded. The accounts show liabilities £860, deficiency £194.

——— In the failure of E. J. Paterson and C. F. Cooper a first dividend of 7s. 6d. will be payable on and after 23rd inst. at Messrs. E. Moore and Sons' offices, 3, Crosby-square, London, E.C.

Deed of Arrangement.—James Robert Powditch and William Jones, trading as Powditch and Co., electric lighting contractors and shop-fitters, Victoria Works, Percy-square, London, W.C., have executed a deed of arrangement. Mr. B. C. Wotton, Poplar Wharf, Croydon, is trustee. The liabilities are returned at £1,596. 14s. 6d., assets £785.

Dividend.—A second and final dividend of 1s. 9d. in the £ (making a total of 6s. 9d. in the £) has been declared in the voluntary liquidation of William Banks and Co. (Limited), electrical engineers, &c., 32, Corporation-street, Bolton, and is payable at the offices of Messrs. Yates and Scampton, 4, Wood-street, Bolton, on Tuesday.

Liquidation Petition.—Official notice is given that a petition for the winding-up of the Ariel Arc Lamp Syndicate (Limited) was presented on Feb. 28 to the High Court of Justice by Mary Ann Jones and John and Alex. Galt Ross, and that the petition will be heard on 16th inst. Messrs. Pollock and Co., 6, Lincoln's Inn-fields, W.C., are the petitioner's solicitors.

Correction.—By a printer's error the name of the firm of manufacturers of the compact telephone set described and illustrated on page 625 of our last issue was given as Anderson, Kant and Co., instead of Henderson, Bunn and Co.

"Q" and "V" Type E.P.S. Storage Cells.—Mr. J. W. Barnard, 4, Great Winchester-street, London, E.C., who, as mentioned in our last issue, has been appointed sole agent for these cells manufactured by the Electrical Power Storage Company, has ready for users a handy price list, which can be obtained on application.

Kenway's System of Electric Traction.—Mr. W. E. Kenway, of Birmingham, has invented and developed a novel system to fulfil the function of the ordinary trolley. In the "Kenway" system a single "trolley" wire only is needed. Even to supply a double track this wire is supported along one side of the road at about the usual height from the ground by being clipped to short backets projecting from side poles. A trolley arm, having motion in a horizontal plane only, is provided on the car, and this arm carries at its extremity a short, vertical length of rod as a sliding contact-piece. The trolley arm is set inclined upwards from the standard on the car to its extremity.

and is furnished with a spring tending to set the arm, when free, in a position at right angles to the track. The trolley arms, being longer than the distance from the swivel standards on the cars on the track furthest from the trolley wire, assume a raking position, by which, when the cars are in motion, the vertical contact-piece slides along the *side* of the conductor and is pressed against it by the action of the springs in the swivel of the arm. The arms of cars on both the up and down lines slide on the same side of the same wire—the passing of the contact-pieces being easily provided for. Mr. Kenway is also the inventor of the "Victor" rail joint, which appears to present a decided advantage over the ordinary fishplate joint.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 2 to 8, with the ports of destination :—

Argentina—Buenos Ayres, £657 (including £115 telegraph material); Rosario, £39. *Australasia*—Adelaide, £13; Albany, £45; Melbourne, £752 (including £695 telegraph material); Sydney, £51. *Belgium*—Antwerp, £174 (fuses). *Ceylon*—Colombo, £17. *China*—Shanghai, £6; Tientsin, £36. *Denmark*—Copenhagen, £25. *Egypt*—Suez, £12,140. *France*—Boulogne, £32. *Germany*—Hamburg, £120; Stettin, £91 (telegraph wire). *Holland*—Amsterdam, £50. *India*—Bombay, £40; Calcutta, £148; Madras, £1. *Japan*—Yokohama, £270. *Malta*—£33. *Norway*—Christiania, £34. *Portugal*—Beira, £1,995 (telegraph apparatus); Lisbon, £935. *Russia*—Libau, £60. *South Africa*—Cape Town, £1,216; Durban, £630 (including £529 telegraph material); East London, £594; Port Elizabeth, £411. *Spain*—Barcelona, £1,182; Bilbao, £155; Malaga, £156; Santander, £59. *Straits Settlements*—Penang, £16 (telegraph material); Singapore, £265 (telegraph material). *Sweden*—Gothenburg, £76; Stockholm, £365 (telegraph cable). *United States*—New York, £1,654 (telegraph material). Total £24,543, against £8,379 in the corresponding week last year (March 3 to March 9).

"The Engineering Magazine."—The contents of the March number of this magazine include articles on "The Gold Mines of the Witwatersrand, South Africa," by J. H. Hammond; "Mining Law in British Columbia, Mexico, and the United States," by R. W. Raymond; "The Economical Utilisation of Exhaust Steam," by Bryan Donkin; "Ship Building as a Productive Industry in Great Britain," by James McKechnie; "The Construction of Slow-Burning Buildings," by F. C. Moore; "British Railway Fares and their Influence on Traffic," by W. J. Stevens; "The Development of Machinery for Metal Stamping," by Oberlin Smith; "Methods for the Recovery of By-Products of the Blast Furnace," by Prof. A. Humboldt Sexton; "The Adjudication of Water Rights in Irrigated Regions," by E. Mead; "The Electric Development of Hydraulic Power," by F. C. Finkle. The usual Review of the World's Engineering Press is also given. Copies of the magazine may be had at the office of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London, E.C.

"The Journal."—No. 132 of the *Journal* of the Institution of Electrical engineers is now ready, and contains Mr. J. W. Swan's presidential address, and the Papers read by Major-Gen. C. E. Webber and Mr. Sherard O. Cowper-Coles, with the discussions thereupon.

Inquiry.—A correspondent (J. E. Owen), writing from "Brookhill" on Feb. 27, asks us to give the name of the firm who manufacture apparatus for welding and brazing with the electric arc, a description of which appeared in our issue for Nov. 26 last. As the postal authorities have been unable to locate Brookhill, we give here the address of the Electric Metal Working Syndicate (Limited), 61 and 62, Gracechurch-street, London, E.C.

Law Relating to Electric Generating Stations.—Last evening Lord Morley was to move in the House of Lords the appointment of a committee to join with a committee of the House of Commons to inquire into the law relating to electric generating stations (Electric Lighting Act, 1882, Sec. 12).

Aberdeen.—The accounts of the electricity department for the past year were presented at the Town Council meeting on Monday. The net profit is £169. The revised scale for current for motive power purposes (6d. per unit for the first hour's daily maximum demand, and 1½d. after) was approved.

Acton.—A special meeting of the District Council in Committee was held last week for the purpose of further considering the electric lighting question, when the two experts (Mr. Lacey and Mr. Trentham) who have been retained to prepare confidential reports on the matter were in attendance.

Bath.—The accounts of the electricity department from Jan. 17 to Dec. 31, 1897, show a revenue from public lighting of £2,184. 11s., private consumers £4,115. 14s. 5d., meter rentals, &c., £219. 1s. 9d., or a total of £6,519. 7s. 2d. The total expenditure is returned at £5,001. 8s. 9d., leaving a gross profit of £2,227. 12s. 5d. As the undertaking was taken over by the Corporation in January last no comparison with previous years can be given, but the receipts of the Company for the year 1896 amounted to £6,332. 15s. 8d. After deducting the annual expenses, interest, and the amount set aside in view of the creation of a sinking fund, there was a net profit of £645. 5s. 1d.

Belgrade (Servia).—The electric light is now generally adopted in the better class of shops and residences in this city, and is fully expected to shortly entirely supersede all other methods of lighting.

Bournemouth.—The British Electric Traction Company will shortly submit a revised scheme of electric tramways for this town, which is likely to command the approval of the Council.

Bradford.—The half-yearly statement of the gas and electricity accounts was laid before the Town Council on Tuesday by the Mayor (Mr. T. Speight). The total income of the electricity department for the half-year ended Dec. 31 last was £10,842. 0s. 7d., compared with £9,370. 13s. 2d. in the corresponding period of 1896, an increase of £1,271. 7s. 4d. The total expenditure, including interest and sinking fund, was £7,942. 18s. 8d., against £5,570. 4s. 1d. for the corresponding half-year. The profit for the half-year was £2,899. 1s. 11d., against £4,000. 9s. 1d. The decrease was explained chiefly by the increased interest and sinking fund charges (amounting to £885 extra) together with sundry items of repairs to machinery, including renewal of batteries, &c. The number of consumers was 640, against 470, an increase of 36 per cent. The total number of units consumed was 550,300 against 477,342, an increase of 15¼ per cent. The total profits since the opening of the works (Sept., 1889), after paying interest and sinking fund, amounted to £16,733. 0s. 6d., and the total amount written off for depreciation had been £7,307. 15s. 6d., leaving £9,425. 5s. to be appropriated as the Council might direct. The trade profit was equal to £4. 11s. 9½d. per cent. for the half-year on the capital outlay, but the net profit was only £1. 2s. 7d. per cent. Taking the Dec. and June half-years together, the trade profit was £11,234. 10s. 1d., representing £8. 3s. 3d. per cent. per annum on the capital outlay. The accounts were approved. The Mayor announced that the question of a revision of the charges for current for private lighting and for motors was being considered by a sub-committee, who would shortly present a report.

Brighton.—The Corporation have before them a communication from Mr. Magnus Volk dealing with the alterations required to be made to his electric railway. Mr. Volk (who is now sole proprietor of the railway) has arranged to take current from the Corporation mains.

Bromley (Kent).—The seal of the District Council has been ordered to be affixed to the agreement for the transfer of the Provisional Order to the Bromley (Kent) Electric Light and Power Company.

Burton-on-Trent.—The Chairman of the Gas and Electric Lighting Committee (Alderman Lowe) announced at Wednesday's meeting of the Town Council that Mr. Frank Bailey, the engineer of the City of London Electric Lighting Company and of the Metropolitan Electric Lighting Company, had made an exhaustive inspection of their plant and cables, but up to the present his report was not to hand.

Buxton.—At a special meeting of the District Council on Monday, it was resolved that Prof. A. B. W. Kennedy should be instructed to prepare plans and specifications, and that tenders should be obtained for putting down an electric light installation under the Council's Provisional Order. This decides the question as to the Council retaining in their own hands the supply of electricity in the Buxton district.

Cardiff.—At the meeting of the Lighting and Electrical Committee last week the Borough Electrical Engineer (Mr. N. Appelbee) presented a report upon the charges for electric current. At present the price is 6d. for the first two hours' average daily use and 3½d. afterwards. Mr. Appelbee suggested that this should be modified to 7d. for the first hour and 3½d. afterwards, and that current be supplied to places of worship at 5d. per unit, or at the differential rate if desired. These modifications would, he urges, create a greater demand for current, but would reduce the revenue for the next year by 10 per cent. If 6d. per unit were adopted for the first hour the reduction would be about £1,050, or 15 per cent. The matter was discussed by the Committee, but no decision was come to.

Civil Service Estimates.—In the estimates for the year ending March 31, 1899, a sum of £3,500 is to be provided for beginning the installation of the electric light at Buckingham Palace, and in the Colonial Service estimates provision is to be made for establishing telegraphic communication in the Niger territories.

Crieff.—Mr. R. F. Yorke, it will be remembered, recently placed before the Town Council a proposal for forming a company for providing this town with electricity supply works, for which the motive power was to be obtained from the Falls of Turrett. Mr. Yorke has recently placed his full scheme before Sir Patrick Keith Murray, who is, we understand, satisfied with the details and plans submitted; and, if the Council is satisfied that the

scheme will be for the benefit of the town, Sir Patrick has expressed his willingness to give facilities to a properly-financed company.

Darlington.—The Town Council have instructed Prof. Kennedy to prepare an electric lighting scheme for the borough.

Derby.—The borough electrical engineer (Mr. J. E. Stewart) is preparing plans and specifications for wiring the Board Schools. The question of lighting the Market Hall was discussed at the last meeting of the Town Council, and Mr. Butterworth will move at the next sitting that it be an instruction to the Markets Committee to take steps to put the electric light installation in the Market Hall in proper order.

Dublin.—It is expected that the Clontarf section of the Dublin United Tramways Company's system will be opened for traffic early next week.

Dudley.—The Midland Electric Corporation have been asked by the Mayor to submit terms for the supply of electricity "in bulk" to the Town Council. The matter is to be discussed at a meeting on the 22nd inst.

Dundee.—The receipts of the electricity department for the ten months ended February amounted to £3,906. 9s. 9d., an increase of £467. 18s. compared with the same period of the previous year.

East Grinstead.—A resolution in favour of applying for a Provisional Order is to be moved by Mr. Steer at the next meeting of the District Council.

Eccles.—The Town Council have fixed the charge for electric current at 7d. per unit for the first hour for private lighting, and 2d. after.

Edinburgh.—Notice of motion has been given to remit to the Electric Lighting Committee the question of the salary of the electrical engineer, and also the charges to be made for electric current for public and private lighting and power purposes from May 15th next.

Electric Haulage on Canals.—The *Financial News* states that a French company has requested the French, Belgian, and Dutch Governments to allow them to establish along the navigable rivers and canals in these three countries a system of electric traction, in order to form an international network of electric towage which will stretch from the Rhine, in Holland, to Marseilles, through the eastern provinces of France. Several canals of the North of France are to be connected with the Upper Meuse. It is urged that when this project is realised a great and probably favourable influence will be exerted upon the French and Belgian coal mining industry.

Electric Traction in the Potteries.—A conference of local authorities is to be held for the purpose of considering the advisability of taking joint action to acquire and extend the local tramway system. This step has been taken on the initiative of the Hanley Town Council, and has already met with the approval of the Burslem and Longton Councils.

Esher.—Considerable dissatisfaction is expressed as to the indifferent manner in which the streets are lighted and the high price of gas. As a result there is talk of introducing the electric light.

Exhibition.—The following privileges are offered to exhibitors at the exhibition to be held in Madrid from April 10 to July 10 next:—No charge is to be made for space, goods will be imported into Spain free of customs duties, and the Spanish railways will make a reduction of 50 per cent. from the tariffs for carriage.

Fareham.—The District Council have decided to put down additional plant at the electricity generating station at an estimated cost of £2,900.

Festiniog.—The District Council declines to part with its electric lighting powers to a local company.

Greenock.—A sub-committee of the Police Board recommend the establishment of electricity works in this town at an estimated cost of £28,000. The scheme provides for supplying current for both private and public lighting. About 40 arcs are to be erected in the main thoroughfares.

Hampstead.—The Electric Lighting Committee have considered the question of providing additional plant at the electricity works to meet the anticipated demand for current in the winters of 1898 and 1899, and have dealt with a report on the subject by the electrical engineer (Mr. G. H. Cottam). The Committee now recommend that additional plant be obtained, at an estimated cost of £17,000. The recommendation was agreed to, and tenders are to be invited. The Vestry also decided to extend the mains to Belsize-lane, Finchley-road, Downside-crescent, and Ferncroft-avenue. The estimates of the electricity department for the financial year 1898-99 puts the income from private consumers at £19,000, and the expenditure, including working expenses, establishment charges, interest and repayment of loans, at £13,500—an estimated net profit of £5,500.

Hartlepool.—At the last meeting of the Town Council the Borough Engineer was instructed to prepare a report as to the probable cost of laying down, in connection with the proposed refuse-destructor works, an electric lighting plant for the supply of current for public lighting.

Hospital Lighting.—The very complete installation of the electric light at the Devon and Exeter Hospital by Messrs. Massingham and Mann, which is approaching completion, consists of two boilers, engines, dynamos, a battery of accumulators; and power is supplied to three large electric lifts and to a variety of labour-saving appliances installed throughout the building. It is described as one of the largest private electric lighting jobs in the West of England.

Inverness.—It is stated that a movement is on foot for the formation of a local electric lighting company, which proposes to utilise the water power at the Falls of Foyers in the generation of current.

Lectures.—Mr. Wm. Arnot lectured last week before the Architectural Section of the Glasgow Philosophical Society on "The Distribution of Electricity in the House." The lecturer gave particulars of the various systems of wiring, and urged that more taste should be displayed in the design of electric light fittings.

The Right Rev. Monsignor Molloy, D.D., lectured before the Royal Dublin Society on Tuesday, on "The Principles of Electric Signalling without Wires."

At Finsbury Technical College, London, on Monday, Mr. Reginald J. Wallis-Jones lectured on "Electric Welding." The various systems in use—the Benardos, Zerena, Coffin, Voltex, Hoho-Lagrange (Hydro-Electro-Thermic), and the Thomson (incandescence) systems—were described and illustrated by experiments and lantern slides. Many unique and interesting samples of "snap" or rapid electric welding (Thomson process), as applied to the manufacture of cycle parts, &c., were shown. Apparatus and samples were lent by the Electric Metal-Working Syndicate and the Electric Welding Company (Limited).

Leeds.—The Parliamentary Committee have approved the draft of the Provisional Order to be applied for in connection with the purchase by the Corporation of the undertaking of the Yorkshire House-to-House Electricity Company. The following offer for the acquisition of the electricity works was recently submitted to the Company by the Corporation: (1) The purchase to take effect from March 1 next; (2) the Corporation to issue or transfer, as purchase money, Leeds Corporation Redeemable Two and a-Half per Cent. Stock (in lieu of Irredeemable Stock) of such amount as would equal in market value a Leeds Corporation Irredeemable Five per Cent. Stock, this amount to be determined by arbitration in case the parties differ; (3) the Corporation also to pay a sum to make up the dividend on capital expenditure to 5 per cent., and on any agreed expenditure on capital after the date mentioned.

Liverpool.—An error crept into the note under this heading in our last issue. The revised salary of the city electrical engineer (Mr. A. Bromley Holmes) is £1,600; the increase being from £1,000 to £1,600 on condition that Mr. Bromley Holmes gives up his private practice. £600 of the annual salary is to be paid by the Tramways Committee.

The City Council have authorised the members of the Tramways Committee, together with the town clerk, the engineer and the manager, to pay a visit to Hamburg for the purpose of inspecting the tramways in that town.

Manchester.—The salary of the Secretary of the Electrical Committee has been increased from £225 to 250, and that of the Chief Assistant Engineer (Mr. A. A. Day) from £250 to £270 per annum. The question of the utilisation of the water supply at Longdendale in the generating of electric current is to be referred to an electrical engineer for report.

Marylebone (London).—At the meeting of the Vestry last night it was decided, on the recommendation of the Electric Lighting Committee, to inform the Board of Trade that the Vestry would undertake to at once proceed with the erection of electricity supply works in the district as soon as the necessary powers were obtained. It was also decided to omit from the Provisional Order the clause empowering the transfer of the powers to a company.

Milan.—A Foreign Office report from the British Consul at Milan makes suggestions for increasing British trade with Italy. Milan is described as not only the capital of Lombardy, which has a population of 4,000,000, and is the richest district in the kingdom of Italy, but is also a great distributing centre for all North and Central Italy. British goods are stated to still enjoy their old prestige in that country, and Milan could be made the centre of business for the supply of over 30,000,000 of people with British goods of all kinds. It is recommended that agencies be established in Milan in order that the German and Swiss commission agents, who are here to be found in large and increasing numbers, may not occupy the entire field. Numberless articles in which Great Britain ought to be able to compete successfully are stated to be almost excluded from the Italian markets owing to absence of British representatives on the spot.

Morecambe.—Col. R. J. Hepper held a Local Government Board inquiry on Wednesday into the application of the Town

Council to borrow an additional sum of £10,000 for electric light extension purposes. Last year the Board sanctioned a loan of £27,000, but owing to the rapid growth of the town and the increased demand for current it was considered advisable to make additions to the plant and mains. It is proposed to increase the number of arc lamps on the Promenade from 75 to 100, and as there was a brisk demand for current from the west end of the town for private lighting it was proposed to put down new mains for supplying this district. The Clerk explained that, with reference to the recent arbitration case with the Electric Lighting Company, the Council had been awarded as their share £1,179. There was no opposition.

New Orleans (U.S.A.).—During the past three years the street railroads in this city have been converted from mule cars to electric lines at an estimated cost of between £2,400,000 and £3,000,000. The work is now practically completed. The total length of electric lines in the city is 162·86 miles. A contract has recently been entered into with the National Contracting Company, who undertake to deal with the entire drainage system of the city, operating the pumps and other machinery by electric power for a sum of about £200,000.

Northampton.—In reference to the proposal of the Corporation to purchase the undertaking of the Northampton Electric Light Company, in a communication dated the 8th inst., the Secretary of the Company states that the directors do not feel in a position to name a price at which the shareholders might be advised to sell; but they would give their best consideration to any offer emanating from the Town Council.

North Berwick.—A Committee has been appointed by the Town Council, to obtain information as to the advisability of establishing electricity supply works.

Obituary.—Mr. James Gordon Lawson, electrical engineer, died at Barcelona, Spain, on the 27th ult., aged 31 years. (Canadian papers please copy.)

Paisley.—The Town Council had before them on Tuesday the proposals of the British Electric Traction Company for the introduction of electric traction on the local tramways. The Company recently acquired the undertaking of the Paisley Tramways Company, and have asked the Council to grant a 28 years' lease of the lines, in return for which they offer to equip them on the overhead trolley system, and to extend the tramways to the boundaries of the Burgh (Johnstone on the west, Potterhill on the south, Renfrew on the north, and Glasgow on the east). The agreement for the sale of the lines was confirmed, but the other matters were deferred, pending a report from the Borough electrical engineer (Mr. Francis Teague).

Private Bill Legislation.—The Chelsea Vestry have decided to petition against the Metropolitan Supply Company's Bill for the generation and supply of electricity "in bulk."

Radcliffe.—The District Council are obtaining from Dr. Hopkinson and Messrs. Bennett and Medhurst their charges for preparing an electric lighting scheme at an estimated expenditure of from £15,000 to £20,000. The Municipal Electric Supply Company has also been asked to submit particulars of their suggested scheme.

Ramsgate.—This is one of the few seaside towns which have not yet adopted an electric lighting scheme. If this popular summer resort means to keep pace with the times, and to meet the competition of such places as Bournemouth, Brighton, Torquay, Hastings, Eastbourne, Great Yarmouth, Southport, Scarborough, Blackpool, &c., where electricity works are in operation, the Council must speedily consider the advisability of adding the electric light to the advantages of the town. At the last meeting of the Council a debate on the matter was initiated by Councillor Hawkes, who produced letters from a number of leading tradesmen in favour of the introduction of the electric light, and offering to take current as soon as it was available. A Provisional Order is being applied for by a company, and a public inquiry will shortly be held into the matter, as the Council have lodged a petition against the application.

St. Helens.—The Town Council have appointed an Electricity Works Committee to deal with electric lighting and traction matters.

Shannon Electric Power Scheme.—At a meeting of the Limerick Fishery Conservators, last week, a committee was appointed to arrange for a conference with the Shannon Electric Power Syndicate in reference to the scheme for the utilisation of the water power of the river in the generation of electric current.

Sheffield.—At the meeting of the City Council on Wednesday, the Corporate Seal was ordered to be affixed to the agreement with the Sheffield Electric Light and Power Company, for the sale and transfer of the Company's undertaking to the Corporation.

Shoreham.—A special meeting of the District Council was held last week to meet the representatives of the Southern Cross Engineering and Shipyard Company, who submitted particulars of an electric lighting scheme for the district. Mr. M. H. Churchill-Shann estimated that an installation could be provided at a cost of £6,000, which would supply current to 56 1,000-c.p. arcs for public lighting and 15,000 16-c.p. incandescents for private consumers. The present cost of street lighting is about £175 per annum, and he estimated that under the electric lighting project three times the light would be obtained for about the same money. The annual expenses would come to £1,255, and the gross profits to £1,625, leaving an estimated net profit of £370. The scheme is to be discussed by the Council in committee.

South Africa.—According to the *British and South African Export Gazette* specifications and plans of an electric lighting and tramway scheme for East London are required. It is contemplated to lay down a plant capable of supplying current to meet the present public and private requirements of the town, but provision is to be made for future extensions and for furnishing the Harbour and Railway Departments with such current as they may require. The site of the generating station has been fixed in convenient contiguity for coal supplies to the new wharf extension and also to the railway line. The plant will be capable of supplying current to an equivalent of 2,804 16-c.p. incandescents and 43 arcs and for three miles of tramways. For street lighting 18 2,000-c.p. arc lamps and 300 32-c.p. incandescent lamps will be used; for the Harbour Department 21 2,000-c.p. arcs and 725 16-c.p. incandescents; for the Railway Department four 2,000-c.p. arcs and 27 32-c.p. incandescents. For private lighting current will be supplied to about 1,500 16-c.p. incandescents, and the high-tension alternating-current system of supply is recommended. It is proposed to adopt the overhead trolley system of traction, the track being laid with 60lb. rails, and the cars constructed to carry 25 persons. The Town Council have appointed Mr. R. Lewis Cousens as their adviser.

An electric lighting installation is under contemplation for the Monastery diamond mine, Orange Free State.

The question of the adoption of electric traction on the tramway at the Sheba gold mine, to replace the present steam tram, is under consideration.

Tenders ranging from £12,000 to £30,000 have been received by the Bloemfontein (Orange Free State) Town Council for the proposed electric lighting of that town.

Southampton.—At the meeting of the Town Council last week, the Electric Lighting Committee presented a lengthy report recommending the Council to authorise the laying of additional mains at an estimated cost of £4,000, and to apply to the Local Government Board for sanction to borrow this amount, in addition to the amount of £54,000 previously sanctioned. The report was adopted.

On the subject of public lighting a report was presented by Mr. Manville, who suggested that, as the Council had now decided upon the method of traction to be adopted on the tramways, he should be authorised to lay out the position of the new lines. The Council instructed Mr. Manville to submit a further report with plans.

The Corporation are considering the terms upon which the National Electric Free Wiring Company are prepared to undertake the "free" wiring of premises in the district.

Stirling.—The Police Commissioners still retain an opinion that the water power available at the river Fouch reservoirs can be utilised in the generation of electric current. The report recently prepared by Prof. Kennedy was discussed at a recent meeting of the Commissioners, when ex-provost Yellowlees moved that "the report be laid on the table, and that the Lighting Committee be instructed to get from an electrical engineer, who is a specialist in the use of water power, at a cost not exceeding 20 guineas, a further report, with guaranteed estimates as to the utilisation of the water power available at the reservoirs for the electric lighting of the town." Carried.

Stockton.—The Electric Lighting Committee have been authorised to engage expert evidence to advise upon the tenders submitted for the erection of electricity supply works in the town.

Swansea.—The British Electric Traction Company took formal possession of the property of the Swansea Tramways Company last week. So soon as the necessary authority is obtained for the adoption of electricity as motive power steps will be taken to equip the lines electrically.

Synagogue Lighting.—The electric light has been introduced at St. John's Wood Synagogue, Abbey-road, London. The fittings, of an artistic character, were designed and manufactured by the Edison and Swan Company, and the wiring contract was carried out by the Electric and General Engineering Company. There are 207 16 c.p. lamps.

Taunton.—The Electric Lighting Committee report that during the past month the fresh connections were equivalent to 512 8-c.p. lamps, and establishes a record for the department. In moving the adoption of the report at Tuesday's meeting of the Town Council, the Mayor (Alderman Potter), who is also Chairman of the Committee, stated that their expenses had only increased by £178

during the year, against an increase of profits of £271. 8s. 4d. There is a credit balance on the year's working of £43.

The Water Committee are considering the advisability of establishing a system of telephone fire calls in portions of the borough.

Torquay.—The date of the official opening of the electricity supply station has been fixed for Thursday, the 17th inst.

Wells.—The Town Council have been approached by an electric lighting company with a view to obtaining a transfer of the Provisional Order, but have declined the offer. The Wells Provisional Order was obtained in 1896.

Yarmouth.—The Borough electrical engineer (Mr. A. W. Ranken) has resigned his position, the resignation to take effect on May 31st. The Electric Lighting Committee have passed a resolution expressing appreciation of Mr. Ranken's services. The following revised scale of charges for current for motors has been adopted:—Per 1-H P. motor, for a consumption of 100 units per quarter, 3½d. per unit; 100 units to 300 units, 3d.; 300 units to 500 units, 2½d.; over 500 units, 2d. Other size motors in proportion.

The Chairman of the Committee (Mr. R. Martins) referred, at the meeting of the Town Council on Tuesday, to the accident at the electricity works on Saturday evening. The Committee intended making a stringent inquiry with a view to preventing such an unfortunate mishap in the future. The Council decided to engage the services of an expert to assist the Committee in their inquiry.

The solicitors of the Tramway Company have notified the Council that the Company is prepared to carry out the powers of the Great Yarmouth and Gorleston Tramways Extension Act (1897), and are prepared to erect a generating station capable of supplying current, not only for working the tramways, but also for lighting purposes on the west side of the River Yare. The Company have authority to adopt the overhead trolley system of traction on the lines. The matter is at present under the consideration of the Electric Lighting Committee.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

January 31, 1898.

2,433. H. F. PHILLIPS. Guildford. An improved system of adapters to adapt all existing fittings for electric lighting to armoured, sheathed or other concentric cables.

2,455. R. BURN and A. C. BROWN. London. Improvements in electric contacts suitable for railway signalling and other purposes, and apparatus for use in combination therewith.

2,479. G. BYNG and H. BEVIS. London. Improvements in terminals for electrical connections, especially adapted to incandescent lampholders.

2,485. C. OLIVER. London. An improvement in electric arc lamps.

2,487. H. PENGELLY. London. Improvements in apparatus for distributing electricity.

2,495. J. L. BERTHET, M. MOLLARD and L. DULAC. London. Improved method of insulating electrical apparatus and conductors. (Date applied for under Patents, &c., Act 1883, Sec. 103, July 2, 1897, being date of application in France.)

February 1, 1897.

2,522. A. ECKSTEIN and H. J. COATES. Manchester. An improved electrical striking mechanism for bells.

2,538. G. WILKINSON and L. W. HOLMES. Leeds. Improvements in or in connection with the electrical propulsion of road vehicles.

2,551. T. COOPER. Birmingham. An improved combined electrical dynamo and motor.

2,571. C. VALLOT and E. PAUZE. Brussels. Improvements in electro-dynamic elements.

2,580. H. A. KENT. London. Improvements in electric lighting media.

2,584. W. L. WISE. London. Improvements in the manufacture of electric glow lamps. (C. Pieper, Germany.)

2,591. F. T. HARRIS. London. An improvement in electro-plating.

2,604. W. P. THOMPSON. Liverpool. Improvements in systems and apparatus for electric time control. (The Self-Winding Clock Company, United States.)*

2,618. L. WELDON. London. Improvements in supports chiefly designed for electric incandescent lamps.*

February 2, 1898.

2,669. W. MCGEOCH, JUN. Birmingham. Improvements in electrical cut-outs.

2,670. W. MCGEOCH, JUN. Birmingham. Improvements in electrical key-holder and analogous switches.

2,684. F. FISHER, B. J. ROUND, B. J. ROUND and A. ROUND. Birmingham. Improvements in apparatus for the electro-deposition of metals.

2,723. H. CRUDGINGTON. Birmingham. Improvements in electric arc lamps.

2,734. A. J. BOULT. London. Improvements in or relating to electric incandescent lamps. (C. Duvivier, Belgium.)

2,735. M. H. C. SHANN and R. E. C. SHANN. London. Improvements in or relating to dynamo machines and electric motors.

February 3, 1898.

18,718A. SIDNEY HOWE SHORT. London. Improvements in and relating to electric railways and tramways. (Date claimed under Patents Rule 19, August 12, 1897.)*

2,760. A. WILKINSON. Bradford. Improvements in phonographs.

2,761. E. W. COWAN and A. STILL. Cheshire. Improvements in high-tension electric switches.

2,770. G. JAEGER and H. BENDER. Berlin. Improvements in holders for incandescent electric lamps.*

2,784. O. C. IMMISCH. London. Improvements in electric switches.

2,788. R. B. ROXBY. London. Improvements in electric incandescent lamps.

2,805. H. CRUDGINGTON. Birmingham. Improvements in electrical tumbler switches.

2,814. J. F. BRENNAN. London. A new or improved manufacture of insulated wire for electrical purposes generally.

2,819. W. F. KESSLER. London. Improvements in electric cigar lighters.

February 4, 1898.

2,840. T. E. RITCHIE. Manchester. Improvements in and relating to motor starting switches and other like apparatus.

2,849. A. E. TANNER and F. A. C. LEIGH. Manchester. Improvements in electric switches.

2,871. W. H. GRAHAM. London. Improvements in electric furnaces.

2,876. J. ATHERTON and C. M. DOWNIE. London. Improvements in electric lamp bulbs.

2,891. F. B. GRÜNERT. London. Improved announcing and recording apparatus applicable to telephones.*

2,904. THE LINOTYPE COMPANY (LIMITED). (J. Place and M. Barr). London. Improvements in electric heating and melting specially applicable to the metal pots of linotype machines and the like.

February 5, 1898.

2,967. H. L. HAAS. London. Improvements in electro-depositing anodes.*

2,968. R. BELFIELD. London. Improvements in electric switches. (G. Wright. United States.)

2,991. W. MATHIESEN. London. Improved double arc lamps.*

2,999. C. ROSSI and P. FORCIERI. London. Improvements in transmitters of Morse telegraphic apparatus for continuous and alternating currents.*

3,003. P. JENISCH. London. Improvements in and relating to lamps provided with electric igniting devices.

February 7, 1898.

3,032. W. JAMIESON and J. TROTTER. Greenock. Steering torpedoes electrically.

3,074. P. JENISCH. London. Improvements in electric bells.*

February 8, 1898.

3,123. J. M. ANDERSEN. London. Improvements in electric switches.*

3,136. J. SWINBURNE. London. Electrolytic treatment of sulphides.

3,192. E. DE PASO. London. Improved method for the electrolytic treatment of sugar juice. (La Compagnie Electro-Sucrière. France.)

3,193. E. DE PASO. London. Process for the electrolytic treatment of sugar juice. (La Compagnie Electro-Sucrière. France.)

3,198. C. L. SAUNDERS. London. Improvements in the manufacture of carbons for electrical purposes.

3,204. C. A. VIGREUX and L. V. BRILLIÉ. London. Improvements in electric arc lamps.

3,207. S. BERGMANN. London. An improved guide for the carbon holder of an electric arc lamp.

3,209. H. G. LEOPOLD. London. Improvements in electrical signalling apparatus.

3,218. H. H. LAKE. London. Improvements in electric motors and dynamo-electric machines. (E. Cantono. Italy.)

3,219. A. C. HEAP. London. Improvements in electrical measuring instruments.

February 9, 1898.

3,258. E. MARCKWALD. Brussels. New process for manufacturing objects, and specially cases for electric accumulators, in unbreakable celluloid.

3,259. E. DUCRETET. Brussels. Improvements in the construction for producing and receiving Hertzian electric waves.*

3,278. H. R. MEYER. Liverpool. Improvements in or connected with indicating electrically the changes of market prices of goods and other data.

3,285. R. KENNEDY. London. Improvements in and connected with plates for electrical storage batteries.

3,313. P. ISERLOTH. London. Improvements in electromotors.*

3,316. J. E. KINGSBURY. London. Improvements in a self-restoring annunciator, more particularly suitable for employment in connection with telephone switchboards. (The Western Electric Company, United States.

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February 10, 1898.

3,865. D. Sinclair and W. Aitken. London. Improvements in telephone systems.
3,367. D. D'Arbel. London. Improvements in the production of acetylene light by electrolysis.*
3,368. D. D'Arbel. London. Improvements in secondary batteries.*
3,381. H. J. Blakeway. London. Improvements in electric alarums.
3,412. A. J. Lawson and J. D. Dallas. London. Improvements in combined fuse and switch boxes for use with high or low tension electric currents.

February 11, 1898.

3,431. H. E. Beach. Birmingham. Improvements in anodes used in the electro-deposition of metals.
3,449. J. R. Garner. Manchester. Improvements in the electrical driving of machinery.
3,476. J. Atkinson. Cheshire. Improvements in combined motors and electric generators.
3,495. J. S. Raworth. London. Improvements in electric motors.
3,496. L. Andrews. London. Improvements in electrical cut-out apparatus.
3,501. W. S. Simpson. London. Improvements connected with apparatus for producing and utilising electric currents.
3,503. J. H. W. Stringfellow. London. Improvements in insulating materials.
3,507. Eversbed & Vignoles, Limited, and S. Eversbed. London. Improvements in electric meters.

February 12, 1898.

3,514. W. Richardson. Northampton. An electrical conducting boot or shoe for the purpose of bringing electricity from the foot into direct contact with the earth.
3,520. G. H. Verity. Birmingham. An improved holder for electric glow lamps.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

26,425. Sayer. Electric railways and their vehicles.
27,304. Ridings and Crawford. Electric arc lamps.

1897.

1,648. Andrews. Electric switches and apparatus for connecting electric circuits.
1,734. Maycock. System of electrical signalling or communication between the occupant or occupants of a cab, carriage or other road vehicle, propelled by horse or other power, and the driver or drivers thereof, and apparatus therefor.
1,789. Smith and Granville. Electric cables.
1,964. Fesquet and Keys. Electric arc lamps.
2,125. Edmunds. Means of economising electric energy in the heating of electrically-heated apparatus and facilitating the use of such apparatus.
2,291. Engl. Insulating frames for electrodes.
2,418. Bonson. Form of electrode for galvanic or secondary batteries.
2,429. Obelt. Phonographs.
2,430. Obelt. Reproducing diaphragms of phonographs and similar sound recording and reproducing instruments.
2,478. Fabbro. Electric battery cases to render the contents of the cells unspillable, to facilitate the introduction of the electrolyte into the cells to enable the level of the liquid to be easily ascertained and to facilitate inspection of the interior.
2,582. Parker. Means for use in operating successively two or more electrical switches or sets of switches.
2,711. Heys (Dumoulin). Apparatus employed in the electro-deposition of copper and other metals.
2,712. Heys (Dumoulin). Apparatus for the electro-deposition of copper and other metals.
2,721. Obelt. Electric motors.
2,790. Bresson and Pacotte. Electric furnaces for use in the manufacture of calcium carbide, applicable also for obtaining metals from their salts.
2,801. Berry. Electrical transformers.
2,818. De Ferranti. Electricity meters.
2,904. Muirhead. Perforators for use in connection with automatic telegraph transmitters.
2,935. Rawlings and Rawlings. Switches for electric currents.
3,053. New. Separator for the plates of secondary batteries.
3,058. Joel. Apparatus for propelling and regulating locomotives, motor cars, carriages, cycles applicable to steam, gas, electric, oil, or other mechanically-propelled vehicles.
3,254. Obelt. Phonographs.
3,288. Contardo. Electric furnaces.
3,303. De Ferranti. Electric cables.
3,488. Schattner. Secondary Batteries.
3,520. Hartley (Zing-em, partly). Apparatus for the electro-deposition of metals.
3,676. Obelt. Phonographs.
3,772. Walker. Portable electric lamps for use in mines and other places.
4,315. Obelt. Phonographs and similar sound-recording and reproducing instruments.
4,417. Ayrton and Allen. Electromotors and apparatus for the electric propulsion of tramcars, railway locomotives or trains, and other vehicles.
4,461. Mordey. Brushes and their holders for dynamos.
4,755. Morris and Salom. Electric motor-propelled vehicles.
5,040. Rymer-Jones. Telegraph relay suitable for long submarine cables.
5,224. Gaynor. Electric arc lamps.
5,337. Rougham and Bersley. Suspension of electrical accumulators or batteries on motor carriages.
5,353. Yeatman and Donovan. Electrical switch or contact maker or contact breaker.
5,430. Marshall. Speed-regulating governors specially suitable for electric light and other high-speed engines.
5,479. Wade, Moores and Farrell. Dynamo electric machines.
6,276. Crompton and Pochin. Electric arc lamps.
6,305. Siemens Bros. and Co. (Limited) (Siemens and Halske). Telephone installations and apparatus therefor.
6,308. Siemens Bros. and Co. (Limited) (Siemens and Halske). Indicators for telephone exchanges.
6,674. Shaw. Dry primary cell or battery.
6,825. Lewis. Supply of current to and governing arc lamps.
7,235. Edmunds. Switching apparatus more especially adapted for use with electric motors.
7,420. Marquand. Electrical resitances.
7,572. Ashcroft. Combined electrolytic and leaching treatment of zinc-bearing ores and zinc-bearing products.
7,955. Siemens Bros. and Co., Limited (Siemens and Halske). Electric propulsion of vehicles and apparatus therefor.
9,967. Porter. Telegraphic transmitters.
10,086. Fütterer. Electric hair drier.
10,295. Bussby. Electrically-illuminated advertising balloon.
12,028. Atkinson and Walker. Carbon plates for galvanic batteries.
14,469. Baswitz. Compound for waterproofing and other purposes, applicable also as an acid-resisting and insulating material for electric cells.
15,878. Wertheimer. Coin-freed and other apparatus for making observations by means of Röntgen or "X" rays.
18,871. Grunow, McElroy and McElroy. Electromagnetic contact systems for electric railways.
20,521. Owen, Williams and Donaldson. Electrical signalling apparatus and circuits.
22,215. The British Thomson-Houston Company, Limited (Shand.) Alternating current energy meters.
22,807. Bradley. Alternating current electromotors.
24,382. Tischendorfer. Generation of multiphase currents and multiphase electro-motive forces from single-phase currents and single-phase electro-motive forces and to the utilisation of the same.
25,205. Poore. Coin-freed electric shock machines.
25,744. The British Thomson-Houston Co. (Limited) and Hobart. Alternate current induction motors.
26,023. Allison (Banks). Electro-magnetic switch apparatus for railway signalling and other purposes.
26,306. The British Thomson-Houston Company (Limited) and Hobart. Switching gear for transformers, reactance coils, storage batteries, and the like.
26,657. Holsten and Elektrische Bogenlampenfabrik Naeck and Holsten Gesellschaft Mit Beschränkter Haftung. Device for guiding the carbons in electric arc lamps.
26,660. Holsten and Elektrische Bogenlampenfabrik Naeck and Holsten Gesellschaft Mit Beschränkter Haftung. Electric arc lamp.
26,729. Wise (Churchward). Alternating-current electric motors.
27,129. Nodon, Bretonneau and Shée. Electrolytic method of and apparatus for saponification.
27,543. Gould. Electric cables.
28,461. Riebel. Globe carriers for arc lamps for retaining ash or loose particles.
28,480. Vojácek. Application of electric propulsion on railways and tramways.
28,853. Heys (Ehrhardt, Thom and Connor). Electric magazine fuse blocks.
28,921. Oxley. Switching apparatus for transformers and alternating current systems of electrical distribution.
28,926. Gilbert. Electric switch apparatus and electric wire binding posts.
29,273. Lake (Francke). Plates or electrodes for electric accumulators.
29,377. Kaselowsky. Propulsion of railway trains and the like by electricity.
29,493. Bernstein. Field telephone and telegraph stations.
29,507. Engl. Method of and apparatus for producing perforated accumulator plates.
29,585. The British Thomson-Houston Company (Limited). (Rice.) Method of and means for regulating alternating-current dynamo electric machines or distribution systems.
29,588. The British Thomson-Houston Company, Limited. (Rice.) Method of and means for braking alternating current induction motors.
29,589. The British Thomson-Houston Co. (Limited) (Thomson and Harthan). Electric arc lamps.
29,586. The British Thomson-Houston Co. (Limited). (Moody.) Electrical transformers.
29,587. The British Thomson-Houston Co. (Limited). (Priest). Dynamo electric machines and electric motors for electric railways.
29,835. Porter. Electric heaters.
30,264 The British Thomson-Houston Co. (Limited) and Hobart. Windings for polyphase machines.
30,445. Siemens Bros. & Co. (Limited) and Holmes. Apparatus for simultaneously connecting a number of repairs of electric conductos.

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COMPANIES' MEETINGS AND REPORTS.

Hove Electric Lighting Company (Limited).

The sixth annual general meeting of this Company was held at the City Terminus Hotel, Cannon-street, on Monday, under the presidency of Col. A. J. Filgate, R.E.

The SECRETARY (Mr. Francis R. Reeves) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, it gives me much pleasure to be able to lay before you such a satisfactory record of our stewardship as that contained in the report and accounts of the year, and to congratulate you on the position the Company has attained. In the statements of account we have submitted to you full particulars of our transactions and the results of the year's working under all important heads, and I doubt if there is any point calling for special explanation; but it seems desirable that I should give you a brief summary of the leading features of the year's transactions. You will notice from the accounts that the capital expenditure has increased from £62,022 at the end of 1896 to £66,896 at the close of 1897, or by £4,874. Of this increase £3,764 was expended on mains and £887 on meters. The demand for the supply of electric current in new streets necessitated increasing the sizes of the conductors in many places and the construction of about 2¼ miles of new mains, from all of which we hope to realise a fair return. This brings the total length of mains constructed up to December 31st last to 12 miles. The demand for new mains is a satisfactory feature in our business, and we have every reason to believe that this demand will continue. Since the close of the year we have sanctioned further cddi-tions to our system to the extent of 1½ miles of mains. The increase under meters is due to the expansion of our business and also to the introduction of the demand meter system, which necessitated our providing demand meters in addition to the ordinary supply meters. In order to cope with the increasing demand on our works for current we ordered a new 350 H.P. Willans Crompton set for delivery early in the autumn, but owing to the engineering strike and other causes this set has only recently been delivered at the works. Owing to the non-delivery of the new set we were somewhat anxious as to our capability of meeting the heavy load during December, but our plant worked satisfactorily and we met the demand without any hitch. With this new set the power of our plant is increased from 750 H.P. to 1,100 H.P. This should enable us to meet any probable fresh demand for some little time, but no doubt a further increase will be needed at no distant date; we shall, however, be obliged to increase our boiler power before next winter. To meet the expenditure we have to incur we have determined to ask your approval to increase our share capital by 2,000 shares of £5 each, 1,000 of these we propose to issue at an early date, and to offer them to the proprietors, *pro rata*, at a premium. As your shares stand well in the market we have no doubt that this issue will be a success. We further take advantage of this opportunity to ask you to increase our borrowing powers from £25,000 to £50,000. We have no present intention of increasing our debentures beyond the £25,000 now authorised, but it is desirable that we should have power to raise more money should this be found necessary hereafter. Turning now to the revenue account I think that you must allow that the year's working shows a satisfactory result, and this notwithstanding the large reduction we have made in the prices charged to our customers for current, amounting to about 20 per cent. This reduction has no doubt increased the number of our customers and the consumption of current. The number of our customers has grown from 270 at the end of 1895 to 314 at the end of 1896, and to 397 at the end of 1897. The number of lamps attached to the system at the same dates were the equivalent of 18,298, 21,914 and 27,777 respectively. The number of units delivered to customers in the three years was: in 1895 162,428, in 1896 200,562, and in 1897 2c8,243. These figures show the healthy and progressive nature of our business. The gross revenue for 1897 amounted to £7,269, compared with £6,518 in 1896, an increase of £751, while the working expenses stand at £3,667, against £3,404 in the previous year, an increase of £263. Considering the large increase in units delivered to customers, which amounted to 34 per cent., I think you will agree with me that your work has been conducted economically. This I must attribute to the care bestowed on your business by Mr. C. B. Smith, the resident engineer at Hove, to the good work done by Mr. Reeves our secretary at headquarters, and to the thoroughly satisfactory machinery supplied to us by Messrs. Crompton and Company (Limited), which has worked in a highly satisfactory manner. During the year we have received a further sum of £96 in premiums on debentures issued, which has been added to the reserve fund, and with the amount of £600 we propose to add to the fund out of the profits of 1897, the amount at credit of the fund will be increased to £2,259. Under the contract with the Hove Commissioners we have to set aside the balance unexpended out of a sum of £600 a year to meet future outlay under depreciation and maintenance; the amount set aside in 1897 is £390, and the total sum standing in this account now amounts to £914. The net revenue of the year is, as already stated, £3,602. 9s. 8d., and to this has to be added the balance brought forward from 1897 of £183. 7s. 10d., making in all £3,785. 17s. 6d. From this amount the interest paid and payable on debentures and loans for the year 1897 has to be deducted; this absorbs £915. 5s. 9d.; we have also to provide £40. 14s. 8d. for income tax; and, further, there is the interim dividend, at the rate of 4 per cent. per annum, paid last October, amounting to £737. 9s. 2d. This leaves us with a balance of £2,092. 7s. 11d. to deal with. We propose in the first place to write off £150 from the amount standing in our capital account under "preliminary expenses," reducing the balance under this head to £1,200; to set aside (as already mentioned) £600 to the credit of the reserve fund; to pay a final dividend for the half-year at the rate of 6 per cent. per annum on the capital of the Company, making, with the interim dividend paid in October, 5 per cent. per annum for the year; and to carry forward the balance, £218. 7s. 2d., to the current year. I have no doubt you will be glad to hear that our business continues to increase. Up to the 3rd inst. the units delivered to customers from January 1 reached 81,400, compared with 61,700 delivered up to the same date last year, an increase of 30 per cent. Altogether our prospects are very satisfactory. We trust you will approve of our policy in strengthening the reserve, but we look upon it as a matter of first importance in a business of this nature that a considerable amount should be held in reserve to meet contingencies which might arise at any moment. We desire to make your undertaking thoroughly sound in every particular, and we consider that we are in a fair way to attaining that end. We trust we shall see our dividends ere long advancing steadily without interfering with this policy. I am glad to say that the Hove Commissioners have again taken up the question of increasing the light in the streets of Hove, but are apparently debating as to whether the increased light which the public is demanding should take the shape of the Electric light or an increased consumption of gas. We have made the Commissioners numerous proposals during the last five years for the supply of current for public lighting, but none of these have found favour with that body. We, at their request, made a further and very liberal offer some two months ago, but have as yet received no communitation regarding it. I do not think there are any further matters connected with the Company that require to be brought to your notice. I shall, however, be happy to endeavour to answer any questions which the shareholders may be pleased to put to me. He concluded by moving the adoption of the report and accounts.

The VICE-CHAIRMAN (Col. H. Wood, C.B.) seconded the motion.

Mr. HUTCHESON inquired what the premium on the new shares would be.

The CHAIRMAN replied that the Directors had not quite settled this point; they had left it open. It would, however, be in favour of the shareholders. He then put the motion, and it was carried unanimously.

A motion for the payment of the dividends and a resolution increasing the capital of the Company by £50,000, and a further resolution authorising the Directors to borrow any sum not exceeding £50,000, were carried unanimously.

Col. Wood was re-elected a Director and Mr. Robert Payne, F.C.A., was re-appointed Auditor of the Company. A vote of thanks to the Chairman and Directors having been unanimously approved, the proceedings terminated.

Dover Electricity Supply Company (Limited).

The fourth annual general meeting of this Company was held at Dover on Wednesday, under the presidency of Sir W. H. Crundall.

The CHAIRMAN said that the shareholders would see that the revenue account had resulted in a gross profit of between £1,100 and £1,200, which had been applied to charges for debenture and other interest. This gross profit, however, compared with a loss the previous year of about £456, would make an improvement of £1,500 in the year's working of the Company. The capital account showed an expenditure of about £12,000, £8,000 of which represented a necessary expenditure for traction plant which would be of undoubted revenue-earning capacity, and which was now supplying current to the Dover Corporation Tramways; £1,500 was for ordinary plant; £1,000 for mains, extensions to which the Board considered were advisable from time to time, and from which in the future they hoped to derive considerable revenue. Further plant, and consequent capital expenditure, might become necessary at no distant date, but it would be an indication of the growth of the Company. With regard to the actual trading accounts for the year, the total receipts in 1896 amounted to £2,838. 13s. 5d., and the total payments to £3,294. 13s. 4d. The total receipts in 1897 were £5,248. 11s., and the total payments £4,070. 13s. 7d. The increase in receipts in 1897, compared with 1896, were 85 per cent., against an increase in payments for the corresponding periods of only 24 per cent. The increase in units sold in 1897, compared with 1896, was 58 per cent. As to the rates which the Company had charged, and as to which some little dissatisfaction had been expressed, they had adopted the Wright system, and he felt sure that as this became better known it would meet with the approval which it seemed to earn in other towns. In 1897 they had only had the advantage of three months' working with the trams, whilst they would for the current year have a full year's working; and taking this and other circumstances into consideration, he hoped the Company would be placed at the end of the year on a dividend-paying basis. The Board were negotiating for important contracts which would have considerable influence upon the future of the Company. He proposed the adoption of the report and accounts.

Mr. B. H. VAN TROMP, in seconding, said the Directors had given careful attention to the question of rates, and that both consumers and shareholders might be assured that whatever could be done to popularise the light, consistently with safeguarding the interests of the shareholders, would be done. They had at present no accumulated profits to fall back upon, and consequently great care had to be exercised in the consideration of this matter. The winter season was now rapidly drawing to a close, but any scheme formulated would be in time for the next season's lighting.

The report and accounts were then unanimously adopted, and the retiring Directors (Mr. C. W. Bagshawe and Mr. R. Percy Sellon) were re-elected. A vote of thanks to the Chairman (who in reply feelingly referred to the able assistance of his co-directors and the staff) terminated the proceedings.

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Chelsea Electricity Supply Company (Limited).

The Directors' report for the year ended Dec. 31 last is as follows:—

In October, 1897, an issue of 8,000 Ordinary shares of £5 each was made, and was fully subscribed. The final instalment on these shares, due on Jan. 1, has now been paid, and a Stock Exchange quotation for the new issue has been applied for. The balance of premiums received in respect of this issue, after deducting expenses of issue, amounts to £21,983. 5s. 6d., and a portion of this has been applied to the extinction of legal and other extraordinary expenses incurred during the year. The balance remaining, £20,851. 15s. 5d., has been placed to reserve, making the total £36,717. 9s. 5d. The sum of £2,000 has been added to renewals and depreciation out of net revenue. After deducting this amount, and after payment of interest on Debenture Stock (£2,700), there remains a balance available for distribution of £11,344. 5s. 2d, including £1,526. 17s. 4d. brought forward. The Directors recommend that this balance be applied as under:—

Dividend of 6 per cent. for the year on Preference shares ...	£1,800	0	0
Interim dividend on 26,000 Ordinary shares for half-year to June 30, at the rate of 5 per cent. per annum (paid July 1), and dividend on ditto for half-year to Dec. 31, at the rate of 7 per cent. per annum (making 6 per cent. for year) ...	7,750	0	0
Dividend at the rate of 6 per cent. per annum on instalments of £1 per share to Dec. 31 on new issue of 8,000 shares	92	1	1
Balance forward ...	1,652	4	1

The number of lamps connected on Dec. 31 was 96,638, an addition of 16,178 during the year. A large part of the capital expenditure has been incurred in the purchase of freehold land, and building thereon a substantial sub-station, in the extension of the new generating station at Alpha-place, and in the purchase of leasehold property. Considerable amounts have also been spent on generating machinery and on mains to supply the increase in demand.

House-to-House Electric Light Supply Company (Limited).

The annual report of the Directors of this Company for the year to Dec. 31 last, states that the revenue account shows a credit balance of £12,033, which, with £44 brought forward, and £177 dividends and balance of interest received, makes a total of £12,254. 4s. 1d. After deducting £2,250 for interest on Debenture stock paid and accrued, and £1,404 for interim dividend paid on the Seven per cent. Cumulative Preference shares, the Directors recommend that the sum remaining, viz., £8,600, be dealt with as follows:—Depreciation account, £3,000; payment of remainder of dividend to Dec. 31, on Seven per cent. Cumulative Preference shares, £1,750; reduction of preliminary expenses account, £1,391; payment of dividend on Ordinary shares for the year at 4 per cent., £2,233; and £226 carried forward. £11,926 received as premiums on the last issue of shares and £1,097. 6s., profit on sale of 300 Yorkshire House-to-House shares, have been applied in extinction of the balance of preliminary expenses account and construction business development account. The following table shows the progress of the Company's business since 1890:—

Year.	Equiv. 8c.p. lamps connected.	Houses connected.	Gross receipts.	Expenditure.	Net receipts.
1890	13,665	248	£5,010 9 2	£4,624 6 5	£386 2 9
1891	19,388	373	8,328 3 11	6,077 14 10	2,250 9 1
1892	23,700	471	10,688 18 6	7,851 19 6	2,836 19 0
1893	28,429	599	12,063 10 10	7,832 6 8	4,231 4 2
1894	35,858	755	13,695 11 8	7,431 16 8	6,263 15 0
1895	44,162	932	15,394 16 11	8,554 0 10	6,840 16 1
1896	55,265	1,164	17,442 6 5	8,410 8 4	9,031 18 1
1897	66,364	1,416	20,810 10 1	8,777 5 2	12,033 4 11

Additions and alterations to plant and mains have been made at a cost of £24,326. 16s., and the expenditure for 1898 is estimated at £28,000. This outlay will be provided by the proceeds of the Ordinary and Preference shares issued under agreement with the holders of Founders' shares.

The Leeds and London Electrical Engineering Company (Limited), having resolved upon voluntary liquidation, gave notice to determine the agreement with this Company. The Directors have decided, in view of the unsatisfactory position of this asset, to write off the whole. The relations between the two companies are receiving the careful consideration of the Board.

A portion of the capital expenditure in recent years having been incurred in superseding earlier and less efficient plant, it will be necessary to make proportionately larger annual contributions to depreciation account than hitherto, in order to preserve the capital intact at the expiry of the concession. On the other hand, the revenue account will, in future, be relieved by the extinction of preliminary expenses now effected.

The agreement with the holders of the Founders' shares, which was passed by the shareholders, having received the approval of the High Court, has now been carried out. During the year a further 1,661 Ordinary and 3,322 Seven per Cent. Preference shares have been issued.

British Insulated Wire Company (Limited).

The report of the Directors of this Company for the eight months to Dec. 31 last will be presented to the meeting of shareholders to be held next week, and is as follows:—

The result of the working shows a profit of £33,281. 6s., and the Directors regard this result as very satisfactory, especially as there has been considerable interference with the manufacturing business, owing to the construction of new buildings. No benefit accrued to the Company last year from these new buildings or from the new machinery, which are now approaching completion, portions being already in use. The profit actually realised has been in excess of the estimate inserted in the Company's prospectus. After deducting administration expenses, interest on debentures, the dividend on Preference shares, and writing off depreciation and a portion of the preliminary and reconstruction expenses, there remains a balance of £17,754. 4s. 2d., and the Directors recommend a dividend at the rate of 15 per cent. per annum on the Ordinary shares for the eight months to Dec. 31, leaving £1,529. 4s. 2d., of which the Directors have decided to transfer to patents and goodwill account £1,500, carrying forward £129. 4s. 2d. The volume of business in the hands of the Company continues to be exceedingly satisfactory.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH AUTOMOTIVE PROPRIETARY SYNDICATE (LIMITED).—This Company was registered on March 4 with a capital of £55,000, in £1 shares, to enter into an agreement with the Automotive Syndicate (Limited), and to carry on the business of manufacturers of and dealers in electric, steam, gas, oil and other motors, &c.

EDISON-BELL CONSOLIDATED PHONOGRAPH COMPANY (LIMITED).—This Company was registered on March 2, with a capital of £110,000, in 10,000 Preference shares of £10 each, and 10,000 Ordinary shares of £1 each, to enter into an agreement with Mr. Stephen F. Moriarty, the Edison United Phonograph Company (of the United States), and the Edison-Bell Phonograph Corporation (Limited), for the acquisition of the undertaking and all the assets of the latter Corporation, to manufacture, sell, let on hire and deal in phonographs, graphophones, telephones, phonogram-cylinders, tablets, diaphragms, motors, batteries, generators, &c., and to carry on the business of electricians, and mechanical, metallurgical, and chemical engineers.

ELECTRIC LIGHTING AND FITTINGS CORPORATION (LIMITED).—This Company was registered on March 6, with a capital of £50,000, in £1 shares, to carry on the business of electrical and mechanical engineers, and manufacturers of and dealers in electric, telegraphic, telephonic and other appliances, and to construct, lay down, repair, supply, deal in, or otherwise dispose of cables, wires, lines, accumulators, meters, and electrical apparatus of all kinds. The first subscribers are: A. Cross, J. A. Dargue, C.E; J. B. Hepburn, engineer; L. Hughes, T. H. W. Walker, H. Isaac and C. Birchall. The first directors are: J. A. Dargue, L. Hughes, A. Cross, T. H. W. Walker and J. Hepburn.

NORTH LONDON ELECTRIC SUPPLY COMPANY (LIMITED).—This Company was registered on March 1 with a capital of £100, in £1 shares, to apply for and obtain and carry out the terms of Provisional Orders and licences under the Electric Lighting Acts (1882 and 1888), and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The first subscribers (each with one share) are: F. J. Leslie, A. E. Haptie, F. W. Lintern, W. M. M. Forwood, J. Atherton, C. O. Grindrod, and A. Ruckley.

PARIS AUTOMOBILE CAB COMPANY (LIMITED).—This Company was registered on March 1 with a capital of £10,000, in £1 shares, to enter into an agreement with M. Jules P. Juvenet, and to carry on the business of manufacturers and vendors of motor carriages, motors and carriages of all kinds, mechanical engineers, &c.

PHŒBUS SOLDER AND ELECTRIC SOLDERING FLUID COMPANY (LIMITED).—This Company was registered on March 4 with a capital of £4,000, in £1 shares, to acquire and carry on the business of solder, soldering fluid and alloy manufacturers.

BUENOS AYRES ELECTRIC LIGHT COMPANY (LIMITED).—The annual return to May 11, 1897, was filed on Jan. 1 last. The capital is £100,000, divided into 9,936 Ordinary shares of £10 each, and 70 Founders' shares of £2 each. The Founders' shares have been taken up, but no calls have as yet been made.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The annual return to Feb. 8 has been filed. The capital is £1,300,000, in £20 shares, and 60,710 shares have been taken up, all of which are considered as fully paid.

HEADLAND'S PATENT ELECTRIC STORAGE BATTERY COMPANY (LTD.). The annual return to Jan. 12 has been filed. The capital is £20,000, in £1 shares, of which 19,665 have been taken up; 14,993 have been issued as fully paid, and the full amount has been called on seven shares, and 10s. per share on 4,665.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY (LIMITED).—The annual return to Feb. 19 has been filed. The capital is £200,000, in £5 shares (of which 100 are Founders'); 37,474 Ordinary and the whole of the Founders' shares have been taken up, and the latter are considered as fully paid. The full amount has been called on 18,848 Ordinary, and £3 per share on 18,626 Ordinary.

TOTTENHAM AND EDMONTON GAS COMPANY.—The electric lighting clauses of this Company's Bill now before Parliament have been withdrawn. The Chairman of Committees in the House of Lords objected to the Company proceeding by means of a Bill for electric lighting powers on the ground that this legislation had hitherto been entirely in the hands of the Board of Trade.

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CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 25 1/16d. per oz. (March 10). Consols (2¾ per cent.) 111⅛—111⅜ for money, 111⅜—111½ for account; 2½ per cent. 105—105½ (March 10). Stock Exchange Settling Days: Consols, April 1; Stocks and Shares Continuation Day, March 28; Ticket Day, March 29; Pay Days, March 11 and 30; Mining Share Carry-over Day, March 26.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT, ST. PETERSBURG.—This is the title of a company which has recently been formed in Berlin, with a capital 1,000,000 marks (£50,000), for the purpose of engaging in electric lighting and general electrical enterprises in St. Petersburg and elsewhere, in Russia.

CAPE ELECTRIC TRAMWAYS COMPANY.—The Directors of this Company have declared an interim dividend of 2½ per cent. The transfer books are closed from the 8th till the 12th inst. inclusive.

COMMERCIAL CABLE COMPANY.—The annual report states that last year's revenue from cable traffic amounted to $1,200,155, an increase of $76,502, and from land lines $645,185, a total of $1,845,341, which, after payment of the usual 7 per cent. dividend, leaves a surplus of $405,341.

CANZ AND CO.—The Directors of this Company have declared a dividend of 25 per cent. for the year 1897, against 27½ per cent. in the previous year.

W. T. GLOVER AND CO. (LIMITED).—A prospectus has been issued this week inviting subscriptions to the capital of £200,000 in this Company. The list opened on Tuesday and closed on Wednesday.

HARP ARC LAMP SYNDICATE (LIMITED).—The Secretary of this Company has requested that its name be struck off the register. No business has been done for over a year and the patents have lapsed.

LIVERPOOL DISTRICT LIGHTING COMPANY.—In their annual report the Directors of this Company state that both their stations are now complete, viz., the one at Waterloo, for the supply of that district and Blundellsands, Crosby and Seaforth, and the station at Gateacre, which will supply Woolton, Allerton and Childwall. From various causes, but principally owing to the late strike, the engines and dynamos will not be ready until September next, but in the meantime temporary plant has been erected, and a satisfactory supply of electricity provided. The total number of equivalent 16 c.p. lamps supplied by these stations is now about 650, and orders keep coming in. The Directors have decided to put down mains in roads where it is probable that electricity will be required, as well as in those in their compulsory area. They also contemplate duplicating the plant at both stations. In order to defray the cost of these extensions, and to meet the liabilities incurred in the carring out of the Gateacre station and the general extension of mains, it has been necessary to make two calls on the capital of the Company of £1 each. During the year the Company have carried out a fair amount of contracting work, but owing to competition the profits have been small. The Board of Trade have revoked the order the Company had obtained so far as regards Garston, the Local Authority in that district having given notice of their intention to undertake the supply themselves. The Directors consider that the prospects of the Company are encouraging. Sir William Forwood has retired from the Board.

LONDON ELECTRIC OMNIBUS COMPANY (LIMITED).—THE COMMITTEE REPORTS FAVOURABLY AS TO THE PROSPECTS OF THE COMPANY.—A meeting of the shareholders of this Company was held last week to receive a report on the affairs of the Company from a committee recently appointed. Major Flood Page (Chairman of the Company) presided. The report states that the Committee first discussed the Company's present unsatisfactory position, which they considered was caused (*a*) by the Board having gone to allotment on too small a firmly-subscribed capital; (*b*) by payment to the vendors of £6,183. 10s. in cash when the Company had a very small available working capital; (*c*) by the Board having made an agreement with Mr. Marshall, a vendor (also a Director of the Company), this agreement depriving the Company of the power to raise the capital necessary to work the business; (*d*) by loss of capital through failure of Mr. Marshall and other shareholders to pay calls; (*e*) by the excesive expenditure upon general charges; and (*f*) by the large expenditure in connection with the development of the Sola Accumulator. With an increased working capital of not less than £15,000, and under economical and careful management, and expending this capital in building and properly equipping omnibuses, the Committee is satisfied the Company has a splendid future before it, with a large earning-capacity. Provided the above capital is secured to work the Ward system and Schanschieff Sola Accumulator agreements, which are both valuable, the position of the Company is much better than was represented to the public previous to the annual general meeting. The Company is to have the benefit of all improvements Mr. Ward may make in relation to electric accumulator traction in omnibuses, cabs, &c., other than vehicles used on tramways. Mr. Schanschieff's agreement conveys the exclusive right to use his patents for accumulators for omnibuses and cabs for London, and the granting of sub-licenses for all public carriages, excepting tramways. Mr. Spagnoletti affirms that the "Sola accumulator was most suitable for street traction, because it was lighter and cheaper than the average accumulator, and more economical to manufacture and work." The Committee requested the Board to make a practical test of the running of the omnibus, the arrangements being under the direction of the Board, who requested Mr. Spagnoletti and Mr. Schanschieff to take observations and Mr. Ward to act as engineer. The omnibus carried 17 passengers, and ran out to Hammersmith-broadway from Trafalgar-square and back to Whitehall, a distance of 14 miles, going and returning by circuitous routes, and the omnibus maintained a uniform rate of speed. The steering was perfect in every respect, and the control in starting and stopping was thoroughly successful, the omnibus threading its way through the crowded traffic with perfect facility. The Directors agree to accept two-thirds of the fees fixed in the Articles of Association, and Mr. Ward has reduced his annual salary one-half until the Company is able to pay a 7 per cent. annual dividend. Mr. Ward also relinquishes his seat at the Board. It is now proposed to construct 12 omnibuses at a cost of about £9,000. Lieut.-Col. Turnbull proposed that this report be adopted, and Mr. J. E. Condict, in seconding, said the action of the Board in their development of the Sola accumulator had been satisfactory, and they had not spent an unnecessary sum of money in that direction. The Sola accumulator was half the weight of any other accumulator in the market. The resolution was carried, and £100 voted to the Committee.

NEW YORK EDISON COMPANY.—The capital of the Edison Electric Illuminating Company of New York is to be increased by 15 per cent.

RUSSISCHE ELEKTRICITATS GESELLSCHAFT UNION.—This Company, which has a capital of 6,000,000 roubles, has recently been registered in St. Petersburg. Amongst the founders are the Dresdner Bank and the Berliner Union.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has been asked to appoint a special settling day in, and to grant a quotation to, 10,000 Six per Cent. Cumulative Preference shares of the British Electric Traction Company, the "A" and "B" Six per Cent. Cumulative Preference shares, and fully and partly paid provisional certificates for the Five per Cent. Debenture Stock of the Buenos Ayres and Belgrano Electric Tramways Company (Limited), 22,500 Ordinary shares of the City and South London Railway Company, the further issue of 12,000 Ordinary shares (Nos. 40,081 to 52,080) of the St. James's and Pall Mall Electric Lighting Co. (Ltd.), and the further issue of 2,500 Ordinary shares of W. T. Henley's Telegraph Works Co. (Ltd.). The Committee has been requested to allow £540.000 Ordinary stock of the Waterloo and City Railway Company to be quoted in the Official List in lieu of the shares now quoted. The Committee has also ordered £540,000 Ordinary stock of the Waterloo and City Railway Company, and 30,008 fully-paid £2. 10s. shares (Nos. 1 to 30,000, and 53,001 to 53,008) and £150,000 Four per Cent. Debentures (Nos. 1 to 1,500) of the West Coast of America Telegraph Company (Limited) to be quoted in the official list, the securities of the latter Company being in lieu of the shares and debentures in the old Company of the same name now quoted.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 4 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,099.

WESTERN UNION TELEGRAPH COMPANY.—The usual quarterly dividend of 1½ per cent. has been declared.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half month ended Feb. 28 is £1,621, against £2,070 in the corresponding period of 1897.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Mar. 5	3,417	+154	...	...	...
Bristol Trams & Carriage	„ 4	2,322	+220	9	21,136	+ 3,312
City & South London Ry.	„ 6	1,089	+ 27	10	10,719	- 56
Dover Tramways	Feb. 26	101	...	26	2,879	...
	Mar. 5	99				
Dublin United (Southern)	„ 4	379	- 58	10	3,594	- 319
Liverpool Overhead Rly.	„ 6	1,364	+ 49	10	13,494	+ 763
Sheffield Tramways	„ 6	906	+ 20	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price March 2.	Price Wednesday, March 9.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 5. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	3/0	Central London Ordinary	10¼ 11	10¼ 11	2 14 1	June and December	10⅞	10¼
143,106	10	1/9⅜	Do. (6s paid)	6¼ 7	6¼ 7	2 11 6	„ „	6⅞	6⅝
£680,000	Stock	1¾%	City and South London Railway Con. Ordy.	67 69	67 69	2 14 4	January and July	69⅛	67
8,419	£10	5%	Do. 5% Perpetual Preference	15 16	15 16	3 2 6	„ „	..	..
£185,701	Stock	4%	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	..	..
54,000	10	2/8⅞	Waterloo and City Ordinary	13⅞ 14⅛	13⅞ 14	2 2 10	June and December	14⅛	13⅞
37,500	10	3½%	Liverpool Overhead Railway Ordinary	10⅞ 10⅝	10⅛ 10⅜	3 0 2	February & August	..	..
10,000	10	5%	Do. 5% Preference	15⅜ 16⅛	15⅜ 16⅛	3 1 6	„ „	..	..
125,000	Stock	4%	Do. 4% Debenture	108 110	108 110	3 11 5	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 2.		Price Wednesday, March 9.		Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending March 5.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£923,960	Stock	19.6	Anglo-American	59	61	59	61	4 13 4	Feb., May, Aug., Nov.	60½	..
£3,038,020	Stock	19 0	Do. Preferred	107½	108½	108	109	5 10 4	" "	109½	107¼
£3,038,020	Stock	5/0	Do. Deferred	11⅝	12½	11½	12	..		12 1/16	11⅞
£ 37,400	£100	4%	*African Direct Telegraph (Red)	100	104	100	104	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	6½	7½	6½	7½	..		..	..
130,000	10	3/0	Brazilian Submarine	16¾	17¼	16¾	17¼	4 1 2	Mar., June, Oct., Dec.	17 7/16	16¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	112	116	4 6 2	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	187	192	187	192	4 3 6	Jan., Apr., July, Oct.	189	..
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	106	108	106	108	3 14 1	" "	107½	106½
16,000	10	6/0	Cuba Submarine xd	7	8	7	8	8 15 0	February and August	7⅝	7⅛
6,000	10	10%	Do. Preference 10 per Cent.	14½	15½	14½	15½	6 9 0	" "	15⅝	14½
12,981	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877	10¾	11¼	10¾	11¼	5 15 7	Jan., Apr., July, Oct.	11⅛	..
400,000	£10	2,6	Eastern	18	18½	17¾	18¼	3 11 3	" "	18¼	17 1/16
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	19	20	18¾	19¾	3 1 6	" "	19⅜	..
£1,304,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	131	134	129	132	3 1 4	May and November	131⅛	131
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension	18¾	19¼	18¾	19¼	3 13 8	Jan., Apr., July, Oct.	19	18¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	130	133	130	133	3 0 2	February & August	..	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99	103	99	103	4 17 3	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99	103	99	103	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 15 2	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞	111⅞	108⅞	111⅞	3 12 1	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	12	12½	11¾	12¼	3 17 7	Jan., Apr., July, Oct.	12⅛	11⅞
180,042	10	6%	Do. 6 per Cent. Preference	17¾	18¼	17¾	18¼	3 5 9	" "	18⅛	17⅝
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	29	30	3 6 8	January, April, July	28¾	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B" xd	100	103	100	103	4 17 1	March & September	..	..
17,000	25	12/3	Indo-European	52	55	52	56	4 10 11	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904. xd	103	107	106	109	5 10 1	March & September	106½	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105	108	105	108	3 13 5	June and December	..	..
11,839	8	4/0	Reuter's	8	9	8	9	4 8 11	April and October	8⅝	..
3,351	£100 Cert.	6%	Submarine Cables Trust	139	144	139	144	4 4 3	" "	141	..
15,609	10	6/0	West African Telegraph	4½	4¾	4½	4¾	5 0 0	..	..	..
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.) xd	100	103	101	104	4 16 2	March & September	..	..
30,000	10	..	West Coast of America	½	¾	½	¾	..		..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	107	105	107	3 14 9	June and December	..	..
88,321	10	1/0	West India and Panama	½	¾	½	¾	..	May and November	..	..
34,568	10	6/0	Do. 6 per Cent. 1st Preference	8	8½	8	8½	7 1 2	" "	8⅜	8
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	11½	13	11¼	11¾	2 11 0	May and November	11⅞	11 1/16
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	8	7½	8	3 15 2	" "	7⅞	7⅜
33,129	7½	1/6	Do. Deferred Ordinary	4	4½	3½	4½	..	" "	4⅜	3⅝
£382,230	..	4%	Do. 4 per Cent. Debenture Stock	106	108	106	109	3 13 9	June and December	109½	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	..	..
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.) xd	100	105	100	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3	3½	3	3½	5 14 4	August	..	..
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16	1/16	1/16	1/16	..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	..	..
484,597	5	3/0	National xd	6¼	7	6½	6¾	4 8 11	February & August	6 1/16	6⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref. xd	16	18	16	18	3 6 8	" "	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid) xd	15	17	15	17	3 10 7	" "	16½	15⅝
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid) xd	5⅜	6½	5¾	6½	4 0 0	" "	6 7/16	5 1/16
1,329,471	Stock	3½%	* Do. Debenture Stock, 3½% (red.)	104	109	104	109	3 4 0	June and December	105½	105
171,504	1	0/4	Oriental	⅜	¾	⅜	¾	6 13 4	April and October	..	..
58,000	5	5/0	United River Plate	4	4½	4	4½	5 11 1	July	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	107	106	109	4 12 7	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.								
£200,000	5	4½%	Birmingham Electric Supply (fully paid)	10⅜		10½	1 3	..	March	..	..
50,000	£10	14/0	City of London Electric Lighting (fully paid)	28½	29½	28	29	3 9 0	February & August	29¼	28⅝
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17½	18½	17½	18½	3 4 10	January and July	18½	18
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	..	..
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp xd	14	15	13½	14½	2 8 6	February & August	14 7/16	14 1/16
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	6 1/16	..
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)						January and July	..	..
£ 36,000	5	2,6	Chelsea Electricity Supply Ordinary	11½	12	11½	12	3 2 6	March	11 3/8	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	115	117	115	117	3 17 5	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	15½	16	14¾	15½	..		15⅜	15⅛
20,000	£10	6/0	Do. 6% Cumulative Preference	15½	16½	15¾	16¼	3 13 10	March & September	18⅛	15¼
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	11	12	11	13	..		11⅜	11⅛
10,000	£5	7%	Do. 7 per Cent. Preference	11½	12	11⅝	12½	2 17 2	March & September	12⅜	..
111,000	£5	..	London Electric Supply Ordinary	4½	4¾	4	4½	..		..	..
48,050	£5	..	Do. Preference	6½	7½	6½	7½	..		..	..
49,900	10	5/0	Metropolitan Electric Supply Ordinary	20	21	20½	21½	2 11 2	April and October	21¼	20½
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	19½	20½	20	21	..	" "	20⅜	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	119	118
6,452	10	8/0	Notting Hill Electric Ordinary	19	20	20	21	2 17 2	March	20½	19⅞
275,000	1	..	Rand Electric	1½	1⅝	1 7/16	1 9/16	..		..	..
£125,000	Stock	5%	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90	95	90	95	5 5 3		..	..
150,000	$100	8/2	Royal Electric Company of Montreal Shares	145	147	145	147	..		..	..
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 4 1	April and October	103⅜	106
19,980	5	11/0	St. James and Pall Mall Electric Ordinary	18½	19½	18½	19½	3 14 4	February & August	19⅜	19
90,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	..	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	107	110	107	111	3 13 1	June and December	..	..
67,900	5	8/0	Westminster Electric Supply (fully paid) xd	17½	18½	17½	18½	3 4 10	March & September	18	17⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	5%	Brush Electrical Engineering	2	2½	1⅞	2¼	..		2 1/16	2
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2½	2¾	2½	2¾	4 16 0		2⅝	2½
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock xd	106	110	110	114	3 13 11	February & August	..	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 6 2	June and December	..	..
10,000	£10	..	British Aluminium Ordinary	..		..		..		..	..
20,000	10	..	Do. 7% Cumulative Preference	..		..		..		..	..
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	9	10	9	10	5 0 0	June and December	9⅛	..
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	110	113	110	113	4 0 0	" "	9½	9½
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1	1½	1	1½	..		..	..
28,140	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	2¾	2½	2¾	..		..	..
£82,450	100	..	* Do. 5% First Mortgage Debentures (red.)	86	91	86	91	5 6 5	January and July	2⅜	2⅜
99,861	5	1/6	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3	5 10 0	February & August	87½	..
17,139	5	2/6	Do. (£5 paid)	4	5	4	5	5 10 0	" "	2⅝	..
£100,000	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.)	103	105	103	105	3 16 2	June and December	4⅜	..
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅜	2⅞	2⅜	2⅞	3 13 1	February & August	104½	..
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3⅝	3½	3⅝	4 3 4	August	2 1/16	..
91,196	1	10/0	Elmore's Patent Copper Depositing	½	¾	½	¾	..		..	..
14,500	10	6/0	Henley's Telegraph Works Ordinary	23	24	23	24	4 3 4	February & August	23 7/16	23 1/16
8,000	10	7/0	Do. 7 per Cent. Preference	19	20	19	20	3 10 0	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.) xd	110	115	110	115	3 18 3	" "	..	..
50,000	£10	15/0	India Rubber, Gutta Percha, &c., Works xd	21½	22½	21½	22½	4 8 11	" "	22½	21⅞
8 0,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	104	108	104	108	3 14 6	March & September	..	..
87,350	12	12/0	Telegraph Construction and Maintenance	38	41	37	40	4 9 11	March and July	39½	38½
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July	..	..
£ 25,500	£5	3/0	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	..	..
£22,500	£5	3/0	Do. 6% Cumulative Preference	7	7½	7	7½	4 0 0	" "	7 7/16	..
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	106	103	106	108	3 18 6	May and November	106	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

The third Tyndall Lecture, by Dr. J. A. Fleming, at the Royal Institution, yesterday afternoon, dealt with the phenomenon of diamagnetism. Commencing with an ingeniously-arranged experiment for projecting upon a screen Quincke's method of determining the magnetic susceptibility of liquids, the lecturer proceeded to show the essential points of difference in the behaviour of various substances when placed in a powerful magnetic field. Even the associations recalled by the use of apparatus employed in the early researches of Faraday on this subject would scarcely have retained the interest of a Royal Institution lay audience but for the ingenuity of the lecturer in selecting homely and striking substances for investigation. Thus cardboard, cold mutton and a cigarette were shown to be paramagnetic, while among the diamagnetic bodies were a chip of apple, a piece of bread and some roast beef.

From the bare fact of a difference of behaviour of substances in a magnetic field Prof. Fleming proceeded to elaborate a highly interesting and instructive discourse, in which the special conditions which influence that behaviour were separately investigated. As on previous occasions, the lecture was profusely illustrated with experiments, the admirable arrangements for the exhibition of which call for the highest praise. The first condition, affecting magnetic behaviour, to be noticed was the all-important influence of environment. Weakly diamagnetic substances were shown to exhibit a pseudo-paramagnetism when placed in a strongly diamagnetic environment. Next, attention was directed to the influence of the internal structure of the substance acted on, the effect of this being well exemplified by comparing two bars of paper laminæ, in one the laminæ being longitudinal and in the other transversal. The apparent change in the magnetic property of a piece of bread when squeezed along one axis was also shown in further illustration of this point.

Flame has long been known to exhibit a diamagnetic action, and, after an experiment showing the behaviour of a gas flame in this respect, Prof. Fleming commented on his own and other researches on the magnetic properties of gases in respect of temperature. Incidentally he alluded to the difficulty he had experienced in making researches in this direction, with liquid oxygen as the cooling agent, owing to the pronounced magnetic properties of that element. The diamagnetic susceptibility of gases was stated to be very nearly inversely as the absolute temperature. In the concluding part of his lecture Prof. Fleming reviewed the evidence afforded by the rotation of plane polarised light as to the magnetic properties of transparent substances and thin films of metals. The original notion had proved erroneous that the direction of rotation was opposite in diamagnetic and paramagnetic substances, for all elementary bodies are found to exhibit positive rotation; while certain compound substance, only exhibit negative rotation, in many instances this latter being accompanied by anomalous dispersion.

We commend to the careful consideration of electric supply companies, and such local authorities owning electric supply works as may have the power to resort to a similar practice, the method recently adopted by the House-to-House Electric Light Supply Company (Limited) for popularising the electric light and encouraging householders to adopt it. The method consists, as the Chairman announced at the ordinary general meeting on Friday last, in giving householders "a limited installation, not only free of all initial expense, but free from any additional charge for electricity." Inquiry has elicited the information that the installation thus provided consists of six glow lamps of 16 c.p., the wiring, fittings and everything necessary to the installation being put in free of cost; the consumer, on his part, paying for current at the usual rate of 6d. per unit, but agreeing to a minimum charge of 1s. per lamp and a meter rental of 2s. per quarter. In order to protect themselves against transitory customers, it is stipulated by the Company that if the tenancy of the premises will

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expire earlier than two years from the date of the contract an agreement on the part of the landlord must be arrived at. It is further stipulated that before extensions of any free installation may be carried out the cost of the work shall be paid for by the consumer, such cost not exceeding £6; and the consumer has the option of at any time making this purchase.

During the past two months this simple and excellent device for bringing the electric light under the practical experience of small householders has been in operation over the area supplied by the House-to-House Company, and so successful has it proved that a further scheme for supplying consumers with a larger number of lights is in contemplation. We understand that over 30 new consumers have already been supplied on this system, and many of these have been so pleased with the light that they have purchased their installations and considerably extended them This, indeed, was only to be expected, and might have been predicted with the assurance with which an astronomer forecasts a solar eclipse. All that is necessary in order that the average householder shall adopt the electric light is that it shall be available at moderate cost, and that he shall have an opportunity of discovering its superiority over every other illuminant. The charge of 6d. per unit now made by the House-to-House Company is reasonably low, and the scheme we have just described does all that is requisite in the way of making the advantages of the electric light familiar to householders. Hence its success. It will be seen in a note elsewhere, by-the-way, that the Liverpool District Lighting Company have adopted a similar arrangemement on a small scale.

Mr. J. H. Rider has recently brought the subject of free wiring before the Electricity Committee of the Plymouth Corporation in a report, of which a copy has been sent to us. The report commences with a recognition of the benefits, both to consumers and the supply department, of "a good easy-wiring system," Mr. Rider's conscience evidently objecting to the term "free wiring" for what the consumer either directly or indirectly pays for. Discussing next the system adopted by the Free Wiring Syndicate, he alleges that "the wiring is by no means 'free.' In fact, the only man who gets his wiring actually free under this arrangement is the one who never consumes a single unit." His further criticisms are worthy of notice also:—

"Looking at the proposal from a commercial standpoint, it means that the Corporation would act as the collector of the Syndicate's debts. It is also a question as to whether the Corporation would be entitled, under the Electric Lighting Acts, to make an agreement with a third party by which a certain class of consumer is made to pay an increased price for the energy used, in return for a free installation of wires and fittings. A much fairer system would appear to be to let each consumer actually pay the cost of his wiring, but to spread the payment over a considerable time. By this means the heavy initial cost would be done away with, the consumer would only pay the regular price for current, and at the end of the fixed period his payments on account of wiring would cease. A scheme on these lines was proposed by the writer to the Bolton Corporation in 1894, and it has been in successful operation ever since."

Experience has proved in many cases, Mr. Rider thinks, that it is unwise for Corporations themselves to undertake wiring work; and he recommends the Plymouth Corporation to adopt the following plan:—

The wiring contractor would canvass for orders in the usual way, and could carry out work for any customer on his own terms without reference to the Corporation. But when a person wished to avail himself of the easy-payment system he would have to proceed in the following manner: The quotation to such customer would be made out upon a special form, binding the contractor to carry out the work to the satisfaction and under the supervision of the Corporation, and naming such a price for the work as would permit him to allow a discount of 5 per cent. for cash. If the customer agreed to this price he and the contractor would notify the acceptance in writing upon a form of application to the Corporation.

This form would provide, among other things, that the consumer shall pay for the installation in full "by means of eight equal instalments," the payments being spread over a period of 21 months. Thus Mr. Rider finds nothing more suitable to his purpose than the instalment system so popular in many other branches of trade. It remains to be seen whether the electric light can be popularised in this manner; and it would be interesting to have the views of other central-station engineers on the subject.

Personal.—Prof. J. A. Ewing, M.A., F.R.S., has been elected to the professorial Fellowship of Cambridge University.

The Northampton Institute.—It is announced that the official opening of the Northampton Institute, Clerkenwell, will take place to-day. For this purpose the Lord Mayor and Sheriffs have consented to pay a state visit this evening.

Cable Interruptions.—	Date of Interruption.
Latakia—Cyprus	Feb. 10, 1898
Saïgon—Hong Kong	Feb. 28, 1898

The "Nernst" Incandescent Light.—In technical circles in Germany doubt is expressed as to whether the newly-discovered "Nernst" incandescent light can be patented, and attention is drawn to the fact that Gaston Planté dealt with the principle of the present "Nernst" discovery in his "Recherches sur l'Electricité." It has, however, yet to be proved that Planté was in possession of precisely the same process.

Will.—The will, dated May 20, 1896, of the late Lord Sackville Cecil, chairman of the Exchange Telegraph Company, and a director of the Eastern, Brazilian Submarine, Pacific and European, and Globe Telegraph and Trust Companies, who died on January 29th last, aged 49 years, has been proved. The personal estate has been valued at £283,891. 7s. 8d. The executors are Lady Margaret Elizabeth Cecil (sister) and Mr. Arthur J. Balfour, M.P. (nephew).

The British Association.—A meeting was held in the Bradford Town-hall, yesterday, the Mayor presiding, for the purpose of considering a proposal to invite the British Association to Bradford for the year 1900. There was a large attendance. It was unanimously decided to send an invitation to the Association for the year 1900, and an executive committee was appointed to make arrangements if the invitation should be accepted.

Canadian-Australian Cable.—In the House of Commons, on Monday, Mr. Webster asked the Secretary for the Colonies whether any further steps had been taken in regard to establishing a direct cable communication betwixt the Dominion of Canada and Australia; and if any papers would be laid upon the table on that subject. Mr. Chamberlain replied that the question was still under consideration, and no papers could at present be laid on the table.

The Telephone in the United States.—To all interested in telephony, but especially such as are interested in the independent telephone movement in the United States—a movement which has been growing since the field has been opened by the expiration of the fundamental Bell patent—the issue of the *Western Electrician* of Chicago for February 26th may be commended for notice. This number is almost entirely devoted to a discussion and descriptions of the various independent telephone concerns as opposed to the Bell Company. It is stated that there are, in round numbers, about 2,500

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independent exchanges in operation in the United States to-day.

A Tower Railway.—A novel feature of the intended Pan-American Exhibition, which is to be held at Cayuga Island, Niagara Falls, is a huge round tower of steel, 500ft. high, around which, like the blades of a spiral conveyor, run two railway tracks, one to serve as the up and the other as the down line, the two tracks forming two independent threads on the outside of the tower. The grade of the tracks is intended to be about 20 per cent., and as the tower is to have a diameter of 80ft. at the bottom, and about 50ft. at the 400ft. level, the railway will rise about 40ft. at every completed circuit of the tower. A rack rail is to be used, and the cars are to be worked by electrical power generated from the Falls. The seats on the cars are to face radially outward from the tower, which is to be surmounted with the orthodox "powerful search light."

The Institution of Junior Engineers.—This Institution held a most successful *conversazione* on Saturday last, at which some 200 assisted, including a large proportion of the fairer sex. Among the other attractions were "lecturettes" on the Maxim gun by the inventor himself, cinemetograph displays, the electrophone, and some excellent professional and amateur music. Mr. Wallis-Jones exhibited the latest form of electric welding apparatus made by his firm, and an interesting collection of test-pieces. Mr. Leslie Miller telegraphed without wires from one end of the reception room to the other, and worked very hard explaining to inquirers how it was done. Of exhibits of a non-electrical character, that of acetylene gas was the most *en evidence*, appealing markedly, as it did, both to the senses of sight and smell. Among the distinguished persons present we may mention Mr. J. A. F. Aspinall (the president), Prof. Greenhill, and Mr. Hiram S. Maxim.

Use of the Kelvin Quadrant Electrometer as a Wattmeter.—A Paper recently contributed by Prof. E. Wilson to the Royal Society describes in great detail experiments made to determine whether a quadrant-electrometer could be used as a wattmeter. The quadrants of the instrument were connected to the terminals of a manganin strip through which the current was flowing, and the difference of potential factor was connected between the needle and case of the instrument. It was found that the readings were proportional to the watts, whatever the frequency and whatever the phase-difference. It is necessary, however, as originally pointed out by Dr. John Hopkinson, to first see whether Maxwell's formula for the deflection of the needle of a quadrant-electrometer $[(A - B)\left(C - \frac{A+B}{2}\right)$, where C is the potential of the needle and A and B that of the two pairs of quadrants] is verified. This can be conveniently done with steady potential differences, measuring these by Poggendorff's method.

European Electric Traction Statistics.—Our contemporary, *l'Industrie Electrique*, publishes in its issue of March 10th its annual supplement of statistics of European electric tramways and railways. From the summary given it would appear that France is second only to Germany in the number and length of electric lines, having 44 lines, aggregating 247 miles in length, Germany having 65 lines estimated (considerably higher than in the statistics of the *Electrotechnische Zeitschrift*, referred to in our issue of January 14th) at 706 miles. Switzerland appears to be as well provided with electric railways as our own country, having 23 lines, aggregating 91 miles, while Great Britain and Ireland, with the same number of lines, can show a total mileage of 105 (being slightly underestimated in the table). Italy, with its 11 lines, also runs us close in matter of length. The total mileage in Europe comes out at about 1,400, there being 204 lines, of which 172 are on the overhead, eight underground, eight central rail, 13 accumulator, and three on the "mixed" system (accumulator and trolley). This represents over 68,000 kilowatts and over 4,500 motor cars or locomotives.

Testimonial to M. Gramme.—At the Institution of Electrical Engineers, on Thursday, the 10th inst., the President stated that a testimonial was being organised in Belgium as an appreciation of the work done by M. Gramme. The testimonial would be presented at a banquet to be held in Brussels on the 27th inst., and it was the feeling of the Council that the Institution should not be entirely unrepresented in such an important matter. Every member knew to what a large degree electrical engineering was indebted to M. Gramme, who was undoubtedly the first to produce the machine which the modern dynamo had developed into. The Council had decided to issue a circular asking for subscriptions. In connection with this subscription there would be an issue of commemorative medals, every donor of 10s. receiving a bronze medal, and every donor of 25s. a silver medal with an inscription referring to the occasion. M. Gramme was recently made Commander of the Ordre Léopold by the King of the Belgians, and it is with the jury of the electricity sections of the Brussels exhibition that the idea of a banquet to commemorate this, has originated.

Calcium Carbide and Acetylene.—At an ordinary meeting of the Institution of Civil Engineers on Tuesday, the 15th inst., Mr. Henry Fowler read a Paper on "Calcium Carbide and Acetylene." The author remarked that acetylene was first isolated by E. Davy in 1837 from potassium carbide, a by-product of Sir H. Davy's method of manufacturing potassium. In the middle of the century Berthelot investigated its properties, and Wöhler produced it from calcium carbide. During the past few years it had assumed commercial importance owing to the development of the electric furnace, in which calcium carbide could be readily produced from lime and carbon. The furnaces used consisted essentially of crucibles with carbon rods forming the positive electrode and a bottom plate lined with carbon for the negative. In the more recent furnaces these crucibles were mounted on small trollies so that they might be run out of the furnace when ready and a fresh one inserted wthout loss of time. The carbide formed was a hard, dense substance of reddish colour, unacted upon by most of the ordinary re-agents. It was, however, rapidly decomposed by water into acetylene and lime, giving 5·9 cubic ft. of acetylene, at a temperature of 60°F. and a pressure of 30in. of mercury per 1lb. of carbide. As the energy required theoretically to produce 1lb. of calcium carbide in an electric furnace was more than 2 H.P. hours, its manufacture was at present restricted to localities where power was cheap, as, for instance, where water-power was available.

The Paris Exhibition of 1900.—In the House of Commons on Monday, on a Supplementary Vote for £20,000 as a grant in aid of the expenses of the Royal Commission for the British Section of the Paris International Exhibition of 1900, Mr. Strachey said that the sum of £75,000, of which this Vote formed part, which the Government intended to devote to the expenses of the forthcoming Paris Exhibition, was totally inadequate for the purpose, and was not in accordance with what other countries were doing. He understood the area expenses would already amount to £68,000 for general expenses. The German Government intended to devote £245,000 to the expenses of their section of the Exhibition. The Chancellor of the Exchequer said he was not a very ardent admirer of these Exhibitions, particularly when they were initiated by countries which did their very best to keep out our goods in competition with us; but everyone would agree that it was essential that we should be represented at this Exhibition. It having been so decided, there should be generous expenditure in the matter. Doubtless a further contribution would be given by India and the Colonies. The sum of £75,000 would be probably a sufficient sum for this country to devote to that purpose. He knew that there was a view entertained that this sum was not likely to be sufficient, and he expected to have representations made to him to that effect. He was not inclined to be anything else but liberal in the matter, and should feel it his duty to ask Parliament for whatever sum might seem necessary for the proper and adequate representation of this country at the Exhibition.

The Dublin Electric Tramways.—On February 22nd Mr. H. F. Parshall read a Paper, with the above title, before the Institution of Civil Engineers. The Paper embodied an account of the Dublin Southern Tramways, an illustrated description of which line was published in *The Electrician*,

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Vol. XXXVI., p. 382. The author stated that the installation as originally designed would not conform with the Board of Trade regulations in the matter of the fall of potential in the earth return. The machinery had been ordered, and the work proceeded with before the author had been called in to advise in the matter. The problem became, therefore, to utilise as much of the machinery ordered as possible, and to instal such other machinery as would be necessary to distribute the electricity under the Board of Trade regulations. The high-tension alternate-current method of transmission was considered most suitable. The three-phase machines and switchboards were specially designed for the installation, which was the first one of its kind established in the British Isles. It had now been in operation for nearly two years, and had been found entirely satisfactory. The operation of the sub-stations had been found to be very simple, so simple in fact, that only a boy was employed in each station to work the machinery. Owing to the low frequency the motors were very easily synchronised, and even though they were thrown in considerably out of phase they quickly fell into step. Since the opening of the road the load had been greatly increased by a considerable number of additional cars and trailer-cars, yet the machines had never given trouble, nor had the synchronous motors fallen out of step, even in the case of the most severe loads. The requirements of the Board of Trade had been satisfactorily met, and owing to the number of points of distribution it was possible to work some sixty cars on the line instead of twenty, as originally designed to comply with the Board of Trade regulations. As originally designed the fall of potential in the earth return would have been some 18 volts to 20 volts, whereas at present it was found to be 3½ volts. Formerly the traffic was worked by three disjointed horse lines, none of which were profitable. They were finally sold for about £14,000, whereas the value of the present property was estimated at £300,000, and the revenues were consistent with this figure. Owing, therefore, to the largely-increased load the capacity of the power-house at Ballsbridge had been greatly added to by a large direct connected unit which was more suited for heavy traction loads. Likewise the sub-station at Blackrock had been re-designed, and in the place of the 60-kilowatt motor-generator sets originally installed there were two 200-kilowatt rotary converters, with the necessary stationary transformers, and an improved switchboard for manipulating it. The efficiency of the system was shown by the working cost to be satisfactory, although, as might be gathered from the Paper, the efficiency of the machines in the sub-stations was not so high as would be the case with larger machines and large rotary converters. For a small tramway installation, however, the sureness of operation and the minimum of labour were of vastly greater importance than any small gain in efficiency.

The "Crowdus" Storage Battery.—As presenting many original features the "Crowdus" storage cell is of some interest. The principal objects in view with the inventor has been to provide an efficient storage battery, an economical method of manufacture, and, above all, a decrease of weight for a certain capacity. A good idea of the design of the "Crowdus" cell may be gained by following the method employed in its formation:—A positive plate is made of thin rolled sheet lead; this plate is then provided with a series of rectangular or elongated perforations, and with terminal lugs both at the top and bottom, so that plates of the same polarity may be electrically connected together at the top and bottom, and thus ensure uniform electrolytic action. The strips of material formed by and between the elongated perforations are bent alternately to opposite sides of the plate, so as to form longitudinal recesses substantially the entire length of the plate and openings on each side thereof, to hold the active material, which, it is stated, is a specially-prepared hard but porous paste of red lead. This arrangement permits of a very light plate presenting a large active surface, and, it is claimed, a greater amount of active material than any other form of construction. To form the negative element a plate of aluminium—otherwise similar to the positive plate—is used, and filled with similar paste, the latter being locked from side to side and throughout its entire length as in a cage. In practice the weight of the positive lead support, when compared to the active material upon it, is as 1 is to 2. The elements are connected together by bending the terminals substantially at right angles to the plate and connecting the plates of similar polarity to each other by means of rivets in the case of the negative plates, and by autogenous soldering of the lugs on the positive plates. The sets of plates are then immersed in the special forming bath consisting of an aqueous solution of about one-third saturation of sulphate of zinc with 15 per cent. (by volume) of sulphuric acid. In this solution are placed the plates to be formed, suitably arranged between sheet lead anodes as dummies, and a current of about one ampere for every three square inches of the plates to be formed is used. On passing the current to the plates the sulphate of zinc is decomposed, depositing pure zinc upon the negative pole plates, which is dissolved from the plate as fast as it is deposited by the sulphuric acid of the solution, thus producing a quantity of hydrogen. By the reducing action of the hydrogen the oxide of lead is rapidly converted into spongy lead. Under this process the time of formation is reduced to about two hours, about one-fifteenth of the time required in the processes in actual use at present. By this method of forming the elements the dissolved zinc is returned to the solution, so that the same solution can be used over and over again for an indefinite period. It is found from experimental tests that the positive plates when first formed into negatives of spongy lead by this process, and then into positives, will give almost their full output on the first discharge, while the old methods require several charges and discharges before the positive plates are fully formed. The formation of positive plates by the use of quick negative formation is therefore quickened and cheapened. After formation the elements are placed in the battery, and in order to strengthen and insulate the plates and prevent warping or buckling, between the opposing pairs of plates a corrugated, insulated, perforated separator which touches the plates at their inactive portions is inserted. It is well known that each time a cell is recharged the negative element decreases in capacity. This is avoided, and the efficiency of the conversion increased between charges and discharges by adding to the usual sulphuric acid electrolyte (with which all batteries are supplied) a very small proportion of sulphate of zinc, just sufficient to hasten, as described in the case of the forming bath, the restoring of the negative element.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, March 19th.

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' visit to the works of Messrs. Easton, Anderson and Goolden (Limited), Erith. Train 10:2 a.m. from Charing Cross. Applications to join the party must be made at once to the Students' Hon. Sec.

MONDAY, March 21st.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II. on "The Thermo-Chemistry of the Bessemer Process," by Prof. W. N. Hartley F.R.S.

THURSDAY, March 24th.

ROYAL INSTITUTION.

3 p.m. Tyndall Lecture IV., on "Recent Researches in Magnetism and Diamagnetism," by Dr. J. A. Fleming, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Cost of Generation and Distribution of Electrical Energy," by R. Hammond.

FRIDAY, March 25th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Circulation of the Residual Gaseous Matter in a Crookes Tube," by A. A. Campbell Swinton; (2) "On Some Improvements in the Roberts-Austin Recording Pyrometer, and Notes on Thermo-electric Pyrometers," by A. Stansfield.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Internal Governor Friction," by H. O. Eurich.

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday noon.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

The Arc as a Telephone.—If the circuit of an arc lamp happens to be close to another circuit traversed by feeble intermittent currents, the arc emits a loud rattling noise. The intermittent currents may be produced by a tuning-fork interrupter, or by the hammer of a small induction coil. They produce in the arc circuit intermittent induced currents, and the latter affect the temperature of the arc and produce the noise. That the noise is due to the arc itself, and not to the regulating mechanism, is proved by the fact that the sound is heard equally clearly when the carbons are a fixed distance apart. The phenomenon has been discovered and studied by H. T. Simon. He attempted to obtain a photographic record of the flickering of the arc, but failed because the changes of brightness are too slight in comparison with the total brightness. On placing a microphone in the primary circuit, the note of a tuning fork, and the sounds of whistling, tapping and singing were reproduced by the arc with every detail of intensity, pitch, and quality. Experiments made with a shunt circuit showed that the quantity of electricity capable of producing an audible sound was 5×10^{-6} coulombs, corresponding to a change of temperature of 0·3°C. Sound waves acting upon the arc direct produced changes of density and fluctuations of the current, which could be transmitted to a distance and reproduced by a telephone at the other end.

[H. T. Simon, *Wied. Ann.*, No. 2, 1898.]

Laws of Frictional Electrification.—The phenomena of contact electrification may be said to be solved in a general way by the work of Nernst and others, who have reduced them to questions of ionic mobilities. Nernst started from solutions, and his success is due to the fact that the intimate structure of these is fairly well known, better at all events than the intimate structure of solids. But even the latter are subject to the laws governing solutions, as is evidenced by the fact that the contact series of the metals is simply the series of their solution pressures. All this reasoning, however, applies to conducting substances only, and the contact or frictional electrification of non-conductors is as little reached by it as a displacement current is explained by a conduction current. A. Coehn has apparently succeeded in discovering a definite law of frictional electrification, which says that the frictional series of insulating substances is the same as the series of their dielectric constants. The fact that the charge of a condenser depends upon the dielectric capacity of the substance indicates an immediate connection between frictional electrification and dielectric capacity. As a matter of fact it is found that whenever a substance has a high dielectric capacity, it would be positively electrified by friction or contact with a substance of lower dielectric capacity. This law applies to insulating liquids as well as solids. Diamond is the most positive of all solids, and its high refractivity indicates also a high dielectric capacity. Water itself is electrified positively in contact with alcohol, aniline, or turpentine. The law thus discovered is a valuable addition to our mastery of natural phenomena.

[Coehn, *Wied. Ann.*, No. 2, 1898.]

Cathode Rays in an Alternating Field.—H. Ebert proves that the deflection of cathode rays by electric oscillations, observed by Schmidt, takes place in a very well-defined manner when the current producing the cathode rays is quite independent of the deflecting current. He uses a transformer driven by a continuous current, and yielding about 14 watts at 60,000 reversals per minute. This alternating current is again transformed by means of a small Siemens spark inductor to about 1,500 effective volts, and the secondary current is communicated to two small plates attached to the outer walls of a Braun phosphorescence tube just behind the diaphragm. The capacity of the condenser being so very small, the transformer can be considered open. This gets rid of all the irregularities usually attending the secondary current at break. The deflections exhibited by the cathode rays on the screen, as studied in a rotating mirror, are most regular, and lend themselves well to quantitative determination. The vertical line on the screen is drawn out into a perfectly regular sine curve. A displacement of the point of origin of the cathode rays cannot be quoted as an explanation. For one thing, the cathode is 30cm. away from the condenser plates, and, besides, the effect ceases when the latter are removed a few centimetres from the tube. The deflections increase with the surface of the plates, and also by connecting another condenser placed at a distance in parallel with the small condenser at the tube. When the plates of the latter are moved apart, the amplitude of the deflections decreases. But an increase takes place when the air adjoining the plates is replaced by a dielectric of greater capacity such as ebonite or glass. It appears fairly certain that these deflections are not due to the magnetic forces of displacement currents, but that they are due in some way to the bending experienced by the rays when impinging upon the dark spaces produced inside the tube by the electric oscillations. Whatever the value of these experiments with regard to the theory of cathode rays, they certainly indicate a valuable and sensitive method for investigating the secondary E.M.F. of open transformers.

[Ebert, *Wied. Ann.*, No. 2, 1898.]

An Alternate-Current Voltmeter.—The advantages claimed for the voltmeter devised by H. Ebert and M. W. Hoffmann are that it consumes no current, has a small capacity, and a sensitiveness variable within wide limits. The principle is the same as that of the plate electrometer devised by V. Bjerknes. A thin rectangular plate of aluminium hangs vertically by a quartz fibre between two parallel vertical plates, but not parallel to the latter, but at an angle of 45deg. The plates form the terminals of a condenser which is inserted in the alternating circuit as a shunt. The electrostatic forces, whatever their direction, tend to turn the suspended plate into a position parallel to the lines of force. The oscillations of the plate are read by means of a mirror attached to it, and are damped by a bar magnet moving in a copper box. The voltmeter may be employed for sinusoidal currents, and also for currents of a very different character. The effective difference of potential is proportional to the square root of the arc of the deflection. The instrument is compact, and not subject to external influence. Its sensitiveness may be reduced from outside by pulling out the rods holding the condenser plates. These rods also form the terminals for insertion in the circuit. The calibration curve is perfectly straight from 0 to 2,000 volts, and the effective tensions of alternate currents with frequencies up to 1,000 per second have been successfully measured.

[Ebert and Hoffmann, *Zeitschr. für Instr.*, January, 1898.]

Improved Interrupters.—A new interrupter of Dutch construction is described by N. G. van Huffel. It consists of a little water mill provided with four platinum pins dipping into mercury. The current passes through the mercury into the pins, and thence into the shaft of the wheel. A circular plate is mounted on the shaft, and dips into a smaller trough of mercury, and so the circuit is completed. The novel and ingenious plan of the apparatus is that the water which drives the little mill falls on the mercury and overflows, carrying away with it all impurities due to oxidation. Moreover, the speed of the interrupter may be minutely regulated by turning the water supply on or off, and there is no preferred period as there is in the case of a spring interrupter. When the new interrupter is substituted, the length of spark obtainable is sometimes doubled, and X-ray experiments are greatly improved in consequence. Since the dipping of the platinum pins takes place for a definite time, the full strength of the current is at play for a measurable period. This is more than can be said of the Ruhmkorff hammer. But for this also an improvement is suggested in the way of an additional spring, which presses against the main spring and prolongs the contact, besides getting rid of the natural period of the main spring. An improvement of 40 per cent. is claimed for this device.

[Van Huffel, *Zeitschr. für Instr. Beiblatt*, January, 1898.]

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TORQUAY MUNICIPAL ELECTRIC SUPPLY WORKS.

Yesterday evening, at 7 o'clock, the Mayor of Torquay formally started the electricity supply works recently erected by the Corporation. As long ago as 1891 a Provisional Order was acquired by the local authorities, and Mr. W. H. Trentham, of Westminster, was instructed to draw up a report embodying an electric supply scheme. This report, although considered and recommended by a committee, was not immediately carried out, and progress with the electric supply scheme was delayed and postponed until 1896, when the Corporation suddenly awoke to the necessity for practical action if they were to retain control of their Provisional Order. Accordingly, tenders were invited. The system recommended and eventually adopted was the high-pressure alternate-current transformer system, with rectifiers for the street arc-light circuits.

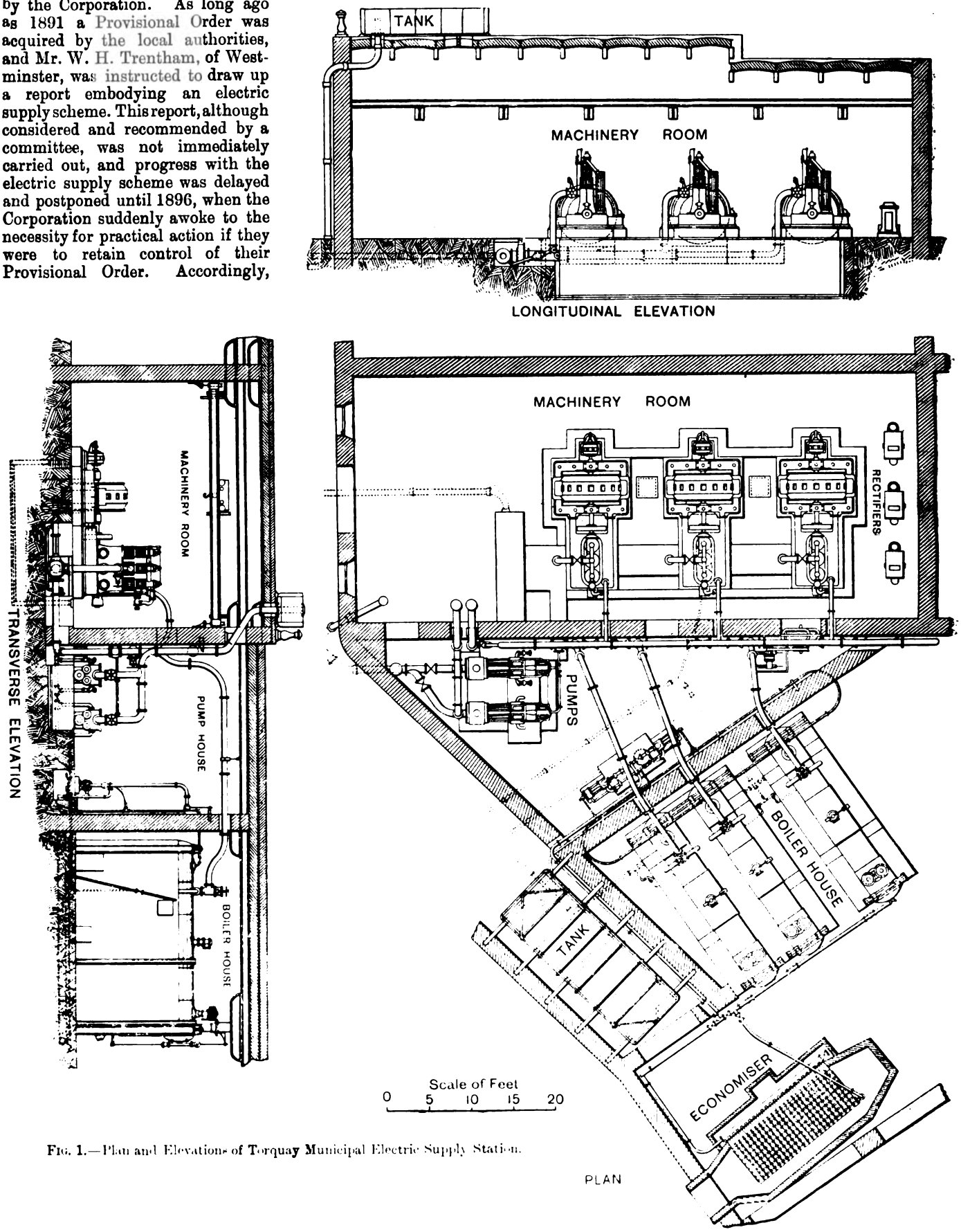

FIG. 1.—Plan and Elevations of Torquay Municipal Electric Supply Station.

Mr. Trentham was instructed to prepare another report, which, being done, specifications and plans were issued and

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A list of the principal contracts and sub-contracts is given below, with the names of the contractors:—

Boilers	Messrs. Babcock and Wilcox.
Engines and alternators	Messrs. Easton, Anderson and Goolden.
Engines (sub-contract)	Messrs. Willans and Robinson.
Cables and street work	British Insulated Wire Company.
Switch gear	Messrs. S. Z. de Ferranti (Limited).
Transformers	Messrs. Nalder and Hilton.
Overhead traveller	Messrs. Isles (Limited).
Meters	Messrs. Chamberlain and Hookham.
Demand Indicators	The Reason Manufacturing Company.

It was naturally desirable that the generating station should be situated near the principal area of supply, and Torquay being a popular sea-side watering place, it was almost inevitable that this area should be close to the shore. A suitable site ready to hand for the plant was found in a range of lofty and capacious coal cellars or arches, owned by the Corporation and situated beneath a roadway at Beacon Quay. To convert these cellars into a building suitable for a central station it was only necessary to remove one of the partition walls, replacing it by iron columns and roof beams, and to excavate the hard limestone rock below the floor, so as to allow of an anti-vibration foundation for the engines. This latter was rendered necessary by the imperative obligation to avoid nuisance from vibration—a problem which Mr. Trentham solved by excavating the rock to a considerable depth and filling-in with concrete separated from the rock by hair felt. A further problem arose when it was found that at high tide the sea-water was liable to percolate through the rock, the felt being thereby exposed to risk of rotting. To obviate this difficulty Mr. Trentham decided to line the excavation with waterproof asphalte, and it has been found that the foundations have by this means been preserved from injury from sea-water. The situation of the works near a residential district also rendered it necessary to restrict the height of the chimney to 60ft., and with so small a natural draught forced draught for the boilers was hardly to be avoided.

In the accompanying illustrations (Fig. 1) are shown scale, plan, and elevations of the generating station, the manner in which the cellar space has been adapted to the novel purpose being clearly indicated. It will be seen that in the boiler house there are three Babcock-Wilcox water-tube boilers. These are provided with superheaters, and are fired with a mixture of three parts of coke to one part of Welsh smokeless coal—a practically smokeless fuel. The coke costs 12s. and the coal 20s. per ton. Adjoining the boiler house there is a furnace economiser plant of a well-known type.

Within the machinery room two of the complete set of three steam alternators have been erected. These sets are all of similar size and type, and were described and illustrated in an article on "Torquay Electric Supply Plant," which appeared in *The Electrician*, November 26th, 1897. Each of these sets comprises a three-crank compound condensing 1,225 I.H.P. Willans automatic-expansion engine, direct-coupled to a 125-kilowatt Fynn alternator, built by Messrs. Easton, Anderson and Goolden. The combined set runs at 375 revolutions per minute, developing from 2,000 to 2,200 volts and a frequency of alternation of 50 cycles per second. As stated in the full description already referred to, the alternator is of a type in which both field and armature coils are stationary, the iron core of the field alone revolving. The condensing plant consists of Ledward ejector condensers, supplied with condensing water from an overhead tank, which is supplied with sea-water by circulating pumps. The arrangements of the steam, feed, exhaust and condenser piping are shown in the accompanying plans.

For the arc-lighting plant three Ferranti constant-current rectifiers have been erected. Each of these has a capacity of 35 lamps in series, and delivers a rectified current of 12 amperes. The adoption of this system of arc lighting enables the public lighting load to be combined with the ordinary supply load. The arc lamps are of the latest Crompton-Pochin type, and were supplied by the British Insulated Wire Company, who contracted for the whole of the mains and street lighting.

The switchboard at the generating station is the standard pattern of Ferranti switch-gear, which has several times been described in our columns. In this form of gear the switches and instruments are placed on one set of mains, the other—or return—mains being earthed. The gear is at present arranged for three alternators and nine feeders, but it is one of its most useful features that it can readily be extended. The feeders and distributing mains are laid in wooden troughs filled in with a hard-setting insulating compound.

Current will be charged for on the Brighton system, the rates being fixed for the present at 7d. for the first hour and 3d. after. Already some 3,600 lamps (8-c.p.) have been connected, besides the street lamps, so that the station starts with a satisfactory load, sufficient indeed to load fully one of the generator sets. It is expected that applications for lamp connections will be such that by the end of the current year extensions of plant will have to be undertaken. We may mention that the existing plant has cost £23,400, Mr. Trentham's initial estimate being £23,716.

In conclusion, we express our thanks to Mr. W. H. Trentham, the consulting engineer to the Corporation, for his courtesy in supplying us with information regarding the undertaking, as well as to Messrs. Easton, Anderson and Goolden for furnishing us with the drawings from which the accompanying illustrations were prepared.

ON THE MANUFACTURE OF LAMPS AND OTHER APPARATUS FOR 200-VOLT CIRCUITS.*

BY G. BINGSWANGER BYNG.

(Concluded from page 657).

Arc Lamps.

Coming now to the subject of arc lamps in relation to the higher pressure, I do not see that with alternating currents the increased potential materially affects the consumer. The practice may bring a single-parallel system into vogue, with economy coils—an alteration which will, in my belief, increase the commercial efficiency of alternating arcs. But the disadvantages are apparent in the case of a continuous-current circuit. For instance, in small installations of one or two lamps on the 100-volt circuit, these must be doubled on the 200-volt circuit, or useless resistances interposed. To equalise the conditions it has been proposed to substitute low-current lamps—say four 5-ampere instead of two 10-ampere lamps. As this substitute has been advocated by one of the foremost central station engineers, and many others will possibly follow him, it may be useful and not out of place to prove that both in theory and practice low-current arc lamps are deficient in points of economy and efficiency.

It is generally accepted that the current-density of an arc is independent of its size; assuming this as correct, the area of an arc must be proportional to the current, and the cooling surface proportional to its diameter. This is the case with the cooling surface of the carbons, if these are used of areas proportional to to the current taken by the lamp. Thus the cooling effect of the atmosphere will have a direct relation to the diameter of the arc and to the square root of the current. Therefore, for illumination, large arcs are more efficient than small ones, and the practical arc is attained when the benefit of increasing the number of light centres balances the inefficiency of small arcs. This gives, in practice, an arc of about 10 amperes.

Small arcs worked under same conditions are more unsteady than large ones, which is due to the fact that with an arc of a given length the E.M.F. decreases as the current increases. An experiment in which a fixed length of arc at 5 amperes and 44 volts was suddenly increased from 5 amperes showed—

Normal	5 amperes	44·0 volts
Sudden increase from	5 to 6 amperes	40·5 „
„ „ „	5 to 7 „	38·5 „
„ „ „	5 to 8 „	37·2 „
„ „ „	5 to 9 „	36·0 „
„ „ „	5 to 10 „	35·2 „

So an arc, or series of arcs, with a total voltage approximating to the E.M.F. of the circuit is unstable and fluctuating—probably due to the disproportionate variations of the cooling surface, coupled with the decreased resistance of carbon at higher temperatures. If the arc flares, the current will increase, unless there is sufficient resistance in series to reduce the voltage across the arc at a greater rate than the above figures show. Certainly the mechanism tends to lengthen the arc, but to no advantage because the movement continues until the current decreases to the normal value, and the acceleration would extinguish the arc unless an interposed resistance allowed of a rapid increase of the voltage across the arc. Such a

* Paper read at the Institution of Electrical Engineers on Feb. 24, 1898.

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resistance is necessary to compensate the "negative resistance" of the arc, which may be more appropriately termed "decreased cooling surface per ampere." An additional resistance in series is necessary to ensure steadiness. It follows, therefore, that 5-ampere lamps must be worked on a higher E.M.F. or "pumping" will ensue.

The possible current through four lamps on 200 volts, allowing 50 volts across each arc, is five times the normal; with five lamps on 230 volts, 7·6 times the normal; while with four lamps on 230 volts it is only 3·3 times the normal. Therefore, when 5-ampere lamps are used upon a 230-volt circuit, it is better to run four with steady long arcs than five with unsteady short arcs.

It is probable that the enclosed arc lamp will be brought into prominence in this direction, offering certainly many advantages; but I would point out that in practice the current cannot be largely increased, because of the frangibility of the enclosing envelope under an accession of temperature. If the cooling surface be increased so that the temperature of the gases surrounding the arc remain about the same, the efficiency of the lamp is considerably reduced.

Adverting to the manufacture and installing arc lamps, to meet the contingencies of the high voltage, we have to consider that, if the carbons run short or the slides stick in one lamp, the other lamps close together, and the full voltage of the circuit is maintained across the shunt coil of that particular lamp. The possible troubles are that the shunt coil is burnt up, and that the carbon-holders are damaged with the excessive flaring of the arc before it breaks. It would hardly be practical to make magnets to stand such overload. Of course we can instal a cut-out and equivalent resistance to each lamp. But this expedient is very costly, and presents the further difficulties of finding suitable room near the lamp or making it self-contained with the lamp, and of teaching the consumer that the full current can be used although the lamps are not alight. Some sort of cut-outs must be installed, and I am of opinion that there is a field for inventors in this direction. I will indicate how I have endeavoured to meet these difficulties.

If, as is generally the case, one pair of carbons burn at a greater rate than the others, the slide in that lamp will touch the stop first, and the stumps will burn away until the gap is wide enough to break the arc. I append a table showing the results of five trials.

FOUR 10-AMPERE LAMPS ON 200 VOLT CIRCUIT.

(+carbon 18mm. cored, −carbon 11mm. solid.)

(1)	Arc flared and was extinguished at.....	$1\frac{1}{2}$in. gap.
(2)	" " "	$1\frac{3}{16}$ "
(3)	" " "	1 "
(4)	" " "	$1\frac{1}{2}$ "
(5)	Current switched off when arc was at...	$2\frac{1}{4}$ "

In the first four trials the arc broke while flaring; that is to say, it travelled up the side of the carbon and ignited the loose dust, taking a spiral course, this course being continued until the length is too great for the voltage. The arc only leaves the point of the carbon when there is sufficient dust to maintain it and counteract its increasing length; thus, when the supply of dust fails, the arc is extinguished before it can return to the points. During trial No. 5 the carbon became pointed, and the temperature rose to the extent of freeing the surface from dust; hence the arc did not leave the crater.

We may deduce from this the desirability of maintaining a considerable gap between the carbon-holders, exceeding even 3in. For absolute safety it is better to extinguish the arc automatically. Now an automatic switch is useless, because it is necessarily controlled by the potential across the lamp, and could not discriminate between the increased voltage caused by the carbons burning short and that caused by the extinction of a flare; and, since this may happen at any time, the arc could not be re-formed even when the carbons came together. The circuit, in fact, would be inert, and the arc would have to be re-established by hand. An efficient cut-out must extinguish the arc, and simultaneously cut the shunt coil out of the circuit, the mechanism of the lamp also being free, that the carbons may travel together. The shunt must on no account be cut out whilst the brake is on, since it could not then compensate the series coil and draw the carbons together.

For the protection of the shunt-coil I have used a temperature fuse, made of an alloy with a melting point of 210°F., and having sufficient sectional area to be independent of the amount of current likely to traverse it. The carbons could be held apart several minutes before fusion took place. Although a decided advantage was gained over a plain lead fuse, and the shunt coil was efficiently protected, the carbon-holders were not protected, and the fuse required renewing each time it became ruptured. The chief difficulty in constructing an automatic "cut-in" and "cut-out" lies in the necessity for a rapid make or break, to save vibration and sparking. My system may be briefly explained, in that the arc is first short-circuited through a shunt path, and so put out by reducing the voltage across the terminals. This short is then broken by a quick break switch, the same action reversing the shunt switch simultaneously, ready to fall upon its normal contact when the carbons touch, or are replenished. The mechanism is actuated by the main armature of the lamp, and the movements take place while the armature is below the feeding point, so as not to interfere with the working of the lamp.*

HEATING AND MOTORS.

The effect of the increased pressure upon such applications of the house current as heating, cooking, &c., does not entail a sufficient alteration structurally or electrically to need an exhaustive description. The resistances forming or causing the heating surfaces must be arranged to conform to the higher E.M.F. at the terminals, and it is mostly preferable to increase the length rather than decrease the diameter of the resistance wires; but this fact presents some difficulty in such articles where the space available is small. If the space is too limited, such apparatus can only be used in series, or in connection with an external resistance.

With motors, the greatest difficulty also lies in adopting the smaller sizes, say from one-twelfth horse-power to one-sixth horse-power, to suit the altered conditions of higher pressure. A certain structural alteration is doubtless necessary to arrange a new winding to produce the same efficiency as heretofore on a 100-volt circuit. In the larger sizes, I am, in order to facilitate keeping stock, using a double or differential winding, which, when coupled in parallel, conforms to 100 volts pressure, and with the same winding in series gives an equal efficiency on a normal load at the 200-volt pressure.

In revlewing the subject of higher voltage generally from a standpoint of *cost*, I am of opinion that sufficient time and experience, naturally resulting from an increased demand, will place the cost of most fittings for 200 volts within the margin of those of the lower voltage, except, perhaps, a few cases, among which I may instance incandescent lamps. These will necessarily always be more expensive, owing to increased cost in mounting of larger bulbs and extra supports, and also through increased time of exhaustion and percentage breakage. But we must not overlook the fact that in the matter of wiring there must be a decided saving. The smaller sectional area of conductor per lamp employed, without the necessity of increased insulation, as also in a minor degree smaller connectors and contacts, will in all probability compensate some other apparent disadvantages, and may bring the balance of cost in favour of the high-voltage system.

I do not wish to bring the subject of cables and wires or wiring systems within the scope of my present Paper; but I will only mention that, in my opinion, such matters as the establishment of of revised wiring tables, the use of twin wires, the smallest gauge allowable for single lamps, the best and cheapest system of wiring for high-voltage supply, would be subjects well worthy of the immediate consideration of, and an interchange of opinion between, engineers and manufacturers.

The following is an abstract of the discussion which took place after the reading of the Paper. Speakers who have returned their proofs revised are denoted by an asterisk:—

DISCUSSION.

THURSDAY, FEBRUARY 24TH.

*Mr. H. L. P. BOOT was very pleased to note that manufacturers—or at least one manufacturer—was waking up to the fact that it was necessary to design standard fittings for wiring work, as it was only by this means that they could cheapen and reduce its expense. The one noteworthy point with regard to the use of high voltages was undoubtedly the saving effected in cable; in several instances recently brought to his notice this saving more than counterbalanced the extra outlay for suitable fittings. His experience with fuses seemed to point out that where a fuse was used on alternating circuits there was less necessity for precaution against porcelain "smashings" or "explosions" than there was when using direct current at high pressures. He did not consider high-voltage lamps so bad as the author's remarks might lead people to infer, although he admitted their life was not so long and that their candle-power fell off more quickly than that of 100-volt lamps. As a means of using up all the old 100-volt lamps on the new system, he suggested the use of two 100-volt lamps in series. These lamps could be purchased very cheaply from central stations who were discarding the old voltage. In Tunbridge Wells they were using the 100-volt lamps returned from consumers' installations for the incandescent lamps used for street lighting after the arcs had been switched off.

*Mr. W. M. MORDEY considered that the specific resistance of carbon should be considered in relation to its specific gravity, for he thought that the differences in specific resistance had to do with the mechanical rather than the physical state of the material. An unflashed filament was simply a long string of cinder, full of holes from which the volatile parts had gone. The high resistance caused by what used to be called "microphone" contacts. After it was flashed it became more solid, but even then its resistance was very much a matter of contact. In this connection he might mention that in 1882 or 1883, the first time he had the honour of addressing a meeting of the Institution, he had described some experiments showing that the idea of carbon differing from metal as to the effect of temperature upon its resistance was in a sense a misconception. Finely-divided carbon behaved the same as finely-divided metal, as far as

* An arc lamp fitted with this cut-out was shown after the reading of the Paper.

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the variation of resistance with temperature was concerned. He thought it would be of assistance if some of the lamp makers would tell them to what extent they had found that specific resistance and specific gravity varied. It would also be interesting to find out whether the filaments found on the top of the gas retort, which were of a particularly hard, solid, and probably very pure form of carbon, were taken practical advantage of. He believed that some years ago one maker had used them in the manufacture of scarf-pin lamps. In the first paragraph of the Paper the author made the following admission: "The ultimate success of the high-pressure system will depend largely upon the verdict of the consumer." On account of the very great advantage in transmission in cables this view had rather been lost sight of by some of those advocating the system. He asked members to give actual facts as to the relative cost of lamps on 100 and 200-volt circuits. Central-station and consulting engineers must not suppose that the consumers—the jury whose verdict would ultimately settle the high-pressure lamp question—had been asleep. He had heard remarks of an untirely unsatisfactory nature on various occasions. The central station engineers should take upon their shoulders the whole burden of the supply of lamps to customers, so that the latter would have no ground for complaint, except, perhaps, that they might have a little more trouble with regard to renewals. The advantage should not be retained by the supply concerns and the disadvantage left to the consumer. As bearing on this subject, he mentioned an article by Mr. Robertson on the difference in the effect of alternating and direct currents on the life of lamps, in which it was stated that in Vienna the life of lamps was found to be much greater on alternate than on direct-current circuits. He was very pleased that Mr. Byng, working independently, had arrived at pretty much the same conclusions with regard to fuses as himself. He was also pleased to say that when Mr. Byng had discovered his (Mr. Mordey's) patent, he had not concluded that it had merely been taken out for the purpose of paying the Patent Office and patent agents their fees. With regard to arc lamps, the light was roughly proportional to the watts rather than to the current because with the greater length of the arc, the light got out better. With regard to arc light cut-outs, he thought the author had forgotten the old Brush cut-outs, which had done pretty good service in their time, and complied with all the essential conditions laid down by the author.

Mr. J. S. RAWORTH referred to the imperfections of 200-volt lamps. Mr. Byng had stated that in some cases as many as one in twelve lamps had short-circuited on being placed in their holders. He had a particular dozen, of which 25 per cent. went as soon as they were put into the holders. They also had the peculiar and unfortunate quality that Mr. Byng had pointed out, viz., they would not burn in an horizontal position. The moment they were put in that position the filament came down and touched the glass, and out they went. He was very anxious that they should get the very best system of distributing current with the smallest amount of expense, but he wanted to give the lamp makers sufficient time to get on with their lamp making before the whole country was fitted with 200-volt lamps. He quite agreed with Mr. Byng that high voltage lamps took more watts per candle-power than the 100-volt lamps, and if consumers got to understand that the use of high voltages was going to increase their bills, they would not use them.

Mr. J. N. SHOOLBRED reminded the meeting that in the early days the 100 or 110-volt lamp was as much an experiment as the 200-volt lamp was now. The 110 volts had succeeded over the 50, which was in vogue then, and he felt sanguine that the 200-volt lamp would displace the 100-volt; indeed, he went further and gave it as his opinion that in the course of time we should be using 500-volt lamps. He did not see why the size of bulbs for 200-volt lamps should be restricted. He also mentioned that he had used a good many makes of lamp, burning in the horizontal position, and had never had any difficulty with them.

Thursday, March 10th.

*Mr. C. H. STEARN said he had little to add to and nothing to retract from the statements he had made about two years ago when the same subject had been discussed at the Institution. In the production of lamps for 200 volts there were two alternatives: to use carbon of high specific resistance, with the drawback that there would be a more rapid change in candle-power; or low specific resistance, with such an alteration of the mechanical construction as would give greater rigidity. The first alternative had come into more general use for a time, and he still considered it the best for the transitional period. It was necessary that the lamps should be durable, reliable, that they should not be broken prematurely, and that they should absorb the same amount of energy to which people had been accustomed. It would have been desirable that there should be no change in candle-power, but this was a minor point, as it could easily be remedied afterwards. The adoption of untreated filaments in double filament lamps seemed to him to fulfil the above conditions as to durability, ease of division into small units without increase in the consumers' bills. He admitted the superiority of "treated" carbon in respect to light curve, but this one point was not everything that was necessary in a lamp. In 1880 and 1881 undoubtedly untreated carbon was rough, cindery and fragile, and the duration unless treated was very short indeed. Treating was first adopted in this country principally to strengthen the carbon for commercial use. The advantage of this in the durability was soon found out, but the advantage with regard to light curve was not discovered until later. Since then, however, Mr. Swan had given them that beautiful process of preparing filaments by projecting liquid cellulose into a setting solution, and it was mainly this that had rendered the high voltage lamp of the present day possible at any reasonable efficiency. Carbons prepared in this way when skilfully made and skilfully carbonised did not require a treating process for strengthening. The treating process, good as it was, had many drawbacks and many more perils than good untreated carbons. With untreated carbon, if proper precautions were taken, there would be equal consumption of energy in the filament, or nearly so, equal diameters and resistances could be depended upon, while the durability was all that could be desired. When treating process were used there was a liability to all sorts of variations if the workpeople were at all careless. For this very reason it seemed to him, in view of the experience of previons years, much better to use a process which was safe, and to introduce improvements later on when the form could be rendered more suitable. Treating, to be reliable, must be thick, and if they wished to construct a 16-c.p. 230-volt lamp with a reasonable amount of treating upon it they would have to have a length of filament something like 14in. or 15in. A filament of this length could not be safely used, either singly or double, without some special mode of disposing of it, and a good method of doing this was, he thought, to bend the carbon backwards and forwards so that the whole 16in. could be enclosed in quite a small compass. Unless some such idea as this were adopted he preferred to use the untreated carbon. It was quite possible to make filaments of 16in. in length that would go into the old bulbs without any difficulty whatever. He was very surprised to hear that the general consensus of opinion was that large numbers of lamps were expected to short circuit at once. There were two causes of short circuiting which were not due absolutely to faulty lamps. One of them was that customers who used double filament lamps did not take the trouble to shake the filaments apart before putting them in their holders. This defect would be entirely removed if single filaments came into use. The other cause was accidental cracks in the bulb. Short circuits would also occur from carelessness in connecting the wires together, using improper soldering fluids, or attempting to frost the bulbs of finished lamps with chemicals. He noted that Mr. Byng proposed to put the filaments further apart, but he considered that distance between was amply sufficient if the vacuum was properly made. He had not been able to discover any reason for making a difference either in the time of exhausting or in the manner of doing it, if only proper precautions were taken. He certainly had not found any more difficulty in getting rid of the occluded gases from untreated filaments than from treated filaments. The source of the gas that had to be removed in exhaustion was not from the filament itself, because all that must be driven off as soon as the filament was heated to a white heat. The source of the gas came from the thickened ends or platinum wires which only slowly heated, but this was the same whether treated or untreated filaments were used, The increase of candle-power in running was entirely in the hands of the maker. He could either have a very large rise in candle-power after the lamp was put in use or he could have none at all. If lamps were used at moderate temperatures, such as 3½ watts, they could be so regulated that the rise in candle-power took place very gradually, only expending itself after about 300 hours. The author's proposal to make the efficiency vary with the voltage certainly surprised him, and he was more surprised to hear that it was the general practice of manufacturers. A difference of half a watt per candle-power in a 16-c.p. lamp lasting 1,000 hours meant, at 6d. per unit, 4s. per lamp extra for current in order to decrease the price of the lamp itself. With regard to a standard voltage, the author proposed to make the highest limit 230 volts; but why not, whenever possible, go up to the 250 volts allowed by the Board of Trade? There was no reason why 500-volt lamps should not be used for street lighting. The author's statement that boron, silicon, alumina, &c., all volatilise at 5 watts per candle seemed to him somewhat doubtful. He had seen lamps, the carbons of which contained at least one of these substances, that did not show any material change in efficiency for 300 hours even at 2·8 watts per candle. He mentioned this only to show that the compound at least did not do any harm, and did not volatilise, but his opinion was that as good results could be obtained without it. In conclusion, he was of opinion that, other things being equal, if cautiously done, it was desirable to apply the treating process, but without increasing the size of the bulb or using shackles. With regard to the alleged difference in the life of lamps on alternating and direct circuits, he thought that careless exhaustion had much to do with this.

*Mr. R. E. B. CROMPTON said he had lit the town of Harrow with double voltage and he had had two years' experience of its working. Following Mr. Stearn's advice he had used double filament lamps at first and then single filament lamps, and the result has been that the users at Harrow were as satisfied with their lighting as any 100-volt user. In the course of last year he had been one of a committee appointed by the Council of the Institution to carry out experiments, and if possible, get out a table of the length of arc required for switches at various voltages. They made a long series of experiments with fittings by all makers, and the result was so unsatisfactory in the way of helping them to lay down a rule that they had been obliged to abandon the idea. The sudden explosion which blew the covers of cut-outs to pieces occurred so rapidly that it could only be produced by the sudden expansion of the contained air, and by using a larger cover and putting a number of perforations in the cover the effects might be minimised. To use a substance such as plaster cement round the fuse was a very excellent idea, and probably it worked satisfactorily on account of its keeping down the temperature and minimising the action of the arc. He disagreed with the author on what he said as to arc lamps. The author enumerated a great many troubles and difficulties, all of which were well understood, and were overcome in practice. In the last paragraph the author stated: "I will only mention that, in my opinion, such matters as the establishment of revised wiring tables, the use of twin wires, the smallest gauge allowable for single lamps . . . . would be subjects well worthy of the immediate consideration of, and an interchange of opinion between, engineers and manufacturers." All this had been a matter of very careful discussion on the part of the Committee of the Institution, who prepared the new wiring rules, and it was, therefore, unnecessary that the matter should again be gone into.

*Mr. J. SWINBURNE said that years ago he had made a good many experiments with untreated filaments, because experience showed that these filaments lasted rather better than the treated ones, but he always used to flash them *in vacuo*. By that means he got them very hard, and also got rid of the little weak places at the clips. Another curious thing he had noticed at that time was that certain fibres, when carbonised, had

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nearly the same resistance cold as when hot. With regard to the matter of efficiency varying with the emissivity, he remembered, in a trial between the Edison-Swan Company and Holland, he was in a minority of one when he gave evidence and said that efficiency was simply a question of temperature. He was glad to say that people had come round to his idea at last. Efficiency simply depended upon the colour and nothing else, and the colour depended upon the temperature, and not upon the emissivity.

Mr. C. H. WORDINGHAM said they had always been able to supply at a pressure of 200 volts in Manchester on the five-wire system, but when it came to extensions it was a moot point whether it was best to use the three-wire or five-wire system. He had begun by extending on the five-wire system, but had gone over to the three-wire, although there were still disadvantages in this system. He had had very little practical experience with high-voltage lamps; but he had received very few complaints from consumers, and concluded there was very little difficulty met with in using them. Incandescent lamp makers were rather apt to overlook the fact that arc lamps had to be burnt upon the same mains as incandescents, and he did not think it desirable to go as high as 230 or 250 volts, and so compel the consumer to have at least five arc lamps or waste a great deal of current; and were it not for the fact that enclosed arc lamps were coming into vogue he hardly thought they were justified in forcing high pressures on consumers at all. With regard to Mr Byng's statement that the success of the 200-volt system depended upon the verdict of the consumer, he did not see what choice the consumer had in the matter. A matter in which he took particular interest was the question of fittings. At the Convention of the Municipal Electrical Association in 1896 he was poohpoohed for uttering a warning that ordinary 100-volt fittings would not do for 200-volt lamps; but experience since then had shown that there must be a difference made. He had enforced a regulation that the length of break in switches and fuses used for 200-volt lamps must be such that it would stand a 50 per cent. excess of current at a 50 per cent. excess of pressure without arcing. With regard to cut-outs, he had specified that these must be capable of breaking a short circuit with a fuse wire in the cut-out. This was a very destructive test, but he had applied it successfully to Mr. Byng's fuse.

*Mr. W. R. RAWLINGS spoke from the consumers' point of view. Although he was not a consumer, yet he was one of the unfortunate contractors who had to deal between the supply company and the consumer. He had to deal with some 60 consumers who had gone over from 100 to 200 volts, and it was painful to meet these consumers now, whereas from those who had been fitted at 200 volts in the first instance, and knew nothing of 100-volt supply, there was no complaint. It was ridiculous to say that they must adhere strictly to the 16-c.p. lamp. They were then told to put their low candle-power lamps in series; he knew some houses where there were no less than four different voltages and a very large number of separate candle-powers.

After some remarks by Mr. L. GASTER,

*Mr. A. A. C. SWINTON said the author seemed to think that the wires in a lamp had a greater tendency to discharge from the one to the other the nearer they were together. This was the case in air, but in a high vacuum the nearer the two conductors the greater the resistance. He also suggested that in the future there might come into commercial use high voltage lamps without filaments, in which the light would be produced by the high incandescence of a substance, not necessarily conductive, subjected to an intense beam of cathode rays.

*Mr. H. W. MILLER mentioned that at present in Kensington there were some 600 consumers using something like 50,000 8-c.p. lamps on the high-pressure system. Half of these had been changed over from the 100-volt pressure and without any difficulty. They certainly had a number of complaints, principally on account of the light not being so good as with the lower pressure. There were available at present 200-volt lamps which were quite as efficient and as satisfactory as the ordinary 100 volt, but there were also some very bad ones, and it was the latter that were causing the trouble. He was sorry to hear in the Paper that the results of the last 13 years' experience had been thrown on one side in order to use the same size bulb for a given candle-power at both pressures, for this practically meant that an untried lamp was being put upon the market to the detriment of the public. He had made tests upon combination filaments for some years, and the experience he had gained taught him that the high efficiency lamp of the future would be made of such a combination filament, for the simple reason that they would stand a very much higher temperature than carbon. There was no difficulty in getting a high efficiency lamp with such a filament at 2½ watts to give equally good results in durability and candle-power as an ordinary best quality carbon filament working at 3½ watts. Such a result had been obtained in practice. The author's explanation of the action of his fuse was wrong. When the fuse melted the hot air and the vapour generated rushed out through the two side holes and blew the arc out, it was wrong of the author to state that ventilation holes were of no use whatever, for they were essential to his own fuse. A number of engineers had found some difficulty in knowing what to do with small fan motors when changing from 100 to 200 volts. He put the magnet winding in series with the armature instead of as a shunt. With regard to the author's statement that copper fuses were not satisfactory on account of the maintenance of a dull red heat at normal load, it was not the usual practice to run fuses at a dull red heat. It was impossible to use a very fine pure tin fuse wire, on account of its brittleness and liability to breakage when used under a binding screw.

*Mr. C. J. ROBERTSON thought Mr. Stearn was quite correct in stating that the ideals were to be found in lamps which had flashed carbons, and that as a go-between the flashed filament was certainly serving a good purpose. But the length of unflashed carbon was so great that it was absolutely necessary to have larger bulbs. The present-day lamps were all very similar; 999 out of every 1,000 were produced from a solution of cellulose in zinc chloride (a process due to Messrs. Wynne, Powell and Evans). There were only about two factories in Europe which were exceptions. His experiments on the various types of unflashed filaments now on the market showed that all the lamps were almost identical. It seemed that lamps would remain where they were until some other substance than carbon was used, but there were so many ways of treating carbon that there was an enormous latitude, and he thought it unquestionable that methods of flashing had been devised that had produced carbons far more satisfactory than unflashed filaments. As to the question of the advantages or disadvantages of running lamps on alternate and continuous currents, it had occurred to him since writing the article referred to by Mr. Mordey that Lord Kelvin about 12 years ago laid down that it would tend to increase the life of the lamp by one-third if continuous currents, which were then general, were reversed in polarity from time to time. Many stations had been fitted up with double pole change-over switches, the idea being to change the polarity at least every day. In the manufacture of the Cruto filament, which consisted of a long thin platinum wire stretched in hydro-carbon gas and heated to incandescence, it was found that the negative end was thicker than the positive end, and the reverse of the operation was no doubt going on in an incandescent lamp supplied with continuous current.

*Mr. W. GEIPEL said that the whole question of 200 and 100 volts seemed to have resolved itself into a question of how to keep a constant pressure. He was not at all sure that it was the central station engineers who were bringing forward this question, as he had very often heard makers of 200-volt lamps urge the desirability for them, although, perhaps, not from a disinterested point of view with regard to price. When the matter had been discussed about two years ago one of the few instances of the use of 200-volt lamps was at Bradford, where Mr. Gibbings had stated they were satisfactory, but unfortunately at that time the accounts had not been published. It seemed that after these had been published the Corporation had thought it desirable to supply the consumers with free lamps to keep them quiet.

*Prof. S. P. THOMPSON said that, personally speaking as a consumer, he would much rather remain on with the 100 volts, unless by some means he could be supplied with 50 volts instead. One difficulty in the matter not mentioned by Mr. Byng was in the use of flexibles. Was there a decent flexible wire to be found in the market which could be put up safely at 200 volts? Lamp-makers had surely not yet come to the end of their resources in this direction of improving the carbon. But he did not think there was much hope of improving filaments by coating them with zirconia or other earths. Some years ago he had assisted at some experiments in Sir William Crookes' laboratory, and had tried coating filaments with every substance they could get hold of, but they had been unable to find any material which at the temperature of the carbon filament *in vacuo* was not either volatilised directly, or else reduced by the reducing action of the carbon and volatilised as a metal.

*Mr. C. O. GRIMSHAW said that with regard to the author's remarks as to the lamps short-circuiting when put on, the supply company with which he was connected had supplied 40,000 200-volt lamps, and out of these only 2·7 per cent. had gone wrong, which was very different to the 12 per cent. mentioned in the Paper.

Mr. G. L. ADDENBROOKE did not see why the small candle-power lamp at a high voltage was not possible. He had some 6-c.p. lamps given him by Mr. Stearn, but had not yet tried them. Nobody ever supposed that 200-volt lamps were going to be as good as 100 volts, but he did not think the difficulties were as great as they had been when the 8-c.p. lamp was first introduced.

*The PRESIDENT entirely agreed with Mr. Byng in his statement that the ultimate success of the 200-volt lamp depended upon the verdict of the consumer, and he had no doubt that the customers' verdict would turn upon the question of cheaper supply. Wherever a large area was supplied he thought the tendency of higher voltag would be to lower the cost of thee Board of Trade unit, and therefore the cost of electric light. Mr. Byng had pointed out that at present 200-volt lamps were not as efficient as 100-volt lamps. There was some truth in that statement, but if it was true that the most efficient of the 200-volt lamps now obtainable by the public were not quite as efficient as the most efficient of the lower voltage lamps, it was also true that they were quite as efficient as the greater proportion of 100-volt lamps in general use. He believed there was every reason to expect as much improvement in the 200-volt lamp as had taken place in the 100-volt lamp since its introduction. It was a great mistake to accept the idea that the primary carbon was not open to improvement, and that it could not be made equal to the treated carbon. Taking 200-volt lamps as they were at present, he certainly thought they were sufficiently economical and efficient to warrant their more extended use. Mr. Mordey had called attention to the difference in the physical condition of treated and untreated carbon. No doubt such a difference as he had described did, as Mr. Stearn had also stated, exist in the early days of lamp manufacture, but he was sure Mr. Mordey would be surprised to see how all primary carbons and lamp filaments had altered for the better. He would find, if he examined untreated filaments, that there was no sign of porosity. With regard to the construction of fuses and switches, it was of the greatest moment that everything be done that could be done to ensure that the risk of fire was not sensibly increased by the adoption of higher voltage, and he thought a suitable opportunity was afforded for the younger members of the Institution to take the matter up in a scientific spirit.

Mr. G. BINSWANGER BYNG said a few words in connection with the remarks made by some of the speakers, and expressed his intention of communicating the main portion of his reply in writing.

A unanimous vote of thanks to Mr. Byng closed the proceedings.

Mr. W. GEIPEL (in the course of some additional remarks, which he communicated) expressed the opinion that the Council would have met the desire of the members if more facility had been afforded for the discussion of the questions which were brought before them by the author. At the

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present moment there were many important supply works unable to maintain the pressure within the limits specified by the Board of Trade, who were face to face with the necessity either of extending their present mains or of raising the pressure of supply, and there were many new works in projection where the question whether to adopt 100 or 200 volts must be decided forthwith. It was already late enough in the day, therefore, to discuss this question, but years hence it would be still worse. In his opinion the interest of both undertakers and customers each lay in the same direction. The verdict of the consumer, as far as concerned lighting, would be given almost entirely on the cost of the candle-power hour, and would, as stated by the author, not depend largely upon the ability of the trade to supply fittings comparable in efficiency, economy, safety, convenience, and appearance with the lower voltage system. He agreed with Mr. Preece that the electric light was the poor man's light. He did not know of a case where the adoption of the 200-volt system had resulted in a greater reduction than 20 per cent. in the price per unit. But to obtain this reduction a lamp must be used consuming at least 33 per cent. more energy—probably more like 50 per cent.—to say nothing of the extra cost of the lamp itself, so that the candle-power, instead of costing less, cost more. There might be isolated cases in which it was advantageous to use a 200-volt supply, but in all important towns, where there was, of course, a preponderance of the poorer classes, the use of 200 volts was totally indefensible. It would only be defensible if it were impossible to keep the pressure at the lower voltage within the limits allowed by the Board of Trade.

Mr. C. J. ROBERTSON (in the course of some additional remarks which he communicated) said that the author had not run down *all* high-voltage lamps, but had only pointed out some of the peculiarities of high-voltage lamps with *unflashed* carbon. He had shown that flashed carbon would give us the ideals sought for in a good lamp, stating that "such lamps compare favourably with those of lower voltages." The "Robertson" Lamp Company made several types of high-voltage flashed carbon lamps, but in some cases it was necessary to use larger bulbs than those in general use. For instance, the 220 and 250-volt lamps required bulbs about ¼in. to ⅜in. larger in diameter, and his firm would like to feel that this small increase in the size of the bulb would be acceptable to engineers and contractors, although they were quite prepared to supply 220 to 250-volt flashed filaments in the usual bulbs. Unflashed carbons, if baked in an electrical furnace, occupied a position between a properly flashed and an ordinary unflashed baked carbon. The carbon needles, formed of retort cabon, as found inside gas retorts, suggested by Mr. Mordey for use in lamps, had been tried, but the quality of such carbon was not as good as well-flashed filaments, and it was, besides, in a very unmanageable form. His experience with all wavy-filament lamps on the market was that they were not successful for horizontal burning unless supported, or unless they had unflashed carbons, with their unavoidable peculiarities. His Company were designing their new type of flashed high-voltage lamps with curl filaments, each curl being supported. This type also had the additional advantage that high-voltage lamps with low candle-power were possible, such as 200 or 230 volts 8 c.p. and 5 c.p. at 4 and 4½ watts. After some historical notes as to the adoption of the filament made by squirting cellulose into zinc chloride, Mr. Robertson pointed out that even those firms who now use unflashed carbon for their 200-volt lamps still continued to make all their 100-volt lamps with flashed carbon. With reference to Mr. Stearn's remarks on efficiencies, there was a misprint in the Paper. The comma after the word "voltages" in line 12, page 656, should be deleted, and a comma should be inserted after "efficiencies" in the preceding line.

Mr. R. E. CROMPTON (in the course of some additional remarks which he communicated) said that he did not think that there was any perceptible difference in the life of the double-voltage lamps when compared with that of the ordinary 100-volt lamps, but the makers of the double-voltage lamps had been much more accurate in actually making the lamps to the candle-power named, and he had noticed that this fact had caused a prejudice against them. Coming to the question of arc lamps, he instanced the case of Liverpool-street station, where there are several hundred lamps all worked four in series on 200 volts, and where the number of cases of shunts being burned out by the causes mentioned by the author had not amounted to 1 per cent. per annum for a period of years, although there were no such cut-outs as he proposed to use. The cost of renewing this very small percentage of shunts was so infinitesimal as compared with the cost of upkeep of a large number of cut-outs that no one who had practical experience would propose the use of these cut-outs. He could give many other cases of the same character, where as many as 11 lamps are burnt in series on a 500-volt circuit, and where a similar immunity from failure had been observed, although in this case also there were no such cut-outs.

RAIL BONDING.*

BY WALTER E. HARRINGTON.

It is a difficult matter to determine which rail bond is the best adapted to individual needs; what may possibly answer under certain conditions will not answer under others. The majority of bonds are designed to make lateral contact with a hole in the web of the rail; this at once defines the necessity of good, clean, uniform surface in the hole in order to insure good contact. While it may seem an easy matter to obtain good, clean, uniform surfaces, the fact is that in the majority of instances holes are not true and are full of ridges. The writer has frequently removed bonds where it seemed as if every precaution possible had been observed to make good contact, with barely more than 10 per cent. of contact; in some instances the bonds could be readily pulled out of their holes. Further, rails will be either punched or drilled for bonds at the mill, and the holes will frequently become coated with rust before the rails are placed, resulting in either the necessity of using a file or reamer, making the holes larger than they should be. I do not wish to convey the impression that good contact cannot be made with bonds making connection through a hole in the web of the rail, as such can be done, but the frequent bad contacts upset our confidence in them.

The use of the Edison-Brown amalgam† to improve the contacts of copper bonds showed some very interesting results. Used with the Crown bond, it showed a decrease of 24 per cent. in the resistance by amalgamating, whereas the Columbia bond showed a decrease of only 5 per cent., proving conclusively that the form of contact made by the Columbia bond is far superior to the Crown; this is substantiated by the data in attached table, which shows that the Columbia bond has a resistance of 53 per cent. of the Crown, neither amalgamated. The troubles incident to making contact in a hole in the web of the rail led to the trial of the Bryan bond. This bond consists of a large number of parts, and is open to the objection that a bronze casting is used as part of the conductor. The bond consists in brief of two No. 0000 copper wires, clamped by bronze and iron castings, the bronze casting in contact with a corrugated copper washer which is in contact with a freshly made contact surface upon the face of the rail, the whole held together by a 1in. bolt and nut with a lock washer. This bond overcomes the radical objections inherent in the type such as the Crown and Columbia, depending upon their contact with the sides of a hole. The resistance of such a bond without the Edison-Brown alloy is very high; comparing it with two Crown bonds non-amalgamated shows a resistance 146 per cent. higher, but the amalgamation makes a remarkable difference. Comparing it with the non-amalgamated Crown bond makes a difference of just 42 per cent. in favour of the Bryan (when amalgamated), whereas with two Crown bonds, amalgamated, makes a lesser difference of 23 per cent. in favour of the Bryan bond amalgamated, with a still further advantage of permanency.

Kind of Bond.	Ohms.	% Res. = A/B	Current carrying capacity without heating.	Centre to centre of contacts.	Length of bond.	Size of Contact.	B. & S. Gauge.	Number of wires in bond.
			amps.	in.	in.			
Joint only—no bond	0·00071	...	0	36	...	... ...	...	...
Iron Channel Pin	0·00049	69 %	15	45	48	⅞in. pin	0	1
Bryan Iron Wire	0·000286	40 %	36	36	39	Plate 2¾in. diam., 1in. hole in it	½in.	2
Crown	0·000247	34 %	161	30	36	⅞in. head	0000	1
Bryan Iron Wire (Amalgamated)	0.000224	31 %	46	36	39	Plate 2¾in. diam., 1in. hole in it	½in.	2
Crown (Amalgamated)	0·000185	26 %	210	30	36	⅞in. head	0000	1
Bryan Copper Wire	0·000175	24 %	386	36	39	Plate 2¾in. diam., 1in. hole in it	0000	2
Columbia	0·000131	18 %	161	30	36	⅞in. head	0000	1
Columbia (Amalgamated)	0·000126	17 %	170	30	36	⅞in. head	0000	1
Stranded Crown	0·0001	14 %	161	5	7	⅞in. head	0000	1
Plastic Socket	0·000093	13 %	400	3½	4¼	1 sq. in.	=000	...
Bryan Copper Wire (Amalgamated)	0·000071	9 %	1,030	36	39	Plate 2¾in. diam., 1in. hole in it	0000	2
Plastic Cork, under one angle plate only	0·00006	8 %	1,200	9	...	2 sq. in.	6 0000	...
Plastic Cork, under both angle plates	0·00003	4 %	2,400	9	...	4 sq. in.	12 0000	...
Solid rail—no joint	0·000013	...	1,200	There were holes in web 18in. between contacts.			...	...

Tests made on Pennsylvania Steel Company 7in. girder rail, No. 238. (A = Resistance of bond; B = Resistance of joint only.)

*Abstract of a Paper read before the Electrical Section of the Franklin Institute.

†[The Edison-Brown bond and amalgam were described in Mr. Baylor's recent Paper read before the Institution of Electrical Engineers.—ED. *E.*]

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The great objection to the Crown and Columbia, &c., type of bonds consists chiefly in the mechanical defects inherent in them. The vibration of the rail, with the play of the rail joint, results in a continual stress upon the small area of the contact, followed by the final loosening of the bond. The writer has removed bonds of the above types, which had been in service only a couple of years, that had become loose, and the continual movement had worn the bond approximately ¼in. smaller in diameter in places. The Bryan bond and those types which are flexible, and particularly the Edison-Brown type, are free from such mechanical defects.

While it was not the purpose of the writer to make the tests herein outlined to demonstrate the virtues of the Edison-Brown, still the results were so pronounced that especial stress is laid upon them, particularly since practical experience has demonstrated their permanency. It will be noticed the "plastic cork" type of Edison-Brown bond gave the lowest resistance of any of the bonds tested.

Conclusions.—The Edison-Brown plastic cork bond is the best. The Standard bond under the fishplate is excellent, but is difficult to place. The Bryan bond is the best around fishplate type of bond—both electrically and mechanically—provided, however, that the bond is thoroughly amalgamated with the Edison-Brown alloys. The Crown and Columbia types of bonds would not be so objectionable if stranded, and the strands protected from electrolysis. The Crown type of bond is rendered materially efficient by the use of the Edison-Brown alloys, while the Columbia type is only benefited slightly. In both instances the Columbia is the better. Iron wire bonds are highly inefficient.

Discussion.—The general trend of the discussion following the reading of this Paper was to the effect that rail bonds under fishplates, while good so far as electrical results were concerned, were hard to place, owing to mechanical difficulties. The discussion further brought out the fact, which was not mentioned in the Paper, that the schedule or table of tests was in each instance made from an average of 10 tests each upon each of the bonds.

ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Bedford (Municipal)	March 4	Notting Hill (Company)	March 11
Dover (Company)	March 11	Richmond (Company)	March 4

We deal this week with the accounts of the County of London and Brush Provincial Electric Lighting Company (Limited), with which are concerned the electric supply system of Clerkenwell and St. Luke, and also that of Wandsworth. Owing to the fact that in some respects the one body of accounts deals with these two concerns conjointly, while in other respects they are dealt with separately, we are compelled to depart somewhat from the usual form in our table of costs.

County of London and Brush Provincial Electric Lighting Company (Limited).

Dealing first with the accounts of the combined undertakings, we may notice that, out of an authorised capital of £800,000, some 20,000 £10 Preference shares and 40,000 £10 Ordinary shares have been issued. The loans against securities represent £29,700. The capital received has been appropriated to (1) the Clerkenwell and St. Luke Order, (2) the Wandsworth Order, (3) £517 to the Camberwell Order, (4) to loans to and investments in a number of provincial electric supply concerns, &c. Particulars of these appropriations are set forth in the subjoined table. It will be seen that the business and revenue of the Company are represented by much more than the two undertakings under its direct control, the net revenue from these two sources being only 18 per cent. of the aggregate net revenue, while no less than 65 per cent. is covered by profits made by the realisation of investments. Perhaps it was the uncertainty of ever again making a correspondingly large profit on investments that led the Directors to carry forward £10,091, instead of paying a dividend on the Ordinary shares.

As regards the operations of the Company in the County of London, the area controlled is the largest of any of the metropolitan supply companies. The portions of this area wherein supply has been actually commenced comprise a small area in the north of London, including the parishes of Clerkenwell and St. Luke, and a very much larger area in the south, comprising Putney, Wandsworth, Balham, Clapham, Streatham and Tooting Graveney. Works are in progress over an extensive area in Camberwell and adjoining parishes, and are projected in an extensive district in the east of London, including Mile End, St. George-in-the-East, and Limehouse, as well as in a smaller area embodying the districts of St. Giles, Bloomsbury, and adjoining parishes.

Further particulars of the financial and other developments of the Company will be found in our report this week of the ordinary general meeting held on Monday last.

County of London and Brush Provincial Electric Lighting Company (Limited).

Items.	1896.	1897.
CAPITAL :—		
Authorised Capital	£800,000	£800,000
Share Capital received	386,520	509,808
Loans received	53,650	29,700
Reserve Fund	3,500	5,000
Capital appropriated to Clerkenwell Order	155,597	214,258
Capital appropriated to Wandsworth Order	117,127	196,544
Capital expended in lands and buildings	10,311	10,363
Capital invested and advanced to the Bournemouth, Dover, Richmond and Coatbridge Electric Supply Companies	172,431	104,040
REVENUE :—		
Gross Revenue	8,456	25,371*
Revenue from Interest on Investments, &c.	5,538	6,859
Revenue from Clerkenwell Department	1,145	2,522
Revenue from Wandsworth Department	nil.	1,281
Revenue from sundry sources	1,773	14,709*
EXPENDITURE OUT OF REVENUE :—		
Total	2,581	4,496
Proportion of Directors' Fees, Salaries, Wages, Rents, Rates, Taxes and Insurance	1,561	2,225
Miscellaneous Charges	1,020	2,271
FINANCIAL RESULTS :—		
Balance carried to Net Revenue Account	5,905	20,875*
Balance from last Account	1,209	526
Sum available for Distribution	7,114	21,401
Dividend on Preference Shares	6%	6%
Dividend on Ordinary Shares	nil.	nil.†

Clerkenwell and St. Luke Department.

Turning now to the affairs of the electric supply department at Clerkenwell and St. Luke, a statement and analysis of the accounts of which will be found on the opposite page, we observe that the past year's work shows a very considerable improvement on the previous—and first—year of operations. To begin with, although a lower scale of charges has been in operation, the earning power per kilowatt-capacity has increased from £1. 19s. 7d. to £3. 19s. 2d., or practically 100 per cent. Correspondingly, the total cost of working has increased from £1. 6s. 10d. to £2. 11s. 2d. per kilowatt-capacity, or only about 90 per cent. Hence the percentage of total costs to gross revenue has fallen from 67·9 per cent. to 64·7 per cent. Regarded from the point of view of the output, the aspect is also favourable. Thus the "total costs per unit sold" have fallen from 5·56d. to 4·26d., or 23·3 per cent.; and the "works-costs per unit sold" have fallen from 5·50d. to 3·90d., or nearly 30 per cent., though this is chiefly owing to the altered conditions of working, a certain proportion only of the energy supplied in 1897 having been purchased before the works were got into operation, while the whole of the energy supplied in 1896 was thus acquired. The net earning power of the department for the year 1897 is represented by 1·86 per cent. of the mean capital expended.

Wandsworth Department.

About the Wandsworth department there is little to be said, by way of comment, since the works had been in operation not quite a year when the last accounts were made up. A very fair start, however, has been made, the revenue of £3. 14s. per kilowatt-capacity being a good showing for so youthful a concern. Not less satisfactory is the 61·6 per cent. ratio of expenditure to gross revenue. Indeed, the Wandsworth electric supply system gives good promise of showing an excellent result at the end of the current year.

* Includes £13,691, profits on investments realised.
† Balance of £10,091 carried forward.

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	CLERKENWELL.	WANDSWORTH.
Undertaking Worked by	County of London and Brush Provincial Electric Lighting Company (Limited).	County of London and Brush Provincial Electric Lighting Company (Limited).
Date of Commencement of Supply	1896.	January, 1897.[a]
System of Supply	For lighting—Alternate-current with transformer sub-stations. For power – Continuous-current.	High and extra high-pressure feeders and transformer sub-stations, feeding 2-wire low-pressure network.
Chief Engineer	A. J. Lawson.	A. J. Lawson.

YEAR ENDED DECEMBER 31st.	1896.	1897.	1896. Station not in operation.	1897.
QUANTITIES—				
Units generated	143,442	333,140[g]	...	162,151
„ SOLD (TOTAL)	104,640	260,572	...	116,821
„ sold to consumers	104,640	260,572	...	116,821
„ sold for public lighting, &c.	nil	nil	...	nil
„ used on works	1,540	4,865	...	5,689
UNITS SOLD PER 8 C.P. LAMP CAPACITY	1·74	4·34	...	3·90
Maximum supply demanded	160 kilowatts	322 kilowatts	...	251 kilowatts
Number of public lamps	nil	nil	...	nil
Connections to mains in 8-c.p. lamps	14,179	23,757	...	13,907
CAPACITY OF PLANT IN 8-C.P. LAMPS	60,000	60,000	...	30,000
CAPACITY OF PLANT IN KILOWATTS	1,800	1,800	...	900
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	—[b] —	—[b] —	... ...	—[b] —
Share	—[b] —	—[b] —	... ...	—[b] —
Loan (including Debenture charges)	—[b] —	—[b] —	... ...	—[b] —
RECEIVED (TOTAL)	£155,597[c] £86·5	£214,258[c] £119	... ...	£196,544[c] £218
Share	— —	— —	... ...	— —
Loan (including Debenture charges)	— —	— —	... ...	— —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	—[b] —	—[b] —	... ...	—[b] —
Share (unissued)	— —	— —	... ...	—[b] —
Share (uncalled)	— —	— —	... ...	—[b] —
Loan (including Debentures)	— —	— —	... ...	—[b] —
REPAID (TOTAL)	— —	— —	... ...	— —
RESERVE OR SINKING FUND	—[b] —	—[b] —	... ...	—[b] —
DEPRECIATION FUND			... ...	—[b] —
EXPENDED (TOTAL)	£155,597 £86·5	£214,258 £119	... ...	£196,544 £218
Lands and buildings	52,257 29·0	65,159 36·2	... ...	56,080 62·3
Plant	46,786[d] 26·0	74,041[h] 41·1	... ...	42,924[d] 47·7
Mains	53,329 29·6	69,330 38·6	... ...	93,505 104
Miscellaneous	3,225 1·79	5,728 3·18	... ...	4,035 4·48
BALANCE OF CAPITAL ACCOUNT	— —	— —	... ...	— —
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£3,567 8·19d.	£7,141 6·58d.	... ...	£3,328 6·86d.
Revenue from supply	3,022 6·94d.	6,555 6·03d.	... ...	3,103 6·38d.
„ meters, &c.	122 0·280d.	255 0·235d.	... ...	128 0·263d.
„ public lighting	nil —	nil —	... ...	nil —
„ sale of lamps, &c.	nil —	nil —	... ...	nil —
„ miscellaneous sources	423 0·970d.	331 0·306d.	... ...	97 0·199d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,422 5·56d.	£4,619 4·26d.	... ...	£2,047 4·21d.
WORKS COSTS	2,400 5·50d.	4,229 3·90d.	... ...	1,726 3·55d.
Generation of electricity	*2,400[e] 5·50d.*	*4,116[k] 3·79d.*	... ...	*1,726 3·55d.*
Fuel (including cartage, &c.)	— —	752 0·692d.	... ...	742 1·52d.
Oil, waste, water, stores	— —	136 0·125d.	... ...	80 0·164d.
Wages at station	— —	418 0·385d.	... ...	840 1·73d.
Repairs and maintenance at station	— —	52 0·048d.	... ...	65 0·134d.
Distribution of electricity	— —	*113 0·104d.*	... ...	— —
Wages, &c.	— —	107 0·099d.	... ...	— —
Repairs, renewals of mains, &c.	— —	6 0·006d.	... ...	— —
Public lighting	— —	— —	... ...	— —
Attendance	— —	— —	... ...	— —
Renewals	— —	— —	... ...	— —
MANAGEMENT AND PROPERTY CHARGES	£22 0·051d.	£390 0·359d.	... ...	£321 0·660d.
Royalties	— —	— —	... ...	*nil* —
Rent, rates, taxes	— —	*218 0·201d.*	... ...	*16 0·033d.*
Management	*£22[f] 0·051d.*	*171 0·157d.*	... ...	*305 0·627d.*
Salaries	— —	41[f] 0·038d.	... ...	110 0·226d.
Stationery, &c.	— —	60 0·055d.	... ...	76 0·156d.
Establishment charges	— —	59 0·054d.	... ...	76 0·156d.
Law charges, &c.	— —	11[m] 0·010d.	... ...	43[e] 0·088d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to cap. exp'nded
WORKING PROFIT FOR YEAR	£1,145 0·998%	£2,522 1·36%	... ...	£1,281 0·652%
Sum carried to Depreciation Fund	—[b] —	—[b] —	... ...	—[b] —
Sum carried to Reserve or Sinking Fund	—[b] —	—[b] —	... ...	—[b] —
Net interest on loans (incl. Debenture charges)	—[b] —	—[b] —	... ...	—[b] —
BALANCE FROM LAST ACCOUNT	nil —	—[b] —	... ...	— —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	—[b] —	—[b] —	... ...	—[b] —
Deficit	— —	— —	... ...	— —
ORDINARY DIVIDEND PAID	—[b] —	—[b] —	... ...	—[b] —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	67·9%	64·7%	...	61·6%
Expenditure per kilowatt capacity	£1. 6s. 10d.	£2. 11s. 2d.	...	£2. 5s. 6d.
REVENUE PER KILOWATT CAPACITY	£1. 19s. 7d.	£3. 19s. 2d.	...	£3. 14s. 0d.
Expenditure per 8-c. lamp capacity	9¾d.	1s. 6¼d.	...	1s. 4½d.
REVENUE PER 8-C.P. LAMP CAPACITY	1s. 2¼d.	2s. 4½d.	...	2s. 2½d.
Price charged for lighting, per unit	7d.	6d.[n] (1 hr.) – 2d.[n]	...	7d.[f] (2 hrs.) – 3d.[f]
Price charged for power, per unit	7d.		...	
Price charged for public lighting, per lamp	—	—	...	—

CLERKENWELL.—REMARKS—*a* Purchased. *b* See accounts of the County of London and Brush Provincial Electric Lighting Company. *c* Appropriated to this Order from the capital of the Company. *d* Includes £7,554 for transformers, &c. *e* For purchase of current. *f* Audit fees. *g* Proportion purchased not stated. *h* Includes £8,550 for transformers, &c. *k* Includes £2,758 for purchase of current; generation commenced September 8, 1897. *m* Insurance. Maximum demand system.

WANDSWORTH.—REMARKS—*a* 24-hours' supply commenced in September. *b* See accounts of the County of London and Brush Provincial Electric Lighting Company. *c* Appropriated to this Order from the capital of the Company. *d* Includes £7,648 for transformers, &c. *e* Includes £10 for insurance and £33 for auditing. *f* Maximum demand system.

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The question of the advisability of changing over from 100 to 200-volt supply is occupying the attention of central-station engineers and consultants more than any other at the present moment, and it is to be regretted that the Council of the Institution of Electrical Engineers have not thought fit to give greater facilities for its discussion this session. The space of two evenings may certainly be sufficient time to devote to the reading and discussion of a Paper interesting to but a small fraction of the membership, but a third or even a fourth evening might advantageously have been allotted for the discussion of a subject involving important issues with wide application, in which no less than five branches of electrical engineering—consultants, central-station engineers, makers of lamps and fittings, and contractors—are directly interested. No doubt the Council are well provided with valuable Papers for the remainder of the session, but we would point out that Papers, more important than at least one of those already read since the summer vacation, have ere now been printed in the Institution *Journal* without being first read at a meeting. In the case of the Paper under consideration it will be the major part of the discussion that will be presented for the first time in the *Journal*, as, responding to the invitation of the President, most of the speakers communicated only a portion of their remarks to the meeting, and others reserved the whole of them.

Coming now to the Paper itself and to that part of the discussion which we have already heard, it is evident that nearly everything in 200-volt supply depends on the incandescent lamp. If the average 200-volt lamp cannot eventually be made nearly as efficient and cheap as the present lamp, with as long a life and as good a life-curve, it would be better for the electrical industry to drop it and adopt the compromise of a 150-volt pressure, suggested *en passant* by Mr. Addenbrooke in his Paper a year ago and actually adopted at Leyton. During the discussion which followed Mr. Addenbrooke's Paper, however, the lamp-makers were very sanguine as to their capability of producing this *desideratum;* but now the

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confessions made by Mr. Byng and Mr. Robertson of the difficulties experienced in the manufacture of high-voltage lamps, and other speakers' statements as to its unreliability and the considerate treatment it demands, show that it has not yet reached the same standard of excellence as its low-pressure rival. There is very little doubt that the 100-volt lamp will always be better than the one for higher pressure, but we think that the difference between the two in the qualities we have named will tend to diminish, and that we are not far distant from the time, even if we have not already reached it, when the saving in mains and the increased facilities of distribution will quite counterbalance the disadvantages of the new type of lamp. The 200-volt lamp will supersede the 100-volt, just as the latter has superseded the 50-volt lamp. It is not very long ago since there were numerous advocates of the latter; in fact, there is a little town in Ireland still being lit from a 50 volt low-pressure network. One speaker last week actually regretted that 50-volt circuits had fallen into desuetude, but we doubt whether he has many supporters, except among those holding shares in copper mines.

None of the representatives of the lamp-manufacturing firms told us just where the question of cost came in, but this may, perhaps, be inferred from some of the remarks made. For instance, although Mr. Stearn affirmed that there was no difficulty in making a lamp with a filament of "treated" carbon 16in. long, bent into a sinuous shape, and contained in a bulb no larger than that of the ordinary 100-volt lamp, he yet found it necessary to plead an able and elaborate defence for the "untreated" filament, and to recommend its adoption, at all events provisionally. Again, Mr. Robertson tells us in his communicated remarks that, using "flashed" or "treated" carbon, "the 220 and 250-volt lamps require bulbs ¼in. to ⅜in. larger in diameter," although his firm is "quite prepared to supply 220 to 250 flashed filaments in the usual bulbs." This would point to the advisability of using two grades of lamp or two sizes of bulb at different prices. If we may hazard a surmise, might not some thoughts such as these be passing through the minds of the manufacturers? "Owing to competition, the prices of 100-volt lamps have been ruinously reduced; higher prices are still expected for higher-voltage lamps, but if these lamps cost us proportionately more to produce we are no better off than before; it behoves us, therefore, to cheapen the manufacture of these latter, either by using untreated carbon and saving one process, or by reducing the mechanical difficulties in construction by the use of a larger bulb." But it is not solely as a means of raising the price of lamps that the lamp manufacturers welcome the higher pressure in spite of the difficulties in lamp construction. A 200-volt supply implies at present considerably less percentage variation in the terminal volts, which, given equally good filaments, brings with it a considerable increase in the life of the lamps and an amelioration of the life-curve. But those who favour high voltage must bear in mind that the diminution in the percentage variation and voltage is only a momentary phase; the variation will gradually increase to its former value, for there is no reason to doubt that central-station engineers will continue to economise copper as heretofore. An increase in the size of lamp-tops was recommended in the Paper, but here again Mr. Stearn differed from Mr. Byng, maintaining that the present size sufficed for 200 volts. This would probably not be so in damp situations, and in such places a return to the old-fashioned acorn socket is well worthy the consideration of contractors. Before leaving the question of incandescent lamps we would refer briefly to recent investigations with new material for filaments. Mr. Byng and other speakers spoke disparagingly of combination filaments, whereas Mr. Miller stated that "there was no difficulty in getting a high-efficiency lamp with such a filament at 2½ watts to give equally good results in durability and candle-power as an ordinary best quality carbon filament working at 3½ watts. Such a result had been obtained in practice." It would be interesting to hear more about these lamps from Mr. Miller. Experimenters on novel forms of lamps might follow up the lines on which Prof. Nernst has been working (see *The Electrician* of March 4th, p. 614), as something useful might come of his suggestive experiments, much to the disgust of continuous-current station engineers. Switches and fuses were ably dealt with in Mr. Byng's Paper, and in the remarks of Messrs. Crompton, Wordingham and Miller. We would only add that it is time that the use of clip fuse-holders (in which a fuse can be replaced by anyone while the circuit is otherwise closed) became universal, even if we do not aspire to make fuses for various currents non-interchangeable, as the Verband Deutscher Elektrotechniker are striving to do in Germany.

Coming now to arc lamps, we regret that more was not said in the discussion about their behaviour on 200-volt circuits. There can be no doubt that the adoption of 200-volt continuous-current supply will tell against the employment of arcs singly and in pairs. While not agreeing with Mr. Byng that the stability of the arc is to any great extent influenced by the cooling surface, we, of course, recognise that it is a property of the arc to be less stable at low currents, and we are at one with him as to the disadvantage of crowding too many arcs in series on a constant potential circuit, using short arcs and small steadying resistances. But both these points should already be known to central-station engineers. The difficulty of the shunt coils of lamps burning out is also a real one, in spite of Mr. Crompton's assurance that all the troubles and difficulties enumerated in the Paper were overcome in practice. Shunt coils of series of lamps across constant pressure mains still burn out, and undoubtedly from the cause stated by Mr. Byng. His device of a temperature fuse as a cut-out is ingenious and simple, and should remove the difficulty, but in our opinion an electromagnetic "cut-in" is an unnecessary complication. If the feed of a lamp is faulty, attention should be called to it at once, and it should be adjusted.

OBITUARY.

SIR HENRY BESSEMER, F.R.S.

It is with great regret that we announce the death, on Tuesday evening last, of Sir Henry Bessemer, the celebrated ironmaster and inventor of the process associated with his name for the manufacture of steel.

Henry Bessemer was born on January 19, 1813, at Charlton, in Herts, and was thus in his 86th year at the time of his decease. From his early youth he displayed marked inventive ability and a fondness for modelling and mechanical science. His inventions were numerous and extended over a wide field. No less than £10,000 was spent by him in patent fees, for inventions ranging from a process for making gold paint to the manufacture of steel or the construction of telescopes or steamboats. Electrical engineers are chiefly indebted to Sir Henry Bessemer for his process for manufacturing steel from cast iron, a process which has both cheapened and improved the quality of commercial steel. For a long time his practical researches were ridiculed by steel makers, but fame came at length, and nowadays the number of Bessemer converters in active work is almost countless, while Bessemer steel is adopted for every class of engineering work where steel is required. The first English recognition of Bessemer's work came from the Institution of

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Civil Engineers, who awarded him a Telford gold medal in 1859. In 1871-73 he was president of the Iron and Steel Institute, and founded a gold medal to be given annually for the most important improvement of the year in the manufacture of iron or steel. The Society of Arts awarded him their Albert gold medal in 1872, and in 1877 the Civil Engineers made him a member of their body, at the same time presenting him with the first Howard quinquennial prize. Two years later he became a Fellow of the Royal Society and received the honour of knighthood, while in 1880 he was presented with the freedom of the City of London. From abroad he received many honours. He was offered the Grand Cross of the Legion of Honour, but as permission to wear it was refused he had to be content with a large gold medal given him by Napoleon III. He was an honorary member of the Iron and Steel Board of Sweden, a freeman of the city of Hamburg, an honorary member and gold medallist of the Society of Arts and Manufactures of Berlin, and a Grand Cross of the Order of H.I.M. Francis Joseph of Austria.

REVIEWS.

Elektromechanische Konstructionen. By GISBERT KAPP. (Berlin: J. Springer, and Munich R. Oldenbourg.)

The question is often asked, not only by students of electromechanics, but by those actually engaged in the design and manufacture of such machinery—Which, among the many text-books on the subject, is a reliable up-to-date work, treating on the design and construction of electromechanical machinery, and at the same time is not crowded on every page with higher mathematics, but contains only the practical deductions of mathematical investigations? The answer, for those who can read German, is "Elektromechanische Konstruktionen," by Gisbert Kapp. Unfortunately for many English readers this book is written in German, but this should offer no serious obstacle to anyone with a fair knowledge of German grammar, a technical dictionary, and previous acquaintance with the subject of the work, without which latter no one would have the inclination to study it. Perusal of the work before us reveals the amount of knowledge and skill concentrated on the design and construction of electrical machinery by British and Continental engineers, and the success which attends their efforts; especially with multiphase generators and motors. The success of foreign engineers in the latter class of machinery, however, is no more due to their capabilities than to the natural development consequent on the greater demand for them on the Continent than occurs in those countries where natural water power is not so plentiful, and where fuel is much cheaper. These observations are somewhat outside the subject under review, but when it is found that of all the machines described in the book only one is by an English firm, the question naturally arises—Are British manufacturers holding their own in these classes of machinery? On the other hand, it may have been that the author was unable to acquire further information about British manufactures.

The size of the volume before us is nearly super royal quarto, which, though slightly awkward, is necessary from the size of the numerous plates, which could not well have been folded smaller. The letterpress extends over 200 pp., with a wide margin useful for notes. The plates are bound together, but are detachable from the rest of the volume. The subject-matter naturally divides itself into three parts: (1) a collection of notation, formulæ and text figures, with sufficient explanatory text to show their particular application—these may be called the axioms and postulates, for they must be taken for granted; (2) a description of examples of electrical machinery and apparatus for the transmission of power, with the calculations necessary for deciding the dimensions of the parts from the given data, where possible, and a synthetical treatment of the many conflicting conditions for the determination of the remainder; or an analysis of some machine from its given output or power and dimensions, without other data; (3) a collection of plates of the machinery and apparatus discussed in the second part.

The collection of formulæ is at first somewhat disappointing to one who is searching for the principles which form the basis of all electrical calculations, for no attempt whatever is made to give their derivation; they simply form a key to the second part of the book. This book, as the author says, is not intended so much for students as for practical workers, all of whom, it is assumed, have obtained already a deep knowledge of the subject, and it must be acknowledged that this is very reasonable. The formulæ are applicable to a wide range of investigations, including those for the resistance, heating, and weight of wire (the author does not name the metal the resistance and heating of which is required, but he evidently means copper) transformers, continuous and alternating-current machines, multiphase generators and motors, diameter of shafts and size of bearings, &c. The limitation of the formulæ for transformer work makes them of little use to the average designer, and consequently of much less use to those who study design with a view to possible improvements. It is asserted by the author that if the conditions of working of some well-constructed type of transformer of normal output be known to the designer, then the weight, cooling surface, output, and efficiency of a transformer of the same type, m times larger, can be found by proportion, when the ratio $1:m^{+x}$ is known for the different properties. These ratios are given in a table for three different conditions of cooling. This is all very well, but affords little assistance in the design of a transformer when the output and working conditions are fixed. No mention, by-the-way, is made of polyphase transformers. A formula for centrifugal force would not have been out of place with those for the diameter of shafts and size of bearings, as the effects of the force may be so detrimental to smooth and economical working. The formula $F=\frac{U^2R}{90,000}$ could have been given, where F is the force acting on unit weight at a point R cms. from the axis of rotation, with U revolutions per minute. This equation is used on page 114 in a slightly more accurate though not so workable form, but the decimal point is placed wrongly, as the dimensions are given in centimetres; it requires to be moved two places to the left. Many of the formulæ would have been more readily understood if accompanied by a diagram. Nos. 24 and 25 are cases in point, being respectively $e=Nz\frac{U}{60}10^{-8}$ for *parallel*-wound armatures, and $e=pNz\frac{U}{60}10^{-8}$ for *series*-wound armatures, with p pairs of poles, both referring to continuous-current machines. The same might also be said of Nos. 39 and 80. It might be argued that every designer understands their application; but if that is so, are they wanted at all?

Formulæ 36, 37, 78 and 79 are useful approximations for the output, from the dimensions, of continuous and alternating-current dynamos respectively, and 84 gives the brake horse-power of rotary field motors: but why 36 and 84 contain the detestable 10^{-6} instead of 10^{-8} when the constant C can only be decided by experience, it is hard to imagine. There are 97 formulæ altogether, and they are referred to by number in Part II. whenever occasion requires. Taken together, they are very comprehensive, and indicate that sound judgment and great patience have been exercised by the author in their selection, explanation, and, above all, in presenting them generally in a workable form, this being particularly noticeable in those for rotary field motors.

It is, however, the second part of the work which will appeal most directly to practical men, for, as before stated, this consists of the complete analysis of actual machinery, or the actual calculations for the designs of others. It is these calculations which greatly enhance the value of Part I. by showing exactly how, when, and where the formulæ are to be used. As the author says: "These calculations of examples are not worked out with mathematical exactitude, but only with that approach to accuracy which suffices for practical needs, and which can be obtained without special care with a slide rule."

Proceeding to examine the plates (25 in number), it is found that there is hardly a commercial type of motor or generator absent, while there are besides several transformers

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and one type of battery-charging switch. The plates are very good on the whole, but in some cases are incomplete. The author has devoted several pages in the first part of the book to general arrangements of windings, but the accompanying diagrams are incomplete both separately and collectively; and the absence of diagrams, with two exceptions, from the plates illustrating particular machines under discussion, is unpardonable; for of all things which appeal to an engineer a diagram stands first, and it is a diagram of windings and connections which appeals mostly to an electrical engineer. The value of the book to those for whom it is evidently intended is considerably diminished by these omissions. Take, for example, the machines on Plates I. and XV. These are both three-phase generators, but of different types and voltage, and both have star coupling, but the first has two contact rings, the other three. Now, the reason of this would not at first sight be clear to a man with only a slight knowledge of the subject; but two simple diagrams would have made this clearly and quickly understood.

As the calculations are in C.G.S. units the absence of English scales on the first five plates is immaterial, but a word of caution is necessary regarding the scales on about one-third of the number of plates, where the misleading practice is adopted of sub-dividing the first division of the numbered scale instead of sub-dividing an extra division. The drawings appear to be made to scale, but the insertion of a few leading dimensions on all the plates would have been serviceable.

In the description of the machine shown on Plate I., which is a 100 kilowatt rotary current three-phase generator with fixed armature, the author discusses the effect of centrifugal force on the bearings, if the revolving part is out of balance, and the effect of ordinary wear in the journal on the magnetic attraction between the armature and the poles. These are very important points to be discussed, for they are apt to be slurred over by the electrician who is not at the same time a mechanic. The author states that a wear of 1mm. in the journal would add 30 per cent. to the weight on it, and if to this is added the effect of centrifugal force due to want of balance of 2½ per cent. of the weight, the amount of pressure on the bearings is more than doubled. These considerations are taken into account in determining the diameter of the shaft. The special feature of the machine on Plate II. is the arrangement adopted by the makers whereby a segment of the armature ring, with its winding, can be detached, and replaced by another from stock without interfering with any other part, suitable where skilled labour for repairs is not readily obtainable. The author also goes into the effect of the small air-spaces which naturally occur between any two segments. An important point connected with the railway generator shown on Plate V. is the arrangement for keeping the armature cool, as the output is necessarily sometimes very high. The description and calculations of the tramway motor shown on Plate VI. will be found to be specially interesting and instructive, as the author goes thoroughly into the question of the gradients of the line, the speed of the car and the draw-bar pull, and the consequent effect on the design of the motor. The two-phase alternating-current generator shown in Plate IX. is another machine in which the segments of the armature ring can be detached with its winding.

On Plates XIII. and XIV. is represented a 624 kilowatt continuous-current generator, with equi-potential connections of the armature or so-called Arnold's parallel winding. The armature is 322cm. in diameter and 31cm. long, and the author shows that this is an economical proportion for output in relation to weight. A diagram of this special winding would have been more readily understood than the meagre description given. Plate XV. shows a 210 kilowatt rotary current three-phase generator. The armature, which in this case revolves, as the volts are low, is drum wound, as for a continuous-current machine, and the number of bars is, of course, a multiple of three. The winding is tapped in three places to form star coupling. One end of each phase of winding is taken to a contact ring on the shaft for the brushes, while the other ends are each brought to a smaller ring.

Plates XVI. and XVII. represent a 200 kilowatt rotary current three-phase generator in which the armature and field winding are stationary, while laminated core pieces, which project horizontally from the periphery of a flywheel, revolve in the annular space formed between the two pole rings. Extra precautions have to be taken to insure a firm attachment of the core pieces to the flywheel. The whole machine is compact, as one bearing is placed inside the magnet rings and is supported by them. Plate XVIII. is the only example given of a rotary field motor or induction motor. It is for 75 B.H.P., runs at 560 revolutions with 50 ∿ at 2,750 volts per phase. The field is wound in star circuit. The description of this machine with the calculations and diagrams is probably the best things in the book, and will be a revelation to those whose knowledge of the subject stops at a single-phase alternator. Plate XIX. shows a 150 kilowatt single-phase generator—the only English-built machine among the number. It is a disc armature without a core, and the magnets are separately excited by a continuous-current dynamo mounted on the same spindle. A special feature of this machine is the ready accessibility to the armature coils. The author might well have given drawings and descriptions of both generators and motors in some particular installation, because the description of each would have become doubly valuable by reason of its relation to the other. This does not seem to have been done in any case.

It must not be supposed that because other machines are not mentioned they are not noteworthy, for this is far from being the case. Useful information and examples are found on every page, and the book will certainly find its way into the hands of all who wish to keep their knowledge of the design of such machines up to date. This book forms an admirable continuation volume to one on the transmission of energy by the same author. H. J. F.

"Specification." A Quarterly, No. 1, 1898. (London: The Proprietors of "The Builders' Journal and Architectural Record.")

This is a publication for the use of architects, engineers and surveyors, to facilitate the drawing-up of specifications. Containing, as it does, a great number of facts and notes relative to building and engineering, together with numerous forms of specification and precedents for clauses, the objective in view for this quarterly, which is to be revised and enlarged at each issue, should be in great measure fulfilled. The greater portion of the book is devoted to the first of the three divisions into which it is divided—that of "Construction." This division is subdivided among the various trades, each to be dealt with generally in three respects: by useful notes on material and construction, followed by specimen specification clauses and a glossary of English, Irish and Scotch technical terms. Passing to the sections more strictly of interest to engineers, those under the headings "Structural Engineer" and "Mechanical Engineer" contain much handy information, that of the latter being, however, limited chiefly to the erection of engines and boilers. The section "Electrician" is somewhat limited, having regard to the importance of the subject. As is to be expected in a work of this nature and origin, the notes and specimen clauses referring to incandescent lamp wiring and installation fittings are the most useful and reliable. We are sorry, however, to see included in the small wiring table given a No. 12 solid conductor as suitable for 18 lights, thus implying to the uninitated that its use is sanctioned, while not till under the specification clauses is the use of a larger solid insulated conductor than No. 16 prohibited. Some of the notes referring to arc lamps would, to the class they are directed, prove somewhat misleading, while many of the definitions of electrical terms contained in the glossary need speedy revision. Division II. is devoted to "Notes on Professional Practice," and contains varied information difficult to classify under the usual trade headings. Of Division III. it may merely be mentioned that it contains illustrations of architectural designs, and therefore is of little interest to engineers.

It would be distinctly unfair to judge this, the first number of "Specification," in too critical a spirit; we prefer to look upon it as a nucleus to be added to and revised at each succeeding issue, and, we think, to thus become an indispensable work of reference for the architect and engineer.

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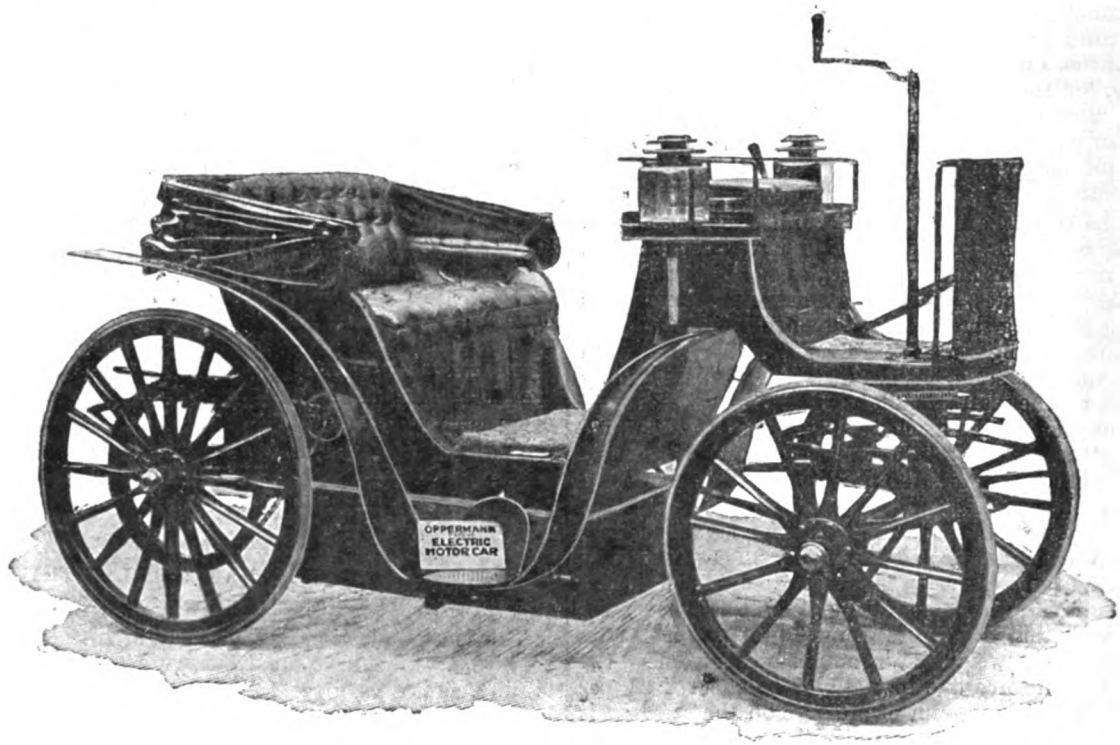
THE OPPERMANN ELECTRICALLY-PROPELLED MOTOR CAR.

The annexed illustration shows the latest pattern of electrically-driven motor car, as devised by Mr. Carl Oppermann. This vehicle has been a conspicuous object in the streets of Paris during the past two months, where it appears to have performed feats difficult for either a horse or a motor. Thus, it is said to have ascended the Montmartre Hill with four passengers, and to have successfully climbed a 14½ per cent. gradient. In view of this claim further information as to the construction of the vehicle will be awaited with interest by English engineers, who will also be glad of an opportunity to test the car which it is stated to be Mr. Oppermann's intention shortly to put on the streets of London. The principal objects the inventor has held in view in designing and perfecting this pattern of motor car have been, firstly, freedom from vibration and noise; secondly, simplicity of construction and control, together with a high efficiency in commercial work. The control of the motors is effected without the use of resistances, the controller allowing of six different grades of speed. Moreover, the reversing gear and electric brake are controlled by one and the same lever. There are also two powerful band brakes on the rear wheels. The motor is carried on a steel frame suspended under the seat, and drives, by means of gearing, an intermediate shaft carrying a differential gear; this shaft drives two chain gears actuating sprocket wheels on the rear wheels of the vehicle. The weight of the vehicle is 28cwt., of which 12cwt. is accounted for by the accumulators.



The Oppermann Electric Motor Car.

WATER RHEOSTATS.

The following considerations respecting the setting up of water resistances for artificial loads are abstracted from an article under the above heading in the *Journal of Electricity* of San Francisco. Whenever it becomes necessary to load generators or prime movers up to full capacity, and, further, when it is necessary or desirable that the load shall be non-inductive, the suitability of water rheostats is universally recognised as applicable for all conditions of load and pressure. Pure water is of very high resistance, and it is necessary in absorbing energy under low pressure to increase the conductivity by the addition of common salt, or, preferably, sulphate of soda. The solution of common salt has the disadvantage that its increase of conductivity with rise of temperature is much greater than that of a solution of sodium sulphate. Foaming does not occur in properly-manipulated rheostats, either when common salt or sulphate of soda is used, but it almost invariably arises when barrels are impressed into service, probably for the reason that oil barrels are generally used, and the traces of oil saponifies with the soda.

As illustrating the use of water rheostats, mention may be made of the test made to determine the efficiency of a set of Girard wheels that are direct-coupled to a 450-kilowatt 500-volt three-phase generator at Bakersfield, Cal.

The water rheostats consisted of three separate redwood tanks, each measuring 4ft. by 4ft. by 6ft. in size, and each containing two sheet-iron electrodes of such size as to give 5in. in the clear when suspended in the tanks. Three of the six electrodes, one from each tank, were coupled together in short circuit, while the three legs from the three-phase generator were each taken to the remaining electrode of its respective tank. Each phase, therefore, was in this manner provided with an independent rheostat which was capable of absorbing 150 kilowatts. The amount of load on each phase was regulated by varying the separation between the electrodes of its particular tank, and so well proportioned was the amount of sulphate of soda placed in the tank that the rheostats would carry a load of 500 H.P. for three hours or more without boiling.

It should be emphasised that it is unnecessary to increase the conductivity of water except for potentials below 1,000 volts, and that the absorbing of energy under high potential is, in some respects, a more simple matter than at low potentials. At high potentials the conductivity of the water is not increased or altered in any way, and the amount of the resistance is gauged only by varying the separation between the electrodes. The operation of a water rheostat absorbing energy under high potential is well illustrated in the method pursued in the experiment made over the transmission plant of the Pioneer Electric Power Company. The water rheostats for this test were arranged precisely as in the Bakersfield test, the only difference being that each of the three tanks measured 8ft. in length by 3ft. in depth by 4ft. in width, and was mounted on three double-petticoat, deep-groove glass insulators. The electrodes consisted of ⅛in. sheet steel of such size as to give 1in. clearance on all sides. Each tank, moreover, absorbed 250 kilowatts at 2,300 volts, instead of 150 kilowatts at 500 volts, as in the Bakersfield experiment.

The distinguishing feature in the use of water rheostats for high potentials lies in the advisability of a constant circulation of water through the tank, in order to keep the temperature as low as possible, and, to a minor degree, to wash off the bubbles of oxygen and hydrogen from the electrodes, so that the resistance of the electrolyte may not be increased thereby. This circulation is accom-

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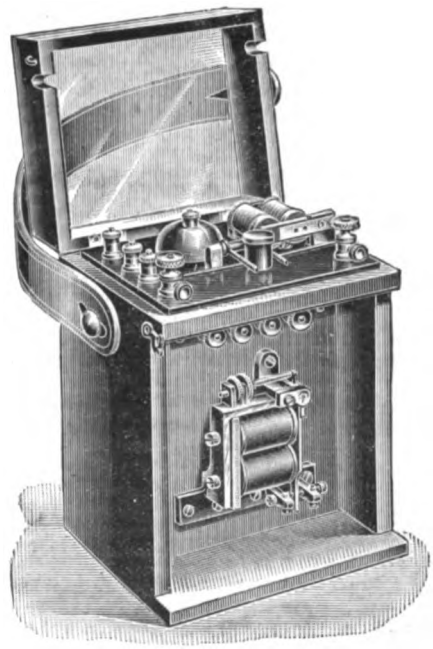
plished by running a stream of water into the tank through a hose, as obviously to carry the water to the tank through an iron pipe would ground the electrolyte—and grounds are never desirable. The overflow or waste from the tank is also carried off through a hose, the length of which, if the water is reasonably pure, and if the hose is of less than an inch in diameter, need not be more than 12ft. or 15ft. for potentials up to 2,500 volts. The water used in the test at the Pioneer plant was of unusual purity, being from the snows of the Wasatch range, a few miles above the plant, and so great was its resistance that no leakage to ground could be observed on holding the finger in the stream running from the outlet of the tank.

The water rheostat due to Messrs. Hitzeroth and Poole, and as used by the San Francisco Gas and Electric Company for testing 2,200 volt alternators and 10 ampere arc machines of various capacities up to 7,000 volts is very simple, consisting of a long wooden box, or trough, closed at the ends, and painted inside and out with P. and B. paint. In this trough are supported two electrodes of plate carbon. These electrodes each measure 10in. square, by ½in. in thickness, and are each perforated with 40 or 50 ½in. holes to facilitate the circulation of water. Fresh water from the city main is run into the tank continuously during use, through about 12ft. of ½in. rubber hose, and the waste water is let to the sewer through about the same length of hose, no grounding resulting from the arrangement. With this rheostat, as with all others, the conductivity of the water varies with its height in the tank and temperature, but when it is filled to within 2in. of the top, and after it has reached a practically fixed temperature, its resistance is such that with a potential of 2,300 volts, a separation of 10½in. between the carbon plates gives an approximate current of 20 amperes, 15½in. gives approximately 15 amperes, and 19½in. gives approximately 10 amperes.

A SIMPLE RECEIVER FOR WIRELESS TELEGRAPHY.

At the *conversazione* of the Institution of Junior Engineers, on Saturday last, Messrs. Miller and Woods exhibited a very simple form of receiver for wireless telegraphy, which they are now



Miller and Woods' Receiver for Wireless Telegraphy.

putting on the market. The pattern shown in the figure is intended for lecture purposes. The coherer is suspended in the middle of a stretched wire, and two small rods, with a screw thread on them, play over the wire like a fiddle-bow over the strings. These rods are attached to the armature of a bell, connected in the secondary circuit of the relay (seen in the front of the case), whose primary circuit is in series with a single dry cell and the coherer. A second cell is used in the secondary circuit. This form of decoherer has the advantage that the decohering action begins directly the armature moves, and continues during its whole travel to and fro. The coherer itself merely consists of a small ebonite cup, inside which the two wires on which it is suspended almost meet, the gap being bridged over by nickel filings. On Saturday a simple transmitter was employed, consisting of a 4in. solid brass ball, with a 1in. brass ball on either side. The spark-gap was comparatively short. Signals were transmitted from one end of the room to the other.

CORRESPONDENCE

SPARKING IN CONTINUOUS-CURRENT DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I much regret that Mr. Reid should think that I cannot possibly have "analysed and explained systematically" the effects with which his Paper deals; as a matter of fact, however, I calculated the variation of current for a number of cases in dynamos and motors, and plotted curves showing the variation of P.D. at the two surfaces under the brush. These results were accidentally destroyed just before the reading of Mr. Sayer's Paper, so that I could only give a general outline in the discussion. If Mr. Reid will refer to the report of the discussion in the *Proceedings* of the Institution of Electrical Engineers he will be able to judge whether he has been anticipated or not. In any case, however, I had much pleasure in reading his Paper, as I do not think the subject has received sufficient attention.—Yours, &c.,

R. H. HOUSMAN.

SYNCHRONISING ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been following with considerable interest the discussion in your paper on the subject of synchronising alternators, and now venture to address you on the subject, as the point raised by H. H. N. is one on which quite a large number of people seem to be under a misapprehension. It is curious that Mr. Kensit does not seem to see that the load on two steam alternators in parallel is absolutely dependent on the work being done in the cylinders of the two engines—that is to say, in the case of automatic expansion engines, on the relative points of cut-off, as adjusted by the governors; and that as the alternators are in parallel, and therefore at the same speed, no amount of adjustment of the field strength of one alternator can possibly, under normal working conditions, affect the point of cut-off in the cylinders of the engine driving that alternator, or, therefore, the load taken by it.

It is far, however, from my wish to appear to throw any discredit on Mr. Kensit's statement that with plant under his charge the distribution of load is habitually effected by adjusting the exciting current. Under certain conditions, which one would hardly characterise as normal, this may certainly be done. I refer to cases in which the governors of one or both engines are not absolutely free, or do not govern to the same percentage variation in speed between no load and full load. Let us take the instance Mr. Kensit gives of two steam alternators in parallel, on their governors partly loaded. The excitation of one is slightly increased. It is called on to do more work and receives synchronising current from the other machine to help it, and the speed of both plants drops slightly, as Mr. Kensit says. Now, if the governors of both engines are quite free, and govern to the same percentage variation in speed between no load and full load, they will adjust the points of cut-off in each engine absolutely equally, and the proportion of the load taken by each alternator will remain exactly as before, though the total load on the two plants will, of course, be increased.

As the speed of both engines has been equally decreased, the admission of steam has been increased equally to both, and therefore both plants do an equal amount of extra work. But supposing the governor of the plant on which the increase of excitation has been made works freely, while that of the other plant is slightly "sticky," *i.e.*, does not respond to small changes of load such as the increase of excitation referred to, then it is apparent that none of the extra work put on to the two plants, by increasing the excitation of one, will fall on to the one whose governors do not respond to the slight drop in

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speed; and therefore it can be said that an adjustment of the load has been made by altering the excitation.

In the instance Mr. Kensit gives as an explanation it is not apparent when the extra load has been put on one alternator, and when (as Mr. Kensit says) both alternators lose speed and the governors can act, why the governors should do so to a greater extent in the case of one engine than in the case of the other. If the governors are free and give the same percentage variation in speed between no load and full load they must act equally in either case, as the alternators are always at the same speed.

Under these conditions the only effect relative alteration of the field strength of the alternators can have is an alteration in the "wattless" synchronising current passing between the machines. A pronounced instance of this recently came under my notice, but I have no doubt Mr. Kensit will have frequently observed the same thing. Two 2,000-volt 150 ampere steam alternators, with automatic expansion governing arrangements, were running, partly loaded, in parallel.

By reducing steam on one engine all the load had been taken off that plant—that is to say, the engine was indicating approximately the horse-power that it indicated when running with its alternator fully excited, but out of parallel, and with no load on. The right adjustment had not, however, been made to the exciting currents of the two alternators, and that whose engine indicated no load was, by its ammeter, apparently doing about 40 amperes. The right adjustment of the fields of both alternators was then made, and the 40 amperes fell to zero, while at the same time the load on the other alternator was *reduced* by an approximately equal amount.—Yours, &c.,

Leeds, March 7, 1898. W. M. Oliver.

ELECTROLYTIC ALKALI.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of March 4th you publish a very interesting description of the Hulin electrolytic alkali process. With reference, however, to the very low electrical efficiency shown in the process, *i.e.*, only 69·8 per cent., some of the results obtained by us, in work of a similar nature, may be of interest. We have carried out a great number of experiments in electrolysing fused lead chloride by itself, using fused lead for the cathode and carbon anodes. When the operation is properly conducted an efficiency of current employed equal to about 95 per cent. can be obtained, when working on a quasi-commercial scale.

Mr. Kershaw seems unable to explain the loss of nearly 19 per cent. of efficiency over and above the 12 per cent. expended in the formation of lead chloride. The only theory which satisfactorily accounts for this further loss of 19 per cent. is that the chloride of lead is not decomposed by the current, but simply reduced to metallic lead by the sodium diffused through the bath, with the re-formation of sodium chloride. That no *electrolysis* of lead chloride takes place is borne out by Hulin's original experiments with cryolite (double fluoride of aluminium and sodium). Although the thermo chemical data show that the sodium requires nearly twice as much E.M.F. to liberate it as the aluminium, Hulin found that when working with a cathode of fused lead no aluminium whatever was set free. This is most likely to be accounted for by the heat of formation of the lead-sodium alloy.

In the Hulin process what probably takes place is as follows:—The 12 per cent. of lead chloride formed descends through the molten electrolyte, and meets the sodium in suspension. This results in the re-formation of an equivalent amount of sodium chloride, whilst the lead thus formed continues its descent in an extremely fine state of division, and meets with a fresh quantity of sodium, which it carries down with it to the cathode.

We thus see that the primary expenditure of 12 per cent. of the current on the formation of lead chloride must obviously result in the total loss of efficiency of 24 per cent., the balance of 7 per cent. being accounted for by the usual losses which occur in this class of work.—Yours, &c.,

O. J. Steinhart,
Julius L. F. Vogel.

LEGAL INTELLIGENCE.

National Telephone Company (Limited) v. Atkinson and Day.

This case came before Mr. Justice Day in the Queen's Bench Division on Tuesday.

Mr. ROSKILL, in opening the case, said there were two separate defendants—viz., Mr. William Atkinson and Mr. A. M. Day—and the plaintiff Company brought their action for an injunction restraining the defendants, or either of them, their servants or agents, from cutting or otherwise interfering with the Company's wires. The dates in the case were very material. On Oct. 12 last the plaintiffs received the following letter from the defendant Day, who described himself as an electrical engineer:—"Mr. Atkinson, tailor, of 49, Fulham-road, has consulted me with reference to your Company's wires going over his premises without his permission. He has placed the matter entirely in my hands for settlement, and I would suggest that a small rental of 2s. 6d. per annum would meet the case. I should be glad to hear from you as early as possible." Not getting any reply to his letter, Day, on Oct. 20, wrote to the plaintiffs again, as follows: "Confirming mine of the 12th, *re* Mr. Atkinson's premises, 49, Fulham-road, I am instructed by him to claim the sum of 2s. 6d. per annum for all wires crossing his premises. Unless I hear from you by 12 noon on Friday, the 22nd, my instructions are to cut or short-circuit the same. Mr. Atkinson is both surprised and annoyed that the wires are still running across his premises . . . ." On Oct. 21 a representative of the plaintiff Company saw Mr. Atkinson, and told him of Day's threat to cut the wires. Mr. Atkinson, it appeared, had never authorised Day to make the threat, and on the matter being brought to his notice he revoked Day's authority to act for him in the matter. Mr. Justice Ridley had granted an interim injunction restraining the defendants from cutting the wires. On Oct. 23 a representative of the Company again saw Atkinson, who stated that the threat to cut the wires was made without his authority, and on Oct. 27 the matter came before his Lordship (Mr. Justice Day) and an interlocutory injunction was granted restraining Atkinson and Day from cutting the wires, his Lordship suggesting that the hearing of that summons should be treated as the trial of the action. He (Mr. Roskill) then pointed out that as Day was in the wrong he ought to pay the costs. Day, however, refused to do so, and therefore they had no alternative but to come before his Lordship again. The question of whether the plaintiffs were right or wrong in taking the wires above Atkinson's premises was not in issue, as the wires had since been removed.

Mr. W. ATKINSON, of 49, Fulham-road, said he was a tailor. In October last, Day, who was then a stranger to him, called and said he had got some people who had instructed him to get a rental for the wires passing over their houses. He said that if witness liked to allow him to write to the Company he thought he would be able to get him a rental, and that he thought witness was entitled to it owing to the disadvantage of having wires on the roof. Witness stated that he authorised Day to get a rental if he could, and agreed to pay him 20 per cent. of such rental if he were successful. He had been in Fulham-road for 30 years, and the wires in question had been there for 10 years, and he had suffered no inconvenience from them. He never authorised Day to write to the Company threatening to cut the wires, and never heard of it until he was served with process. As soon as witness heard of it he revoked Day's authority to act for him. He had learned that the Company never gave rentals for wires passing over people's houses, and therefore it was no use going on further with the matter. It was on Oct. 12 that he signed a contract with Day, and it was upon that contract that Day acted as his agent. The representative of the Telephone Company told him that they intended to stop Day if possible from doing what he had done in this case.

Mr. ALEXANDER BARFORD, district engineer to the plaintiff Company, said 100 wires were formerly carried over the house, 49, Fulham-road, they being separate and without attachment, and being about 40ft. from the ground and about 6ft. from the roof. The standards were about 120 yards from one another. If the wires had been cut it would have impeded the traffic and caused very likely a serious accident. The wires were cut by the Company and removed without any accident at all, but that was done by skilled workmen, and then, of course, there was no danger.

Mr. McCALL, Q.C., for Mr. Day, submitted that the action was brought to trial for no purpose in the world except that the Telephone Company—a wealthy company—might incur costs, and endeavour to recover those costs from Mr. Day.

Mr. ROSKILL said it went on because Mr. Day would not pay the costs.

Mr. McCALL: It was sufficient for him that the Telephone Company were pressing for costs, and insisted upon going on with the trial. If that were so the only question was whether Mr. Day, as Atkinson's agent, was justified in writing the letter he did. The learned counsel submitted that upon his contract with Atkinson he was justified in writing as he had done.

His LORDSHIP: In saying that he would cut the wires?

Mr. McCALL: Yes; until the authority was withdrawn.

His LORDSHIP: Can you justify the threat that he would cut the wires?

Mr. McCALL replied in the affirmative, and pointed out that the Court of Appeal had laid it down that people were entitled to cut the wires placed over their houses without permission.

His LORDSHIP said that he did not see that there was any authority given by Atkinson to Day or to anybody else to cut the wires.

Mr. McCALL pointed out that Atkinson had given Day authority to do whatever was necessary in order to secure a rental for the wires, and the only effective way to secure the rental was to threaten to remove or cut the wires.

Mr. DAY said he was an electrical engineer carrying on business in Queen Victoria-street, London, and that he had had considerable experience on work connected with telephones, &c. Acting upon the instruc-

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tions he received from Mr. Atkinson after the interview on Oct. 12 he wrote the letters which had been put in to the plaintiff Company. On Oct. 22 the writ was served upon him.

Cross-examined: He was an electrical engineer.

What are your qualifications for those duties? Where have you learned electrical engineering?—I served my time with my brother in Queen Victoria-street.

When did you start the Universal Way-Leave Agency?—In June or July last.

How many letters have you written to the Telephone Company claiming a rental for wires which run across persons' houses?—I could not tell exactly; 20, perhaps.

How many actions have you instituted against the Telephone Company?—Not one, sir.

Do you know a lady of the name of Levi?—Yes.

How did you get to know her? You called on her?—Yes; I called on her, and asked her if she received rent for her wires.

And then she brought an action against us for injunction?—Yes.

Did you write to the Company on behalf of Levi and Co. claiming a rental for the wires or otherwise threatening to cut down the wires?—Yes, I did.

Did you write similar letters on behalf of Cambridge, Randall and Leatherby?—No; I wrote claiming a rent, and, failing that, I was to remedy it.

Had you an agreement with those various people to pay you 20 per cent. or any other part of the rental you were to get for the wires?—Yes; I was to get something for it.

Was it 20 or 25 per cent.?—It differed. In Levi's case there were about 600 wires, and in that case I should not charge such a large percentage as in others where there was a smaller number of wires.

Are these agreements in writing?—I do not think they all are.

Is there any document in the cases of Levi, Cambridge, Fielding, Randall and Leatherby?—Yes.

You have indemnified these people against the costs of the proceedings they have taken?—No, I have not; not one.

An action for maintenance has been brought against you?—I think so; for maintenance and champerty.

He did receive authority from Atkinson to cut the wires if the rent was not paid. He told Mr. Atkinson that in Levi's case he informed the Company that if they did not do one thing or the other the wires would be cut, and that that was the best way to bring them down to their knees, because they would not like the short-circuit. Mr. Atkinson acquiesced in that.

Do you say you used those words?—Yes.

You go about to people asking them to bring actions to enable you to earn your 20 or 25 per cent?—No; I do not ask them to bring actions.

His LORDSHIP, in giving judgment, said that, after hearing the evidence, he remained very much of his original opinion. It was obvious that Mr. Atkinson did instruct the other defendant, Day, to try and get him a rental for the wires passing over his premises, and that Mr. Day did write a letter suggesting that if a rent were not paid the wires would be cut. It was very doubtful on the evidence when the withdrawal was obtained. According to the authority of the Court of Appeal in Levi's case people had a right to cut the wires if they objected to them, and he (his Lordship) thought that the authority of Mr. Atkinson to Mr. Day was not withdrawn until the Monday morning, or that it did not reach Day until then. It seemed to him to be a very objectionable proceeding for a person to go about getting people to bring these actions for his own emolument. On the other hand, he did not see how Mr. Day could have effectually proceeded with his claim for a rental unless he had been prepared to cut or remove the wires. In these circumstances he thought the best conclusion he could come to was to find for the plaintiffs without costs.

Order accordingly.

Crompton and Co. (Limited) v. Liardet.

This case came before Mr. Justice Day, without a jury, in the Queen's Bench Division yesterday (Thursday), in which Messrs. Crompton and Co. sought to recover from the defendant, Mr. J. E. Liardet, the sum of £93. 8s., balance of account alleged to be due for supplying two electric motors. The plaintiffs' case was that in July, 1896, the defendant sent an engineer to their works at Chelmsford to select two electric motors for a yacht of his. The engineer presented his report to the defendant, who gave an order for a pair of motors, which were sent in due course. The defendant paid £100 on account, but the balance still remained unpaid.

For the defence it was said that in July, 1896, the defendant was fitting up a launch of some 70 tons, which was the largest boat afloat driven by electricity. After his engineer saw the motors at Chelmsford he ordered twin motors from the plaintiffs, which were to have revolutions of from 500 to 1,000 a minute. The motors were delivered about August, 1896, and the defendant forwarded a cheque for £100. At the same time he stated that the motors were incomplete, and requested that they should be completed. But time went by until it was too late to make a trial test, so he wrote to the plaintiffs telling them they would have to wait for the balance due until a test of the motors was made. The defendant also said he found the motors were not equal and fit for twin propellers.

After hearing evidence His Lordship entered judgment for the plaintiffs for the amount claimed, with costs.

Williamson and Joseph (Limited) v. London County Council.

Before Mr. Under-Sheriff Burchell and a special jury, in the London Sheriff's Court, on Wednesday, this action was heard, it being a claim for about £8,300 as compensation for leasehold interest in premises in Horsely-down, and also for alleged injury to the claimants' business of electrical engineers carried on there. The County Council contended that £100 would amply compensate for any improved rental value which there might be in the premises for the remainder of the term, and that £250 in addition would cover any loss of business during removal from Horselydown to the north of London. The Under-Sheriff, in his summing-up, informed the jury that the greater portion of the claim had been referred to arbitration, and that their business was to assess the value of the leasehold interest and the injury to the business. The jury awarded £350 in respect of the leasehold interest and £1,100 in respect of probable loss of trade, making a total compensation of £1,450. In the arbitration the Under-Sheriff stated that he had appointed Mr. E. T. Horsey (Fuller, Horsey, Sons and Cassell) umpire in regard to those items of the claim which are to be referred to arbitration (the value of fixed plant, machinery, and tenants' improvements, and the cost of removal and replacement of stock, stores, and loose plant).

The arbitrators in the matter are Mr. H. Sherley-Price for the claimants, and Prof. Henry Robinson for the London County Council.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Bibliography of X-Ray Literature and Research, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"Laboratory Notes and Forms."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade. *In the Press.*

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"The Electric Arc."—By Mrs. Ayrton. *In the Press.*

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"Electrical Testing for Telegraph Engineers."—By J. Elton Young. *Ready shortly.*

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Armature Windings of Electric Machines."—By H. F. Parshal. and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"Signalling across Space without Wires by Electric Waves." Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net 2s. 9d. post free.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition now ready. Price 2s., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is *now ready.* Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898, and contains about 150 additional pages over last year's book. Supply houses will find the book very reliable and complete for circularising.

Tenders Invited.—The Vestry of St. John, Hampstead (London) require tenders for the supply and erection at the electricity station, Lithos-road, of the following plant:—(1) One or two 350-kilowatt steam alternators, with armatures, switchboard panel connections and resistances; (2) two switchboard panels; (3) two induced draught wet back boilers; (4) feed-water heater, steam and exhaust pipes, &c.; (5) two duplex compound steam feed pumps; (6) a 50-kilowatt direct-coupled exciter (to replace existing 20-kilowatt alternator, which is to be removed and allowed for by the contractor); (7) feed water softener. An advertisement elsewhere gives further particulars, and conditions, forms of tender, &c., may be obtained of the vestry clerk (Mr. Arthur P. Johnson), Vestry Hall, Hampstead, N.W., to whom tenders must be delivered by noon of Thursday, the 31st inst.

——— The Electric Lighting Committee of the County Borough of Salford are prepared to receive competitive plans and estimates from architects for the erection of a new electricity generating station. Sealed plans and estimates to the office of Mr. Samuel Brown, Town Hall, Salford, by 9 a.m. 25th inst.

——— The Edinburgh Town Council require tenders for certain additions and extensions to the electric lighting installation at the City Chambers. Tenders to Mr. Thomas Hunter, W.S., City Chambers, Edinburgh, by 22nd inst.

——— The Plymouth Corporation invite tenders for the supply of alternating-current electricity meters for the twelve months ending March 31, 1899. Tenders to Mr. J. H. Ellis, Town Hall, Plymouth, by 23rd inst.

——— The Leyton Urban District Council require tenders for the supply and erection of two dynamos, one continuous-current balancing transformer, two gas engines and connections, and switchboards, at the electricity works at Leytonstone. Manufacturers only can tender. Tenders to the Town Hall, Leyton, Essex, by April 4. Mr. R. Vincent is clerk to the Council.

——— The Visiting Committee of the Wilts County Asylum, Devizes, require tenders for the supply and delivery at their new engine house of two 40-kilowatt continuous-current belt-driven dynamos. Tenders to Mr Joseph T. Jackson, office of clerk to the Visiting Committee, Devizes, by noon of 21st inst.

——— The Corporation of Blackpool invite tenders for the supply and erection of plant at their electricity works. Tenders to Mr. T Loftos, Town Hall, Blackpool, by 10 a.m. 22nd inst.

——— The Darwen Corporation invite tenders for the supply of steam engines and dynamos, steam and exhaust pipes, &c; accumulators, switchboards, &c.; underground mains, arc lamps, and pillars. Tenders to the Town Clerk's office by noon 28th inst.

Tenders Invited.—The Derby Corporation invite tenders for wiring their Lunatic Asylum and premises at Rowditch. Tenders to the Town Clerk by the 24th inst.

——— The Horse Committee of the Bournemouth Corporation invite tenders for motor vans for the collection of house refuse, &c. Tenders to the Borough Engineer by April 4.

——— The Gas and Electric Lighting Committee of the Stockport Corporation invite tenders for the erection of electricity supply station buildings. Tenders by 24th inst.

——— The Königliche Eisenbahndirektion, Altona, Germany, require tenders for the supply of 12 months' electric lighting stores, including about 153,000 arc lamp carbons and 1,600 incandescent lamps. Tenders by the 26th inst.

——— The Königliche Eisenbahndirektion, Cologne, Germany, require tenders for 24,650 porcelain telegraph insulators, without supports. Tenders by the 28th inst.

——— The Direccion General de Correos y Telégrafos, Madrid, invite tenders for 40,000 porcelain telegraph insulators. Tenders by the 21st inst.

——— The Municipal Authorities of Ghent invite tenders until the 30th inst. for the supply and erection of electric lighting plant at the docks. Tenders to l'Hotel de Ville, Ghent, Belgium.

——— The Guardians of the Ipswich Union invite tenders for the wiring and for the supply of electric lighting plant. Tenders to the clerk (Mr. A. F. Vulliamy), 6, Tower-street, Ipswich, by Tuesday, the 29th inst. See advertisement.

Tenders Accepted.—The tender of the British Insulated Wire Company has been accepted by the Salford Corporation for the supply of high-tension cable, and that of Messrs. W. T. Glover and Co. for the supply of low-tension cable. The Callender Company, Western Electric Company, W. T. Henley's Telegraph Works Company and Messrs. Siemens Bros. and Co. also tendered.

——— The City of London Common Council have accepted the tender of Messrs. Ashwell and Nesbit for installing the electric light in certain rooms in the Guildhall Library at £145. 9s.

——— The Carlisle Town Council have accepted the tender of Mr. John Laing for the erection of electricity supply station buildings, at £7,668.

——— The tender of Messrs. W. T. Glover and Co. has been accepted by the Newport (Mon.) Town Council for the supply of cables and underground work in connection with the electric lighting extension scheme of the Corporation, at £4,288. 12s. 4d. The tenders of the Electric Construction Company for transformers at £666, and of Messrs. G. Smith and Co. for arc lamp-posts at £395, have also been accepted.

Tenders Received.—The following tenders have been received by the West Ham Town Council for wiring and fitting up various public buildings in West Ham for the electric light:—

National Elec. Free Wiring Co.	£1,340	Electrical General Engineering Company	£969
T. H. Taylor	1,316	Thomson, Howard and Co.	898
Laing, Wharton and Down	1,177	Woodward and Craig	870
New Fowler Lancaster	1,162	Wenham & Waters	798
Geipel and Lange	1,159	Rogers and Co.	713
J. H. Pickup and Co.	1,082	Joel and Potter	No total
True, Curtiss and Co.	1,014	Bostel, Sons and Petrie	No total
J. and F. Mahon and Co.	1,016	P. Speedy	No total
Lovell, Symons and Co.	£967		

The tenders have been referred to the Highways Committee for consideration and report. The electrical engineer's covering estimate was £1,700.

Sale.—Particulars will be found in an advertisement elsewhere of a sale by Messrs. Fuller, Horsey, Sons and Cassell, at the Vulcan Engineering Works, Coventry, on Tuesday, April 5, at 11 o'clock, of a large quantity of engineers' machine tools. The sale is of special interest to electrical engineers, cycle manufacturers and others. Catalogues and all further information can be obtained from Mr. C. Martin, solicitor, 18, Hertford-street, Coventry, or of the auctioneers, 11, Billiter-square, London, E.C.

Appointments.—Mr. J. H. Clothier has been appointed electrical engineer at Stafford in succession to Mr. J. S. Highfield (who is going to St. Helens) at a salary of £125 per annum. Mr. Clothier has acted as Mr. Highfield's assistant at Stafford for about six months.

——— Mr. J. A. Lycett, clerk to the King's Winford Rural District Council, has been appointed district manager of the British Electric Traction Company (Limited).

——— Mr. H. E. M. Kensit has resigned his position as assistant-engineer at the Blackpool Corporation Electricity Works, in order to join the staff of the Westinghouse Electric Company.

——— The *Aberdeen Journal* states that Mr. McWhirter, M.I.E.E., has received a commission in India to carry out a new system of electric train signalling. He will afterwards proceed to Cape Town on similar business.

Appointment Vacant.—As will be seen from our advertisement columns, the Council of the County Borough of West Ham

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require a chief assistant for mechanical engineering at their Technical Institute. Particulars may be obtained from the Principal of the Institute, Town Hall, West Ham, E, before the 31st inst. Mr. Fred. E. Hilleary is town clerk.

Vacancies.—A foreman cable jointer is required at the Salford Electricity Works. Applications to the borough electrical engineer (Mr. C. L. Turner), Walness-road, Salford. See advertisement.

——— Two junior assistants are required by the Wireless Telegraph and Signal Company; must be well up in electrical science, and if possessing a knowledge of Hertzian work and practical telegraphy preferred.

Business Notices.—Messrs. Pritchetts and Gold ask that in future all correspondence in connection with the manufacture of storage batteries should be sent to their works at Feltham, Middlesex, where this branch of the business will in future be conducted.

——— Mr. Robert Hammond, M.I.E.E., notifies that he has removed into new offices at 64, Victoria-street, Westminster, S.W., where all future communications hould be addressed.

——— We are asked to state that Mr. A. W. B. Pearson has severed his connection with Messrs. Henderson, Bunn and Co., and has joined Messrs. Hale Bros., of Fenchurch-buildings, London, E.C., who will answer inquiries relating to the portable telephone set described in our issue of March 4.

——— Mr. S. Harrison, late of Pemberton, near Wigan, has removed to new show rooms, offices and works at 73, Wallgate, Wigan, Lancs. Mr. Harrison has been appointed sole agent for the North of England for the "Crescent" arc and "Hard" incandescent lamps.

——— In consequence of the death of Herr Wilhelm Kücke, the founder and sole proprietor of the well-known firm of W. Kücke and Co. (makers of engineers' tools, linemen's tool wallets, &c., Elberfeld, Germany), the entire undertaking has devolved upon the son of the deceased, Herr Willy Kücke.

Bankruptcies.—The creditors of Trehearne, Son and Crump, electrical engineers and contractors, 115, Fenchurch-street, London, met on Wednesday, at the London Bankruptcy Court. Mr. Trehearne commenced business in June, 1895, and in May, 1897, Mr. Crump became a partner, introducing £750 capital. A balance sheet then struck proved to be inaccurate, and disputes arose between the partners resulting in the present proceedings. A company was formed last January by Mr. Trehearne and his friends and took over the firm's offices. Two or three contracts were on hand when the firm stopped. Failure is attributed to losses by betting, heavy expenses incurred in obtaining business, loss on trading, and bad debts. His partner Mr. Crump, on the other hand, attributes it to Mr. Trehearne's omission to carry out his guarantee relating to the liabilities existing when the partnership was entered into. The accounts show debts £1,066, assets £413. In the absence of any offer Mr. B. T. Norton, accountant, Old Jewry, was appointed trustee to wind up the estate in bankruptcy, with a committee of inspection.

——— John Orme, scientific apparatus manufacturer, Cross-street, Finsbury, applied for his discharge in bankruptcy. In 1893 he promoted Orme's Electric Signal Company (Limited), to take over his patent electric fog signal. As vendor he received £6,000 in shares, which, however, proved valueless, as the Company went into liquidation in 1895. Bankrupt failed in November last, with liabilities £1,769, and a dividend of about 1s. in the £ will be paid. The failure was partly attributed to losses and liabilities incurred in connection with the Fog Signal Company. The learned Registrar imposed a suspension of two years and a-half.

Dividend.—A first dividend of 7s. 6d. in £ has been declared in the failure of Messrs. Edward James Paterson and Chas. Friend Cooper, electrical engineers, late of the European Works, Pownall-road, Dalston, and Victoria-street, London, and West Regent-street, Glasgow. A statement is issued by Mr. Edward C. Moore, trustee, 3, Crosby-square, London, E.C., showing the position of the estate at the date of the declaration of this dividend (March 5, 1898). The total receipts to that date amount to £12,039. 17s. 3d., and after payment of the dividend referred to, there remains a balance, subject to provision for law costs not yet taxed, proofs in abeyance, &c., of £3,084. 4s. 1d. Certain assets not yet realised consist chiefly of patents for bleaching and sundry processes in which the bankrupts have joint interests with Mr. Hermite. The policy adopted by the trustee and committee of continuing the business in order that profitable contracts might be completed, stocks, &c., reduced at good prices and endeavours made to sell the business as a going concern, proved entirely successful, as not only was much of the stock realised profitably, but no less a sum than £2,400 was obtained for goodwill alone.

Liquidation.—A meeting of Edmundsons (Limited) will be held at Broad Sanctuary-chambers on April 15, to receive an account of the winding-up. Mr. F. E. Gripper, Broad Sanctuary-chambers, Westminster, S.W., is liquidator.

Electric Light Fittings and Glassware.—Another important section (F. G.) of the very complete catalogue of Messrs. H. M. Salmony and Co. (Limited), 118-120, Charing Cross-road, London, W.C., is now ready, and for completeness in illustration and detail commends itself for favourable notice. It is not sufficient nowadays to illustrate only the larger and higher-priced goods for electrical work, and it is satisfactory to note that the leading manufacturing and supply houses are devoting no less attention to the smaller accessories of electrical supply. In the catalogue before us electric light and wiring contractors are very thoroughly catered for, full details and illustrations being given of an immense variety of accessories and sundries for electric light work. It is also in accordance with latest practice to illustrate by means of reduced photographs rather than by the aid of wood blocks, and in the catalogue under review a large proportion of the apparatus and fittings shown are by actual photographic reproduction, which although lacking the wood engraver's art enables the buyer to order his goods (or introduce them to his client) by the aid of illustrations showing exactly what he will obtain for his money. The complete catalogue issued by Messrs. Salmony and Co. contains over 600 large quarto pages crowded with illustrations, prices, and particulars of their goods, and is certainly very complete in all respects. The firm point out that they issue cards of introduction which enable those contemplating the installation of the electric light to inspect the fittings on view in the extensive show-rooms at Charing Cross-road before ordering. Where so many specimens call for favourable notice it is impossible in the confines of a brief reference to do justice to these really-important trade compilations, and it only remains to be stated that in the catalogue under review the trade is provided with full particulars of almost every conceivable requirement for electric-light installation work.

McWhirter's Shielded Instruments.—The General Electric Company are bringing out a new pattern of switchboard instrument which they claim has the advantages of the D'Arsonval or permanent magnet type without its inherent disadvantages—that is to say, efficient shielding is claimed without the use of permanent magnets. The chief departure from the ordinary type of electromagnetic instrument appears to be the substitution of an ironclad bobbin ¼in. thick for the ordinary brass one, the shielding effect of this being better than that due to an iron outer case of irregular shape as often used. Tests made by Prof. Andrew Jamieson on a voltmeter reading from 80 to 120 volts show that only 1·25 to 2·82 watts were absorbed by it, and in his report Prof. Jamieson says that the instrument is less affected by external magnetism than any other electromagnetic one he has seen. The temperature error was only 0·25 per cent., at 100 volts, after 20 hours in circuit.

Electric Light Fittings.—We have to hand a neat and well got up illustrated price list of electric light fittings, manufactured by Mr. A. P. Lundberg, Bradbury Electrical Works, Bradbury-street, Kingsland-road, N. A glance through Mr. Lundberg's list is sufficient to give the impression that his reputation for substantial design is being maintained. Some new patterns of fittings to meet the requirements of high pressure supply have been included.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 9 to 15, with the ports of destination:—

Argentina—Buenos Ayres, £391 (including £310 telegraph material). *Australasia*—Adelaide, £10; Albany, £43; Fremantle, £30; Hobart, £105; Launceston, £11; Melbourne, £59; Sydney, £186; Wellington, £445. *Belgium*—Ostend, £65. *British Guiana*—Demerara, £58. *Ceylon*—Colombo, £78. *Egypt*—Alexandria, £49. *France*—Boulogne, £24. *Gibraltar*, £121. *Holland*—Amsterdam, £300; Flushing, £14. *Hong Kong*, £10. *India*—Bombay, £720 (including £670 telegraph cable); Calcutta, £781; Madras, £107. *Italy*—Genoa, £27. *Malta*, £8,216 (including £8,200 telegraph cable). *Portugal*—Lisbon, £425. *Russia*—Odessa, £45. *Siam*—Bangkok, £89. *South Africa*—Cape Town, £39; Delagoa Bay, £3,710 (telegraph material); Durban, £714; East London, £142; Port Elizabeth, £51. *Spain*—Malaga, £334. *Sweden*—Gothenburg, £171; Stockholm, £60 (telegraph cable). *United States*—New York, £525 (telegraph material). *West Indies*—Key West, £1,400 (telegraph cable). Total £19,555, against £11,944 in the corresponding week last year (March 10 to March 16).

Aluminium.—Mr. A. E. Hunt, president of the Pittsburg Reduction Company, has prepared a Paper, in which he sets forth the claims of aluminium as the rival of copper and brass for electrical conductors.

Barrow-in-Furness.—The Electric Lighting Committee recommends the Town Council to appoint Mr. H. R. Burnett, of St. Pancras, borough electrical engineer, at a commencing salary of £200 per annum. There were 70 applications for the position; the Committee reduced this number to 23, and the consulting engineer (Mr. E. Manville) was invited to select a few names for the Committee's final decision.

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Bedford.—The Electric Light Committee recommend the Town Council to reduce the price of electric current to 4½d. per unit from July 1 next.

Brighton.—The Lighting Committee, on Monday, considered the question of reducing the charge for electric current, and after discussion, it was decided to alter the price after the first hour's consumption from 1½d. to 1d. per unit. The revised scale comes into force in three months.

Bristol.—The Electrical Committee have decided to revise their charges for electric current for motive power, subject to a special agreement being entered into. The City Council are recommended to sanction a reduction from £6 per annum per kilo. installed to £5 per annum per kilo. demanded where the customer has no private plant on his premises, and £5 per annum per kilo. installed where the customer has a private plant. It was also decided to reduce the charge for electricity for power purposes from 2d. to 1½d. per unit, subject to a sliding scale of discounts varying from 5 to 15 per cent. The Local Government Board have sanctioned the borrowing of £23,000 for public electric lighting, to be repaid within 25 years. The electric light mains are to be considerably extended.

Chicago.—The Chicago City Railway Company have decided to considerably extend and improve their lines. The underground conduit system of electric traction is to be introduced, at an estimated cost of $1,000,000. The present lines are worked by trolley and cable.

Coatbridge and Airdrie Light Railway.—The inquiry of the Light Railway Commissioners into the application of the British Electric Traction Company to construct an electric tramway between Coatbridge and Airdie will be held at Coatbridge on the 29th inst.

Country House Lighting.—Messrs. Drake and Gorham have secured an order to light electrically Lord Scarsdale's country seat at Keddlestone, near Derby. The work at present comprises about 250 lights. A steam plant is to be put down, with D.P. accumulators.

Darfield (Yorks.).—The District Council have passed a resolution in favour of applying for a Provisional Order.

Edinburgh.—The Town Council will be recommended at their next meeting to authorise an application to the Secretary of State for Scotland for sanction to borrow £146,000 for extension of works under the Edinburgh Electric Lighting Order of 1891.

Electricity in Paper Mills.—The Società Cartiere Meridionale of Naples is an extensive paper-manufacturing concern employing about 1,000 hands. The large range of factories are lighted by electricity, current being generated on the premises. The Company has also recently started an electric tramway, for which plant of 180 H.P. capacity has been put down. Another paper-making firm (E. Courier) in the same city has also the electric light in all parts of its extensive premises. Here, as elsewhere in Italy, Continental firms have exclusively supplied the plant. So far as can be traced not a single machine has been supplied by British firms.

French Customs Tariffs.—By a law dated the 3rd inst. the following duties, per 100 kilogs., are payable on lead, &c., for electric accumulators imported into France :—

	General.		Minimum.
Red lead	fr.8.50	...	fr.5.15
Litharge and other oxides	8.75	...	5.30
Salts of lead not otherwise mentioned	5 per cent. *ad val.* plus 2.40fr.		5 per cent. *ad val.* plus 2fr.
Acetate of lead	11.50	...	7.60
Lead chromate	25.00	...	18.50
Tubes, &c.	8.00	...	6.50
Accumulators	21.00	...	16.50

Electric Lamps for the Police.—The Scotland Yard authorities are engaged in subjecting an electric police lamp to practical tests to ascertain if it will stand the necessary wear and tear of the service. The lamp is stated to be the invention of a member of the Metropolitan police force.

Exhibition.—The Electrical and General Trades Exhibition, which is to be held at Bingley Hall, Birmingham, from the 21st inst. to April 30, will be officially opened on Monday by the Right Hon. the Lord Mayor of Birmingham.

Gateshead-on-Tyne.—The borough engineer (Mr. James Bowes) has presented his report on the scheme of the British Electric Traction Company for the extension of the existing tramway system, and for the introduction of electric traction. The report, as well as the particulars of the suggested new routes, have been before the Parliamentary Committee, who recommend the construction of two or three additional lengths of line.

Glossop.—Dr. Whelan initiated a debate on the advisability of the Council establishing electricity supply works at the meeting of the Town Council on Thursday last. It was decided to deal with the matter at a special sitting. Applications have been received from three electrical engineers offering their services as advisers in connection with the Council's proposed scheme.

Great Grimsby.—Prof. Kennedy paid a visit to Great Grimsby on Saturday, and had a conference with the Electric Lighting Sub-Committee on the electric lighting question. He afterwards made a tour of the town and visited the site selected for the proposed electricity supply works.

Greenock.—A special meeting of the Police Board was held on Thursday last for the purpose of considering the report recently presented by the Electric Lighting Sub-Committee on the question of the erection of an electricity supply station in the district. The Committee had recommended the Board to engage in the supply of electric current, and to erect works which would entail an initial outlay of about £28,000. The recommendations of the Committee caused considerable discussion, but eventually the report was adopted in its entirety.

Hackney (London).—The question of the transfer of the Vestry's Provisional Order still remains in abeyance. The matter was again discussed at a special meeting last week, but a further adjournment for a fortnight was decided upon.

Halifax.—On Wednesday Major P. Cardew held a Board of Trade inquiry into the application of the Town Council to borrow £20,000 for electric tramway purposes. The town clerk (Mr. K. Walton) said that the money was required chiefly to meet the cost of the proposed depôt in Gibbet-street. Mr. T. P. Wilmshurst (the borough electrical engineer) also gave evidence. He said that the Tramway Committee originally decided to order ten cars, estimated to cost £4,170, but they had since determined to have four or five more cars, and the cost would be increased to £6,300. There was an item of £400 for an additional brake that was thought necessary. The ten cars would permit of a ten minutes' service, and the 14 cars would allow for a seven minutes' service. At the conclusion of the inquiry the inspector expressed a hope that the tramways would be a great success.

Hendon and Finchley Light (Electric) Railway.—The Light Railway Commissioners (Mr. Fitzgerald and Col. Boughey) held an inquiry at Hendon on Friday into the application of the Finchley, Hendon and District Light Railways Company for an Order to authorise the construction of a light railway between Hampstead, Finchley and Hendon. Mr. E. F. Vesey Knox, M.P., who appeared for the promoters, gave particulars of the scheme, and stated that the promoters were Mr. J. F. Firbank, M.P., and Mr. W. M. Murphy. The proposed tramway would be seven miles three furlongs in length. For two-thirds of the distance they had not only the acquiescence but the support of the local authority (the Hendon Council) and the clerk was present to support the scheme. Hendon had a population of 20,000, the only railway station being a mile from the town proper, and this short journey cost 3d. by omnibus. Owing to the heavy gradients on the proposed line the overhead trolley system of traction was especially suitable. The Company promise a ten-minute service from Hendon to the Hampstead boundary, and from there to the terminus a five-minute service. Mr. Edward Wragg, who is (in conjunction with Sir Douglas Fox) engineer for the scheme, gave technical details. The total estimated cost of the line, irrespective of equipment, was £44,000. The equipment would cost about £100,000. The line would practically be a single one throughout, with suitable junctions. His experience of electric tramways was that they increased the value of the property of the districts through which they ran. The system would be the same as that at Bristol. The Hampstead Vestry objected to the scheme on the ground that it would cause serious damage to property in the district. Mr. Moon, for the London County Council, said that so seriously did the Council regard this attempt to come into their area without the protection given by the Tramways Act, and to over-ride the public right to purchase the line which they had already so expensively exercised, that they would be compelled, if this scheme were passed, to consider the introduction of fresh legislation to limit the scope of the Light Railways Act. Objection was also offered by the Middlesex County Council and by a committee of Hampstead residents. The sitting will be resumed to-morrow (Saturday).

Huddersfield.—A report of the Electric Lighting Committee, presented at Wednesday's meeting of the Town Council, stated that the number of consumers was 632, an increase of 14 for the month. The equivalent number of 8-c.p. lamps connected was 43,295. A sub-committee was appointed to confer with the Elland District Council as to the terms, &c., upon which current would be supplied to the Elland district.

Kanturk (Cork).—Messrs. Theerman and Co., of Manchester, electrical engineers, are in negotiation with some mill owners in the vicinity of this town for the use of their water power in the generation of electricity for public and private lighting in the district.

Leamington.—Mr. Robert Hammond's report recommending the Town Council to undertake the supply of electric current in the district was discussed at the last meeting of the Council. The Electric Lighting Sub-Committee recommended the adoption of the report, and also that the Corporation should insert a clause in their

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Provisional Order for power to take over that portion of the undertaking of the Midland Electric Light and Power Company (Limited) which would be of use to the Corporation for the purpose of their undertaking. The Committee's recommendations were adopted.

Lecture.—Mr. G. Balfour lectured on "Electric Tramways and Railways" at Dundee on Friday. The lecturer described the various systems of electric traction, and advocated the adoption of the conduit system for the centre of the city of Dundee, and the overhead trolley for the suburbs.

Leeds.—The Yorkshire House-to-House Electricity Company have refused the offer of the Corporation to purchase the Company's undertaking. Particulars of the terms offered by the Corporation appeared in our last issue. In view of this refusal it is understood that the Corporation will proceed with their application for a Provisional Order.

Leicester.—The accounts of the electricity department of the Corporation for the half-year ended Dec. 31, show that, after paying interest on capital, and allowing for sinking fund instalment, there was a net profit of £449. 5s. 10d. Extensions of the electricity works are at present being made, and the Gas and Electric Lighting Committee anticipate that these will be complete in time to meet the next season's demands. The accounts were presented at the special meeting of the Town Council on Wednesday, and, on the motion of Ald. Lennard, were approved. A special committee has been appointed to consider and report upon the advisability of purchasing the tramways in the borough, and also as to the most desirable system of traction to be adopted on the lines.

Lewisham (London).—Mr. Trenchard will move at the next meeting of the District Board of Works that the previous resolution of the Board in favour of applying for a Provisional Order be rescinded, and that consent be given to the application of the Great Western Electric Light and Power Company for an Order for the district, on the terms and conditions recently submitted by them.

Lynn.—The report on the electric lighting question, recently prepared by Prof. H. Robinson, is being considered by the Council in Committee. The report recommends the Council to establish works capable of supplying current for lighting the principal thoroughfares and also for private lighting. A low-tension continuous current system of supply is advocated. The estimated cost is put at £15,150, the working expenses for the first year at £1,600, and the probable revenue at £1,685.

Macroon (Cork).—The Committee recently appointed by the Town Commissioners to obtain information on the electric lighting question presented a report at the last meeting of the Commission on their visit to the Killarney electricity works. Water power is available, and it is probable that a small local company will be formed for the purpose of establishing a station capable of supplying current for public and private lighting.

Maidstone.—The report of the Electric Lighting Committee, submitted at the last meeting of the District Council, stated that they were anxious to have the advice of an electrical engineer as to the best method of complying with the terms of their Provisional Order, and recommended that Mr. W. C. C. Hawtayne be invited to attend the next meeting. It was stated that Mr. Hawtayne would not charge any fee for the preliminary consultation.

Maidenhead.—The Town Council have authorised the Electric Lighting Committee to employ an electrical engineer to prepare an electric lighting scheme for the borough at a fee not exceeding £75.

Millstreet (Cork).—The Town Commissioners have entered into an agreement with Messrs. Theerman and Co., of Manchester, for the erection of an electricity supply station in this town. Water power is to be utilised in the generation of current, which will be supplied for both public and private lighting.

Naples.—The use of the electric light is rapidly spreading in Naples and district. Owing to the high price of oil the electric light has received a considerable impetus. All the theatres, most of the principal streets, shops and offices, and a large number of private houses are lighted electrically. The important town of Capua, the chief military position in the vicinity, is and has been for some time lighted by electricity. The town of Cava dei Torrini and several smaller towns and villages in the neighbourhood are all electrically lighted, current being generated by water-power plant in most cases. The opportunities for the introduction of electric light and power schemes in Italy are numerous, water-power being available at many places. Particular mention may be made of the town of Amalfi, a favourite resort during the period of the English winter, where a number of first-class hotels are well established and many paper mills and macaroni factories are worked by water-power.

Presentation.—Mr. F. A. S. Wormull was, on the 9th inst., presented by his London colleagues of the National Telephone Company with a silver tea and coffee service, to celebrate his appointment as district manager at Newcastle-on-Tyne. In the evening he was entertained at dinner at the Holborn Restaurant, Mr. Dane Sinclair, engineer-in-chief of the Company, presiding.

Prestwich.—A recommendation by the Electric Lighting Committee in favour of obtaining a Provisional Order has been endorsed by the District Council.

Price of Gas in the County of London.—The Gas Light and Coke Company is making hay while the sun shines (if such an expression can be allowed for London). The Company have decided to increase the price of gas to 3s. per thousand. This increase is coincidental with the notification of the decrease in the price of electric current by the City of London Electric Lighting Company. The two circumstances together should act as a fillip to the electric light. We are ourselves users of both commodities, and have no hesitation in saying that the electric lighting at *The Electrician* offices, which superseded gas, has proved decidedly economical in use—even at 8d. per unit. Users of gas for power purposes in the City of London may perhaps derive consolation from the fact that the Directors of the Gas Light and Coke Company have no powers for charging a lower rate for gas supplied for this purpose, and gas users generally will be glad to learn that the Directors hope they will not have to continue the additional charge for any prolonged period, it apparently being only necessary in order to keep up the maximum dividend allowed by law. Meantime we hear numerous complaints against what is described as the saviour of the gas companies, viz., the penny-in-the-slot meters. The increased charge now to be made for supply through these not particularly accurate instruments is to be 1d. per 22 cubic ft. of gas, which brings the price (always supposing the meter registers accurately and not too severely in favour of the companies) to 3s. 9½d. per 1,000. Seeing that the installation of these meters involves a disfigurement of the apartment into which the pipes are taken, and that there is an outside probability that the gas companies will later on make a charge for installing these as they now do for putting in stoves and other appliances, it is reasonable to anticipate a short life for the penny-in-the-slot gas meter which, as before mentioned, is supposed to have come to the rescue of the holder of gas securities. What would be the effect upon gas shares if the public took anything approaching a general dislike to these meters and the companies had the apparatus and connections to remove and the meters thrown upon their hands? Already owners of property are inserting into their leases and tenancy agreements clauses prohibiting the installation of these meters or fittings on their properties. These objections all go to the credit of the electric light, because the tendency is for the gas companies to increase their charges in all possible directions, bringing the superior illuminant nearer every day to universal adoption.

Post Office Concessions.—By a series of concessions about to be made by the Post Office, it is stated that an annual extra cost of over £80,000, in addition to the £308,000 entailed by the adoption of the proposals of the Tweedmouth Commission, will be involved. Under the new arrangement men employed in the construction of telegraph lines are to have a grant of lodging money when the work involves absence from home. Sunday work is to be increased to the old rate of double payment, under certain conditions. With regard to the holidays, arrangements are to be made which will ensure these falling more nearly within the better months of the year than hitherto. The telegraph branch of the service does not appear to benefit very materially by the new arrangements.

Private Bill Legislation.—The Bill promoted by the Eastern Telegraph Company, which originated in the House of Lords, will pass as an unopposed measure through that House, no petitions having been lodged against it.

The City and Brixton Electric Railway Bill has been sanctioned by a committee of the House of Commons. The railway will have stations at Brixton-hill, Lorn-road, Kennington Oval (in conjunction with the existing City and South London station), Kennington Cross, Lambeth, St. George's-circus and King William-street, where there will be another connection with the City and South London, who have now a new tunnel in course of construction under the Thames in connection with their extension to Islington. Mr. Charles Mott (chairman of the City and South London Company) gave evidence as to the preliminary steps which had been taken to ensure the raising of the capital of £1,200,000 necessary for carrying out the work. The first directors are the Hon. Cecil Farrer and Messrs. C. S. Grenfell, J. Crowther and S. B. Howard.

The Norwich Electric Tramways, and the Charing Cross, Euston and Hampstead Railway Bills have been read a second time in the House of Commons, and committed.

The Brighton Undeground Electric Railway Bill has been withdrawn.

Reigate.—The Town Council have passed resolutions in favour of establishing electricity works, and have authorised the Electric Lighting Committee to engage a consulting electrical engineer to assist them in devising a scheme. At the meeting of the Council last week Mr. F. H. Medhurst was in attendance and answered

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various questions as to the most suitable system of supply for the district. He would recommend a high-tension alternating current system as being the most economical for a district like Reigate and Redhill. The initial expense of an installation would be about £15,000.

St. George the Martyr, Southwark (London).—The Board of Trade have intimated to the Vestry that they cannot grant them a Provisional Order, as two companies already possess electric lighting powers for the district.

St. Luke's (London).—At the last meeting of the Vestry the Works Committee presented an important report, in which it was recommended that the City-road, Finsbury-pavement, Old-street, Golden-lane, &c., be lighted by means of arc lamps. The matter was discussed at some length, but eventually the Committee undertook to take the report back and further consider the matter.

Sheffield.—In the Bill for the purchase of the undertaking of the Sheffield Electric Light and Power Company the Corporation are also seeking powers to carry on the business of wiring contractors, and to engage in the manufacture of electric light fittings and appliances, the object of the Corporation being presumably to settle definitely the legal position of local authorities in this matter, so far as the Sheffield Corporation is concerned. A meeting of the wiring contractors and others interested in the electrical trades in Sheffield, was held on Monday evening, in order to protest against the action of the Corporation in asking for such far-reaching powers, and it was resolved to oppose the Bill, with a view of having the "wiring and manufacturing" clause withdrawn. Mr. W. Johnson, electrical engineer, of 2, Victoria-street, Sheffield, is acting as secretary to the opposing body of contractors.

The Electric Light Company have just announced a reduction in the price of electric current from 5d. to 4d. per unit and the City Council, as prospective owners of the undertaking, have offered no objection to this course. At the recent meeting of the local Gas Company the chairman (Sir F. Mappin) made reference to the electric light. He quoted figures as to the cost of electric and gas lighting, of course much to the disadvantage of the former. He felt confident that the Gas Company would continue to prosper and its proprietors had nothing to fear from the electric light. Needless to say, the reduction of 2d. per thousand in the price of gas which has just been made is only a proof of this fearless attitude.

Southport.—A Local Government Board inquiry was held here yesterday by Col. C. H. Luard, R.E., into the application of the Town Council to borrow £21,178 for electric lighting purposes. The electrical engineer (Mr. C. D. Taite) has been instructed to report as to the cost of lighting by arc lamps certain main thoroughfares.

Stirling.—Mr. R. F. Yorke, electrical engineer, of Glasgow and Stirling, has been appointed by the Police Commissioners to prepare a report on the sufficiency of the water power available at their reservoirs for the generation of electric current for street lighting.

Taunton.—Messrs. Kincaid, Waller and Manville have been appointed consulting engineers for the electric light extension scheme of the Town Council. Mr. Manville has already inspected the works, and his report will be presented in due course.

The London Telephone Service.—A conference of local authorities in London was held in the City Council Chamber, Guildhall, yesterday (Thursday) for the purpose of considering the present condition of the London telephone service. Mr. A. C. Morton, who presided, said that 36 out of the 41 authorities in London, besides the Corporation, had signified their intention of sending delegates, and 25 had stated that they had already applied for an official inquiry. A letter had been received from the Chairman of the National Telephone Company (Mr. J. Staats Forbes), and was read by the town clerk (Sir John Monckton). In his communication Mr. Forbes said that his Board would be the first to admit that the service, as at present conducted, left much to be desired, but that was not for want of will on the part of the Company, nor for want of skill and money to cope with the business, but for the want of those reasonable facilities at the hands of the local authorities of London without which it was absolutely impossible to conduct the business with the highest efficiency. It was true that in some few cases such powers had been granted in disconnected portions of the London area, but apart from this the Company's network of lines accommodating now close upon 17,500 subscribers, existed upon sufferance, and was subject to constant interference and interruption by persons who, from caprice or other motives, inflicted heavy losses upon the Company, and serious inconvenience on the subscribers. Under such a condition of things perfect telephony could not possibly be obtained, whilst, of course, it told directly against economy of working, and while it lasted the telephone service must continue to be both inefficient and (relatively) costly. The London area covered 609 square miles; there were 17,371 subscribers at the end of the year; the average subscription was £14. 10s. 6d., equal to 5s. 7d. per week, day and night, including Sundays; and it had been computed by the general manager that during the year there were 30,000,000 of effective calls on the part of the London subscribers, involving 30,000,000 of replies—together 60,000,000 conversations. Those conversations involved an average of 200 spoken words, and each conversation cost the subscriber about one penny. When account was taken of the fact that the Company was subject to a Government tax of 10 per cent. of its gross receipts from exchange business, and to charges for way-leaves amounting to a very large annual sum, one penny a message bore but a small proportion to the actual value to the bulk of subscribers for the use of such a marvellous adjunct to the transaction of business. In conclusion, he expressed the willingness of the Directors of the Company to meet any committee the Conference might appoint. Resolutions declaring the service inadequate, inefficient and costly, and calling upon the Treasury to hold an inquiry into the matter were unanimously adopted. A resolution "that it was undesirable that the local authorities should give permission to lay wires underground until the interests of the public are duly secured by statute, as in the case of tramways and electric lighting, and subject always to the previous consent of the road authorities," was also carried, and the resolutions were ordered to be forwarded to the Treasury, the Corporation of London, the London County Council, the Vestries and Local Boards of the Metropolis, and also to every Corporation in the United Kingdom.

The Telephone in Italy.—The City of Naples is provided with an excellent telephone service by the Société Générale dei Telephoni, which has a concession for 25 years, the Government receiving 10 per cent. of the subscriptions. This Society also conducts the telephone business of Rome, Bologna, Catania, Florence, Livorno, Messina, Palermo, Venice, Genoa, and San Remo. Turin and Milan are supplied by another Company, which is likely shortly to be absorbed in the Société Générale, which will then actuate practically the entire public telephone service of Italy. The annual tariff for a radius of nearly two miles is about £7. 10s., with an additional 4s. 6d. per annum for every eighth of a mile beyond that radius. Naples has 650 subscribers.

Tunis.—From a recent report we learn that a network of telephone exchanges exists connecting the large towns in the Regency of Tunis. There are also 64 telegraph stations working in the Regency, the rates being 5 centimes per word with a minimum of 10 words.

Walsall.—The Electric Lighting Committee have reported to the Town Council that there had been a great increase in the number of customers of the electric light department during the past year. After paying all expenses and allowing for interest and sinking funds there was a deficiency of £531. 17s. 7d. on the year's working.

Watford.—The Board of Trade have notified their approval of the electric lighting scheme proposed to be adopted by the District Council. The tenders for plant recently advertised for were opened on Wednesday, and then sealed up pending the Local Government Board inquiry into the application for borrowing powers.

Whitehaven.—The Local Government Board recently refused to sanction the application of the Town Council to borrow £7,500 for electric lighting purposes, on the ground that the Council have not power to supply electric current outside the area prescribed in their Provisional Order of 1891. The Town Clerk, however, pointed out that £6,000 of the sum was required for carrying out extensions within the present area, and asked the Board to reconsider the matter. The Local Government Board asked for further details, which have been supplied. A Sub-Committee of the Water and Lighting Committee has been formed to consider and report upon the advisability of obtaining an Order for the whole of the town.

Willesden.—The District Council are applying for a Provisional Order in the present session of Parliament, and, in anticipation of the Council's application being granted, the Electric Lighting Committee recommended, at the last meeting, the appointment of an electrical engineer for the purpose of preparing and carrying out an electric lighting project. The recommendation was approved.

York.—Col. A. G. Durnford, R.E., held a Local Government Board inquiry on Friday last at York into the application of the City Council to borrow, amongst other sums, £20,000 for electric lighting purposes. The town clerk (Mr. W. H. Andrew) appeared in support and said that the area proposed to be lighted comprised Coney-street, Spurriergate, High Ousegate, and Parliament-street, Low Ousegate, Clifford-street, Market-street, Fossegate, Davygate, St. Helen's-square, Stonegate, Lendal, Museum-street, and St. Leonards. The consulting engineer (Prof. A. B. W. Kennedy) furnished technical details of the scheme. The station would be erected on Foss islands, a piece of land belonging to the Corporation and situate at the side of the river Foss.

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Smoking Concert.—The last concert of the session of the Electro-Harmonic Society will be held in the Banquet Hall, St. James's Hall, Regent-street, London, on Friday evening next, the 25th inst., at 8 o'clock.

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office." No. 9. Vol. LXXXII. Published by authority of Congress. (Washington: Government Printing Office.)

"Professional Papers of the Corps of Royal Engineers." Edited by Capt. R. F. Edwards. Vol. XXIII. 1897. (Chatham: Royal Engineers' Institute.) Price 10s. 6d.

"The Official Gazette of the United States Patent Office." No. 10, Vol. LXXXII. Published by authority of Congress. (Washington: Government Printing Office.)

COMPANIES' MEETINGS AND REPORTS.

Chelsea Electricity Supply Company (Limited).

The annual ordinary general meeting of this Company was held yesterday (Thursday) at their head office, 19, Cadogan-gardens, S.W., under the presidency of Mr. J. Irving Courtenay.

The SECRETARY (Mr. S. J. Cluer) read the notice convening the meeting, and the Directors' Report and statement of accounts were taken as read.

The CHAIRMAN then said: You have before you the Directors' Report and audited accounts for the year 1897. It is a pleasure to me to be able again to report to you a continual improvement in the results obtained. The £60,000 Ordinary share capital subscribed in 1896 did not rank with the ordinary capital previously subscribed until 1897, and, notwithstanding this additional capital, the increase in the business enables us to show a profit which will allow of 6 per cent. being paid on the Ordinary shares, as compared with 5 per cent. on the smaller capital of previous years, carrying forward a balance of £1,652. 4s. 1d. to meet contingencies. It has always been our policy to lean to the side of prudence, and not to increase the dividend until we felt well assured that we could maintain the rate in succeeding years. That the public is now fully alive to the value of the electric light is amply demonstrated by the substantial addition to our circuits of over 16,000 lamps during the year, and the large increase in the use of the light generally throughout the metropolis and in the provinces. This fact is of itself an explanation of the necessity for the expansion in capital expenditure, and so long as this expenditure brings an increasing return, none will have cause to complain. We have added a valuable security to your property in the form of freehold land, and substantial buildings on this land, to the extent of over £20,000, and have increased the plant, machinery, mains and meters by nearly £35,000. Our progress during the year has been continuous and steady, and it really seems as if an average of 16,000 or 18,000 lamps annually will continue to be added. We must, however, make provision for somewhat larger additions, because it frequently happens that a new estate will be completed, and shops and offices all opened at once. Constant care is exercised by the staff in watching the progress of the various estates. You are aware that we are making considerable extensions into the western portion of our district. A sub-station is being built for this purpose in that quarter. The new sub-station in Pavilion-road is, we believe, of sufficient capacity to cope with the maximum demand ever likely to arise in its neighbourhood. We have laid during the year about 9¼ miles of casing, which is capable of accommodating about 36 miles of conductor; and we have actually drawn in during the year some 16¼ miles of conductors into the ways just mentioned. There were added during the year 16,178 lamps, or their equivalent in the twelve months, so that the total number of lamps on December 31st was 96,758, since which, I am pleased to tell you, we have passed the 100,000. At this point I may conveniently allude to the Bill which has been promoted by this Company in Parliament, and duly approved by the shareholders, for the compulsory purchase of property adjoining to and in the neighbourhood of our works in Chelsea, but as the matter is now before Parliament I consider I am at liberty only to say a few words. We have been compelled to take this step, not only by the very long delays in negotiations for sites—delays which are extremely prejudicial to our interests, and may at any time cause grave injury to the business by preventing the Company from erecting new buildings and adding to its capacity in time to supply the public demand for light in Chelsea—but because of the practical impossibility of purchasing quite apart from mere delay: in short, the position is that we cannot buy at all. Without going into the matter more fully, I suggest it is reasonable that electric light companies, having statutory obligations to fulfil for the convenience of the public, should have powers to enable them to duly perform those obligations. I think they should have the same facilities and equal protection with railways or tramways and other public companies having statutory obligations. You will agree that the necessity for some such relief as would be afforded by the Bill we have promoted is urgent. I now come to the revenue account, in which there is a satisfactory increase, but there is nothing in the figures which calls for any special explanation. The cost of production has been slightly reduced, and from the character of our district, the improvements introduced in our machinery, and the indications in the present accounts, we may fairly expect progressive improvement in the return on capital. You will have observed the item in the balance sheet under the head of sundry expenses as being the subject of litigation. I am glad to say that this matter, which has reference to delay in delivery of some plant, has been settled amicably in a manner satisfactory to the Company. You will also have noticed that besides providing for the maintenance of plant and buildings we have placed £2,000 out of profits to the renewals fund, and have considerably strengthened the position of the Company by carrying the premiums to the extent of £20,851 to the reserve fund, making the total of that fund £36,717. In regard to vibration troubles I need only say that our works are now equipped with the most recent type of plant, and every precaution that the best practical experience can suggest has been taken, and as we have in addition made a careful inspection of the property in the neighbourhood, we have no fear of the ultimate issue of any complaints that may be made against the Company. I now move:

"That the Report of the Directors and Statement of Accounts for the year 1897, now before this meeting, be and they are hereby adopted, and that the payment of dividends of 6 per cent. on the Preference share capital and on the old issues of £130,000 Ordinary share capital for the year 1897 be and is hereby approved; also that the payment of a dividend at the rate of 6 per cent. per annum on the instalments of £1 per share from the due date of the instalment to December 31, 1897, on the new issue of 8,000 shares (in accordance with the terms of the prospectus of October 15, 1897) be and is hereby approved; all the dividends to be payable forthwith."

Major-Gen. WEBBER, C.B., briefly expressed his pleasure and satisfaction in seconding the motion.

A short discussion followed, in which Mr. YOUNG, Mr. DEVONSHIRE and Col. DALE took part, general satisfaction being expressed at the improved position and prospects of the Company.

The CHAIRMAN, in reply, stated that the principle involved in their Bill had been referred to a Joint Committee of the two Houses of Parliament. The Chelsea Vestry had opposed the Bill, but he knew nothing about the reason for this beyond what he saw in the papers. Part of the Vestry's property was scheduled in the Company's Bill, and that would give them a reason for acquiring a *locus standi*. As to the Founders' shares, he unfortunately had never had any. They had not yet considered the question of coming to some arrangement with the holders of the Founders' shares, as the Directors had so far been too busy in arranging to meet the growing demands on them for the supply of electricity. They had pursued the regular course in regard to the issue of shares, and they had always thought it wise to take precautions with the view of avoiding any failure of the issue. They had not made any special arrangements for supplying motor cars, but he had no doubt they would be able to supply them when the cars came forward in sufficient numbers. He then put the motion and it was carried unanimously.

The retiring Director, Mr. G. N. Marten, was re-elected, as was also the Auditors, Messrs. Cooper Brothers and Co.

On the motion of Mr. Daubeny, seconded by Col. Dale, a cordial vote of thanks was passed to the Chairman and Directors, and the proceedings then terminated.

County of London and Brush Provincial Electric Lighting Company (Limited).

The fourth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Monday, under the presidency of the Right Hon. Lord Rathmore.

The SECRETARY (Mr. H. B. Renwick) having read the notice calling the meeting,

The CHAIRMAN congratulated them on the steady progress made by the Company since their last meeting, on the good position in which they stood, and on the encouraging prospect which seemed to be opening for them. He might sum up the general result of their operations by saying that the interim dividend on their Preference shares was paid last June, that the final dividend for the year was provided for in the accounts, and that the sum of £10,090 had been carried forward. Comparing the results of the past twelve months with those of the preceding year, they would have observed that the net revenue amounted to £20,875, as against £5,904, while the gross receipts, which were £8,485 in 1896, had been £25,371 in 1897. A large proportion of these receipts was from profits on investments realised. Anyone who had considered how these arrangements had been carried through must be well satisfied with the result, for which they were much indebted to the able advice and assistance of their colleague, Mr. Braithwaite. It was also satisfactory to observe that they had already derived a substantial profit from their London stations, amounting to £2,521 from St. Luke's and to £1,281 from Wandsworth, making together £3,802, When they remembered what exceptional difficulties they experienced in the preparatory stages, and bore in mind that their two stations were only started for the supply of current during the year—in the case of St. Luke's so recently as September last—they would agree with him that these earnings were on the whole as large as they could reasonably have expected, and gave good promise of what they hoped might follow. Turning to the balance-sheet, he stated that the remainder of the Ordinary share capital had been issued, making the total of capital paid £509,808, and leaving the sum of £90,000 falling due in the current year. A substantial premium was received on the second issue of the Ord

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nary shares, as they would have observed, and this was applied to the reduction of the preliminary expenses, to the writing-off of costs in connection with Provisional Orders, and in increasing their reserve fund which now stood at £5,000. The loans against security had been reduced from £53,600, as they were in 1896, to £29,700. The sundry creditors amounted to £58,344, which was nearly all represented by plant, machinery, and cables, and was more than covered by the amount of sundry debtors on the other side of the balance sheet. As to the assets, they would see that a further sum of £141,066 had been invested in their London districts —a very promising investment. The preliminary expenses, which stood in 1895 at £18,478, had been reduced from time to time, and now amounted only to £8,800. As to the Company's investments, some changes had occurred during the year, the most important of which was that they had disposed of their interest in the Bournemouth and District Electricity Supply Co. They had, however, reserved an interest in that undertaking, for they had obtained a certain number of the Ordinary shares in the Bournemouth and Poole Company, which they believed would before long form a very valuable asset. The sundry debtors amounted to £71,545. This was largely in respect of their interest in the Bournemouth and District Company, and it had now nearly all been collected. Their metropolitan stations were those in which they had invested most of their capital, and they were those to which they looked for their largest profits in the future. With regard to Bournemouth, this station had now surmounted the difficulties with which it had hitherto had to contend, and the interest which this Company had retained in this district was represented by 3,500 Ordinary shares in the Bournemouth and Poole Company. In the Dover Company, the progress of which during the past year was, he thought, considering all things, very satisfactory, they still held practically the whole of the Ordinary shares. The gross profit there for the year had been £1,127, as compared with a loss of £455 in 1896. During the early part of last year a contract was entered into for a supply of electricity to the Corporation's tramways. Altogether there seemed to be a good future before the Dover Company. In regard to Richmond, the progress which had been made was in every way satisfactory, and their colleague, Mr. Frederick W. Reynolds, who was chairman of the local company, and its other directors might fairly be congratulated on the result. A dividend of 3 per cent. had been paid on the share capital of that company, and the whole of this dividend had gone into this Company's coffers. In regard to their London stations, the broad policy adopted by the Company from the first in dealing with electricity supply for the County of London had been the establishment of two large generating stations—one on the north side and one on the south side of the river—each capable of meeting the wants not only of its immediate neighbourhood, but also of supplying the requirements of other localities, for which they had hoped to obtain lighting orders. That hope had not been disappointed, and at that moment they had by far the largest area of any electric lighting company in London. Their plan was founded on the belief that such a policy would be seen by experience to be more economical and satisfactory than the policy of setting up smaller generating stations, which had been too often adopted, and which had led to an expenditure in London, on lands and buildings alone, of £1,300,000, representing at 5 per cent. a standing charge of about £65,000 a year, besides an expenditure in London for the staff and management of these many and scattered undertakings of the enormous sum of £115,000 per annum. It was believed that had the wiser policy of fewer stations for supplying several districts been adopted, those large figures might have been reduced probably by two-thirds. He ventured with all respect to suggest to the vestries of the smaller areas of London who might be now thinking of embarking on electric lighting schemes of their own to ponder whether it might not be wiser to supply their wants in that direction by means of established companies—their own, for instance, which, owing to its larger preparations for business, and its special technical experience, must presumably be able to give a more satisfactory supply, and at moderate rates, without material reduction of its just profits. He did not conceal that this advice was not wholly disinterested, but at the same time it was sincerely offered, and he believed it would be found most useful if it were adopted. They had erected a fine station in the City-road, adjoining the Regent's Canal, so that the carriage of their coal and other material would be cheap and easy. They had to encounter many delays and disappointments, both in St. Luke's and Wandsworth, in the early stages of their preparations; but these difficulties had now all been overcome. The building at St. Luke's was finished, and the plant installed there was capable of supplying the equivalent of 80,000 8 c.p. lamps connected. Since September 8th last a continuous and regular supply had been maintained, to the general satisfaction of their customers in this district. They had good ground, he thought, for expecting that the demand for electric light in the St. Luke's and Clerkenwell district would steadily increase. Then there was the adjoining district of Holborn, as to the eastern portion of which the Provisional Order was confirmed to them in the last Session of Parliament; and work having been at once commenced, current was now available. As to the western portion of Holborn, and also St. Giles-in-the-Fields, they had secured the consent of the local authorities to their application for Provisional Orders, which now awaited the sanction of Parliament. There were several other districts on the north side of the Thames, and in the East End of London, for some of which they had already obtained, and for others of which they were seeking, the necessary authority to enter, and all of which they would be able to supply for years to come from their station in the City-road. So far, he had been speaking of electric lighting only; but he was glad to be able to tell them also that they were confirmed in their anticipations of a large demand in those districts for the supply of electric current for motive power. Special mains for the supply of such current had been laid throughout the principal thoroughfares, and he believed that all preparations had been completed, and that that evening the batteries would be charged for the service. Their Wandsworth station, on the south side of the river, was a fine building, situated at the point where the Wandle joined the Thames. It was completed, and the plant now installed there had a capacity of supplying more than 40,000 8 c.p. lamps connected, while there was space in the building for machinery to supply three times that number. He was glad to inform them that from that vast area a very encouraging demand had already sprung up; and if a year ago they somewhat overestimated what the first year's working in St. Luke's would produce, they under-estimated it for Wandsworth. They had as yet, too, been able only to touch but a small part of the areas which they hoped ultimately to supply from their Wandsworth station. It was a satisfactory symptom that the new houses in course of erection in this large area were being more and more fitted for electric lighting. In Camberwell there was already a considerable demand for motive power, as well as for electric lighting. He hoped he had satisfied them, that having regard to the extended area with which they had to deal, the policy they had adopted bade fair to be justified by experience on both sides of the river. It was a policy which involved, no doubt, heavy capital expenditure at first and a certain delay in obtaining a substantial revenue in return. In their case this delay had been lengthened by various accidents, but they had done with large capital expenditure for years to come, both as regarded buildings and machinery. The further capital expenditure they had to make would, he expected, be principally for laying down mains—an expenditure, however, which, when it became necessary, none of them would regret, for the mains were the immediate sources, if he might use this expression, of their profits. It was true that they had not yet been able to declare a dividend on their ordinary capital, but they had been able to do something which was practically nearly its equivalent, for when they allotted 10,000 Ordinary shares last December of £10 each their market value was £15, and they were allotted at par to their Ordinary shareholders in the proportion of one share for three already held, giving a bonus of about £1. 13s. 4d. on each share, which was equal to a dividend of about 5 per cent. per ann. for the last three years. He knew too well the uncertainties which must always wait upon such enterprises as theirs, but, speaking in all moderation, he thought he might say that their present position was very satisfactory and encouraging, and that they had the probability of a large and lucrative business before them. He concluded by moving the adoption of the report and accounts.

The DEPUTY-CHAIRMAN (Mr. J. B. Braithwaite, jun.), in seconding the motion, stated that the Chairman had put before them the three essential features which it seemed to him (the speaker) were worth the attention of the shareholders with reference to the present position and the prospects of their undertaking. The Chairman had pointed out to them that they already possessed an area for the supply of electricity very much larger than that of any other similar company with which he (the speaker) was acquainted. Their area was many times greater than that of the City of London Company, with the formation of which he was also intimately associated. The second point referred to by the chairman was the policy they had adopted at the outset of getting through with their building operations at once. That was a policy which, had it been adopted by some of the great railway companies in regard to their terminal stations, would have saved them many millions of capital expenditure. He believed the policy followed by their Company in this respect would not be regretted by the shareholders in years to come. The third point to which the chairman had alluded, and which he himself desired to emphasise, was the unique position the Company occupied for supplying motive power. Theirs was the only Company which had laid down special plant for this purpose. For his part he believed that the future of the Company in respect of certain of its districts as regards the supply of motive power, would be equal to its future in connection with electric lighting.

The CHAIRMAN then put the motion, and it was carried unanimously.

Resolutions were afterwards passed for re-electing the retiring Directors, declaring the dividend on the Preference shares, and re-electing the retiring auditor.

Mr. E. K. SMART afterwards proposed a resolution for increasing the Directors' remuneration from the £1,000 mentioned in the articles of association "to the following sums, viz.: For the year 1898 £2,000, for the year 1899 £2,500, for the year 1900 and thereafter £3,000 per annum."

The motion was seconded by Mr. P. D. TUCKETT.

A discussion followed, in the course of which the principle of increasing the Directors' remuneration was generally approved, but it was thought that it would be sufficient to deal with one year only, and to discuss the question again at the next meeting; and an amendment was eventually carried, on a show of hands, limiting the increase to £2,000 per annum for the present year.

A cordial vote of thanks was then passed to the Chairman and Directors.

The CHAIRMAN acknowledged the vote, and, in reply, testified to the valuable services rendered to the Company by the engineer and manager (Mr. A. J. Lawson), the secretary, Mr. H. B. Renwick, and the staff.

The proceedings then terminated.

House-to-House Electric Light Supply Co. (Limited).

The tenth ordinary general meeting of this Company was held on the 11th inst. at Winchester House, Old Broad-street, London, E.C., Mr. Hy. Ramié Beeton presiding. The secretary (Mr. Thos. J. Owens) read the notice convening the meeting.

The CHAIRMAN said: In moving the adoption of the report and accounts I should like to call attention to the fact that the satisfactory features which have characterised the working of our undertaking of late years have repeated themselves during the past year. The extension in the demand for electricity has continued undiminished, and a further reduction in the cost of production has been effected; so that our increased revenue has again been earned without any appreciable addition to our expenditure, and the increase of profit is larger than in any previous

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year in the Company's history. In regard to the future, the applications so far received from new consumers during the current year exceed those received at the corresponding date last year, and although the cost of production cannot be indefinitely reduced, there is no reason to believe that finality has been reached in this particular. Already our works-cost is nearly as low as those of other metropolitan supply companies whose output is four and five times larger than ours, while our capital outlay per unit of productive power compares most favourably with that of our neighbours, notwithstanding that most of them are more favourably situated than we are. The credit of this position, of which we may justly be proud, is largely due to the ability and devotion of the Company's engineer and manager, Mr. Bowden, to whom the thanks of the shareholders are due. I should like to call attention to a plan which we have recently inaugurated for advancing the popularity of the electric light in our district, which we commend to the notice of our consumers and to the emulation of our neighbours. Alone among the electric lighting companies in the metropolis to-day, we are prepared to give householders a limited installation, not only free of all initial expense, but free from any additional charge for electricity. We believe that when consumers realise that they can enjoy the electric light without incurring any capital expenditure, and especially leasehold consumers whose expenditure would not benefit their own property, many will be disposed to adopt the electric light in preference to gas, and as we can make a larger profit on the same number of lights in the form of many small installations than in the form of fewer large installations, it will pay us to expend the capital necessary to extend our business in this way.

The motion was adopted, and dividends of 4 per cent. on the Ordinary and the balance dividend of 7 per cent. on the Preference shares duly declared.

A vote of thanks to the Chairman and Directors terminated the proceedings.

Birmingham Electric Supply Company (Limited).

The annual meeting of this Company was held at Birmingham on Thursday last. The Chairman (Mr. H. Buckley) moved the adoption of the report, which appeared in our last issue, and said that that was the first time in the history of the Company that they had recommended a dividend of 5 per cent. At the close of 1895 they had the equivalent of 18,199 16-c.p. lamps connected; at the end of 1896 25,876, and 1897 39,232. In 1895 they sold 490,000 units, in 1896 a little over 756,000, and last year more than 1,133,000. The increase of 1897 over the previous year was 56 per cent. and for practical purposes they might consider the increase of 1896 over 1895 was about the same percentage. They were rapidly filling up the central area, the sphere of their original operations. As to the jewellers' quarters, they were satisfied that in time it would be remunerative, but he was bound to say that none of the Directors expected it to be so remunerative in so short a time. The position in Edgbaston was entirely to the satisfaction of the Directors. The extension of the works at Dale End had been carried pretty well to their maximum. The extensions in Water-street were making rapid progress, and the demands upon the Company for current were such that they were fully justified in ordering more boilers and engines, so that they might be ready for the increased output in the autumn. The business increased day by day, and he was sure that it only remained for the advantages to be more intimately known by manufacturers requiring small power to have the number of motors increased in Birmingham to an enormous extent. Looking at the profit, they must bear in that it had been made in connection with the reduction in prices. The reduction in the price of current had led to such an increase in the demand that it had thoroughly satisfied them that the step they took was a wise one. He referred to the appointment of a Corporation committee to consider the question of the acquisition of the Company's undertaking. If the City Council thought it advisable to acquire the undertaking it would not be necessary to increase the capital; if, on the other hand, they were willing to leave it in the hands of the Company it would be necessary to raise the capital. The amount would not all be issued for a considerable time, nor would the Directors issue any portion of it without first consulting with the shareholders. In his opinion the reserves and undivided profits of £22,536 would compare favourably with any other undertaking of a like kind in the country. The report was then adopted, and the Chairman proposed that the capital of the Company be raised from £200,000 to £300,000 by the creation of 20,000 additional Ordinary shares of £5 each. This proposition, having been seconded, was agreed to.

Isle of Man Tramways and Electric Power Company (Limited).

The annual meeting of the proprietors in this Company was held at Douglas on the 10th inst., Mr. Alexander Bruce presiding. The Chairman said that, although they had an increase in their receipts, still their profits were less. That arose from various causes, some of which they could minimise. The Jubilee demonstrations, the bad weather, and the engineers' strike were responsible for a considerable falling-off in their receipts. He then referred to the receipts and expenditure from their horse-drawn sections, which worked out at 48·78 per cent. of the receipts. The Company's cable-drawn sections had proved an immense boon to the upper portions of the city, but a severe loss to the Company. The Directors and the Company's staff had had a most anxious time with this part of their service, which, on the slightest carelessness or indecision on the part of the driver, meant trouble and loss. They had now a more competent body of drivers, who he trusted realised how much of the successful working of this section depended upon them. The Company had been put to great trouble and expense in training these men for the proper discharge of their important duties. They had even sent some of their cable-car drivers to Edinburgh to perfect themselves there. He would now turn to a pleasanter subject. On the electric systems they had carried 602,068 passengers, the miles run being 155,927, the traffic receipts per mile 27·68, and the expenditure 43·34 per cent. of the total receipts. The falling-off in their gross receipts was owing to the dull and stormy weather during the four best weeks of the season, causing passengers to limit their excursions to short distances, and consequently to pay smaller fares. He then dealt with the Laxey-Ramsey extension so far as it affected the interests of the shareholders in the Isle of Man Company. They had had some difficulties as to a portion of the route, but these had all been overcome. In order that they might have the very best system for the extension they had sent Mr. Aldworth, Mr. Shaw (their electrical engineer), Mr. Knowles (their engineer), and Mr. Thomas, to inspect several of the best electrical systems in England. Previous to this Mr. Aldworth and Mr. Shaw went to the Continent for the same purpose, and visited the towns where the most modern systems of electric traction had been adopted, and these gentlemen had come back much impressed with their visit. They had then to consider the difficulty of arranging for the supply of the requisite plant and machinery for the equipment of the line, as theirs was a narrow gauge—only 3ft. as against the standard gauge of 4ft. 8½in.—with very severe gradients, and the standard types of equipment were entirely unsuitable for working it; so that the greater part of the machinery had to be specially designed and made to suit the peculiar requirements of the line and traffic. The Isle of Man Company were interested in the Laxey-Ramsey extension in two ways—first, to have a tramway made and equipped in such a manner as would reflect credit upon the Company, and more especially upon their good and valuable officers; and secondly, as contractors who were responsible for the undertaking, that it should in every way come up to the specifications. They had therefore called in the services of Mr. James Walker, who was well known to them, to report upon the estimate for the permanent way. They had also communicated with Mr. Granville Cunningham, managing director of the City of Birmingham Tramways, and recently of Montreal, who had had charge of the electric tramways there, and who was also a consulting electrical engineer in Canada. This gentleman had been called in by the Glasgow Corporation to inspect and advise them upon the electrical equipment of their tramways, and his report to them was to the effect that their arrangements and estimates are entirely satisfactory. Regarding the power station, accumulator house, &c., Mr. James Cowle had been consulted, and he had given them a satisfactory report, so that the Directors had done everything necessary to ensure a good permanent way, the most modern system of electrical equipment, and buildings of a substantial character, combined with economy. And they would employ almost exclusively local labour. They had practically created an industrial technical school, and all the practical work and equipment of the line would be done by their own people, who would be taught practically the construction of the electrical apparatus which they have to handle, and no firm or firms across the water could take the same interest in the construction and equipment as they were doing. Of the prospects of the near future for both companies they would be able to form a judgment soon, as the line would be open for traffic in July.

The report and accounts were adopted, the retiring Directors re-elected, the auditors re-appointed, and a cordial vote of thanks to the Chairman, Directors, and the engineering and electrical staff of the Company approved.

Sheffield Electric Light and Power Company (Limited).

The Directors of this Company have issued the following report for the year to Dec. 31 last:—

Balance from last account	£99	12	11½
Net profit for the year	11,392	16	8
	£11,492	9	8
Interest paid on Debentures	1,125	0	0
Balance	£10,367	9	8
Required for a dividend at the rate of 12½ per cent. per annum (tax free)	9,464	11	8
Balance forward	£902	18	0

The recent issue of shares was wholly taken up, and realised a premium of £3,792, the greater portion of which the Directors have applied to the reserve and depreciation funds, the latter fund now standing at £6,642. 13s. 1d., and the reserve £2,970. 3s. 8d.

The whole of the machinery and plant of the Company is in excellent order and condition. Notwithstanding the reduction in the price of current from 6d. to 5d. per unit the Directors are glad to report that the increased demand has fully justified the course adopted. The revenue from the sale of current for the five completed years of the Company's operations is as under:—

1893	£3,555	11	0	1896	£11,257	15	4
1894	4,849	9	4	1897	14,318	17	0
1895	6,935	4	1				

During the past year £19,980. 1s. 11d. has been expended upon machinery, mains, and other appliances. The offices and show-rooms in Commercial-street are now approaching completion. New machinery has recently been laid down having a distributing capacity of 450 kilowatts, and further orders have been placed representing a distributing capacity of 1,200 kilowatts. In connection with the proposed sale of the Company's undertaking to the Corporation, the Directors issue an interesting review of the negotiations, &c., from the first intimation from the Corporation of its intention to purchase to the

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present time. The statement is, however, too lengthy to be given in full here, but the present position of affairs may be briefly stated as under :—

The first intimation of the Council's intentions was made in March, 1897, and dragged on to the December 7th last, when Mr. Justice North gave his decision in the Corporation's action in regard to the issue of irredeemable stock in favour of the Company, dismissing the action, with costs to be paid by the Corporation. On December 15th the Corporation desired to re open negotiations, and on January 13, 1898, made an offer of £220 Sheffield Corporation Redeemable Stock for every £100 of the capital properly expended by the Company on their undertaking, and chargeable to capital account, the sale to take effect from September 29, 1897, and the capital expenditure to be limited to £112,000, any expenditure beyond that amount to be repaid with 5 per cent. interest only, and, acting upon this offer, and subject to the approval of the shareholders, the Directors propose to transfer to the Corporation the whole of the Company's undertaking and property, the following being the main features of the terms provisionally agreed upon :—

(1) The capital expenditure to December 31, 1897, is agreed at £124,472. 7s. 5d.

(2) The Corporation to transfer to the Company £220 2½ per Cent. Redeemable Sheffield Corporation Stock for each £100 of the capital properly expended by the Company up to a total of £118,500 (with an option to the Company to require £213. 8s. in cash for each £220 of stock, and the sum of £5,972. 7s. 5d., being the balance of the capital expenditure, is to be repaid to the Company with 5 per cent. interest from date of payment.

(3) The Corporation to pay such a sum as, with the dividends declared by the Company, will be equal to an aggregate dividend of 5 per cent. per annum on the total capital expenditure from the date or dates of such expenditure to December 31, 1897.

(4) The Corporation to take over the book debts, stock, and stores of the Company, paying the proper value therefor.

(5) The Corporation require further Parliamentary powers to carry out the agreement, and as from December 31, 1897, until completion of the sale the Company is to be entitled to a dividend at the rate of 10 per cent. per annum upon the paid-up capital.

This agreement is to be laid before the shareholders on the 21st inst.

Oxford Electric Company (Limited).

The report of the Directors of this Company for the year to Dec. 31 last states that the revenue account shows a profit of £3,996. 17s. 5d., to which has to be added £13. 17s. 6d., and £537. 7s. 6d. brought forward, making £4,548. 2s. 5d. After providing £1,499. 1s. 10d. for debenture and loan interest the available balance is £2,846. 5s. 5d., and the Directors propose to appropriate £500 to renewals of machinery and plant, and £2,327. 8s. in payment of a dividend at the rate of 5 per cent. per annum, leaving £18. 17s. 5d. to be carried forward. The £25,000 of 5 per cent. debentures outstanding at the date of last accounts have been redeemed at a bonus of 5 per cent., and replaced by an issue of £35,000 debenture stock at 4 per cent. interest. The premiums received on a further issue of 2,000 shares made in March last exceeded the bonus paid on the redemption of the debentures by £13. 17s. 6d. The gross receipts of the year have been to some extent affected by a reduction in the price of current to consumers from Jan. 1.

Since the last report 2,630 equivalent 8-c.p. lamps have been connected, bringing the total to 21,364. The plant at the generating station has been increased during the year by a 500-H.P. engine ond a boiler of 200-H P. capacity. A new transformer station has also been equipped, and two additional transformers connected to the system. A line of 3in. iron pipes has been laid from the works at Osney to a central position in the city, to provide for extensions of the high-tension feeding system, and to enable the supply to be controlled entirely from the works. The cost of these additions to plant and extensions has been provided by the proceeds of the 2,000 shares issued during the year.

South London Electric Supply Corporation (Limited).

The first report of the Directors of this Corporation states that the works are proceeding in a satisfactory manner. The question of obtaining a suitable site for an electricity generating station and refuse-destructor works presented much difficulty, and caused unavoidable delay. The inconvenience was, however, fully compensated for by the ultimate acquisition of the most favourable site for the purposes of the Corporation within the parish of Lambeth. The land is freehold and consists of three acres on the north-west side of the London, Chatham and Dover Railway between Loughboro' Junction and Denmark Hill stations. Possession was obtained at Michaelmas, 1897, when the contractors, Messrs. Manlove, Alliott and Co. (Limited) were instructed to proceed with the erection of the necessary buildings and dust destructor. Arrangements have been made by which current is being obtained from a neighbouring electric supply company, pending the completion of the station, and thus the nucleus of a promising business is being formed. About two and a-half months have elapsed since a portion of the mains were made available for a supply of current. The total number of 8-c.p. lamps for which energy has already been applied for amounts to 2,659.

The whole of the issue of share capital offered last March, amounting to £325,000 has been subscribed, thus placing the Corporation in a strong financial position, and obviating the necessity of curtailing the contracts, which at one time appeared inevitable. As so short a time has elapsed since the commencement of operations, and no electric supply had been made up to the end of 1897, the accounts merely take the form of a balance-sheet to Dec. 31, showing the position of the Company at that date. Already about 21 miles of mains have been laid in about eight miles of streets. The necessary machinery and plant are being constructed as rapidly as possible.

NEW COMPANIES, STATUTORY RETURNS, &c.

BEST AND LLOYD (LIMITED).—This Company was registered on March 8 with a capital of £50,000, in £10 shares, to acquire and carry on the business of manufacturers of chandeliers and electric fittings carried on under the style of Best and Lloyd at Handsworth, Staffs., and the business of red lead manufacturers carried on at Handsworth under the style of J. and H. Lloyd, and to enter into an agreement with Robert H. Best. The first Directors are: R. H. Best (Chairman), W. R. Nicholl, G. Vale and J. Pinckston.

IMPROVED ELECTRIC GLOW LAMP COMPANY (LIMITED).—This Company's annual return to Dec. 30 shows that the capital is £100,000, in £1 shares, of which 73,390 have been taken up; 33,390 have been issued as fully paid, and the full amount has been called on the others.

INTERNATIONAL TELESCRIPTOR SYNDICATE (LIMITED).—The annual return to March 3 has been filed. The capital is £10,000, in £1 shares, all of which have been taken up; 9,993 have been issued as fully paid, and nothing has been paid on the remaining 7 shares.

JULIUS SAX AND COMPANY (LIMITED).—The annual return to Jan. 10 has been filed. The capital is £20,000 in £10 shares, all of which have been taken up; 1,993 shares have been issued as fully paid, and no calls have been made on the others.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 25½d. per oz. (March 17). Consols (2¾ per cent.) 111⅛—111⅜ for money, 111⅛—112 1/16 for account; 2½ per cent. 105—105½ (March 17). Stock Exchange Settling Days: Consols, April 1; Stocks and Shares Continuation Day, March 28; Ticket Day, March 29; Pay Day, March 30; Mining Share Carry-over Day, March 26.

AKKUMULATORENWERKE SYSTEM POLLAK.—This Company has paid a dividend of 8 per cent. for the past year, compared with 6 per cent. in 1896.

ALUMINIUM INDUSTRIE AKTIENGESELLSCHAFT.—A dividend at the rate of 12 per cent. for the past year has been declared.

BRITISH INSULATED WIRE COMPANY (LIMITED).—The first ordinary general meeting of the shareholders of this Company was held on Wednesday, at Liverpool, Mr. W. Marriner Brigg presiding. The Chairman, in moving the adoption of the report and accounts, an abstract of which appeared in our last issue, expressed the pleasure of the Directors at meeting the shareholders under such happy circumstances. They had already found it necessary to enlarge their working premises, and further buildings were in progress in order to enable them to keep pace with the orders in hand. Fortunately, their area of land at present was large enough for the extensions required, and already a competent authority had informed them that they had the most complete and best laid out works in the country. When the new Company took over the business they had £200,000 worth of orders on hand. The figure now stood at £300,000, and personally, he felt confident that ere long they would require a further issue of capital in order to keep pace with the demands upon them. He was satisfied that they could employ a very much larger capital profitably. He, therefore, felt entitled to congratulate the shareholders both as to what they had already done, and on the excellent prospect before them. Mr. Berry seconded the motion, which was unanimously adopted, and a dividend at the rate of 15 per cent. was declared. The retiring Directors, Messrs. W. M. Brigg and S. Z. de Ferranti, were unanimously re-elected, and Messrs. Chalmers, Wade and Co. were reappointed auditors.

COMPAGNIE GENERALE FRANCAISE DES TRAMWAYS.—This Company proposes to increase its capital from 10,200,000fr. to 25,000,000fr. The new capital will be devoted to the conversion of the Marseilles and Orleans tramways into electrical lines.

CROMPTON AND CO. (LIMITED).—The Directors of this Company have notified the shareholders that, in consequence of certain differences of opinion between themselves and Mr. J. F. Albright as to the management of the Company's business, Mr. Albright is relinquishing his position as a managing director, and has also informed the Board that as soon as may be convenient to the Company he is desirous of resigning his position as a director. The directors have appointed Mr. F. R. Reeves, the Company's secretary, to the post of general manager, Mr. R. E. Crompton continuing to superintend the technical part of the Company's business. Arrangements have been made by which Mr. Albright undertakes for twelve months to give the Company all advice and information reasonably in his power.

CROYDON TRAMWAYS COMPANY.—At a meeting of the shareholders in this Company on Monday, a resolution was proposed by the Directors approving an agreement for the sale of the Company's undertaking to the British Electric Traction Company. The chairman, Mr. Wm. Stansfield, in recommending the proposal for the acceptance of the shareholders, stated that by this offer the Company would get a better price for their shares than if they allowed the lease of the undertaking to run out and to be bought up by the local authorities of Croydon. Considerable opposition was made by the shareholders present, and an amendment opposing the acceptance of the offer was carried by a large majority. A poll was demanded, and is to be held on the 24th inst. at 18, Eldon-place, London, E.C., between 11 a.m. and 2 p.m.

CROSSLEY BROTHERS (LIMITED).—The annual meeting of this Company was held at Manchester on Wednesday under the presidency of Mr. W. J. Crossley. The report stated that the profits for the year amounted to £93,701. A dividend of 7 per cent. was paid for the first half of the year on the Ordinary shares, and a further dividend of 8 per cent. was recommended to be paid for the second half. The sum of £30,000 has been carried to reserve and £1,601 forward. The Chairman said that the pre-

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sent was the best balance sheet that they had issued since the expiration of their patents in 1890. This was due to the increase in their output of engines, in which they were getting the benefit of the new machinery they had put in. In excellence of workmanship no one had yet touched them, and it was universally acknowledged that their engine was the best that could be put on the market. During last year they turned out 2,832 engines, and they had made a very good start for the current year, their output for February being a record one. The report was adopted.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for November were £3,413, against £4,545 in the corresponding month last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The Directors of this Company recommend the payment of a dividend at the rate of 10 per cent. per annum on the Preference shares, and a dividend (free of income tax) at the rate of 4 per cent. per annum on the Ordinary shares, for the half-year to Dec. 31 last.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment, on April 14 next, of interest of 3s. per share (less income tax), being at the rate of 6 per cent. per annum, on the Preference shares of the Company for the quarter ending 31st inst., and the usual interim dividend of 2s. 6d. per share on the Ordinary shares (free of income tax), in respect of profits for the quarter ended Dec. 31 last. The register of transfers will be closed from April 7 to 14 inclusive.

HASTINGS AND ST. LEONARDS-ON-SEA ELECTRIC LIGHT COMPANY, (LIMITED).—The Directors of this Company in their report for the year 1897 congratulate the shareholders upon the increasing business of the Company. The receipts for the year exceeded those of 1896 by £1,633, whilst the works cost only increased £157. The Corporation has taken over and paid for the mains, lamp-posts and other plant relating exclusively to the public lighting. The Company is, however, still supplying the current required for the public lighting, and will probably continue to do so for some time longer. The Directors have entered into a provisional contract for the sale of their undertaking to the Corporation, who are applying to the Board of Trade for a Provisional Order to enable them to carry this contract into effect. The result of the past year's trading is exceedingly satisfactory, and shows a net profit of £1,990. 18s. 4d., out of which the Directors recommend a dividend at the rate of 6 per cent. (absorbing £1,633. 4s.). It is proposed to place £300 to reserve account.

At the meeting of the Company on Tuesday the chairman (Mr. F. A. Langham) said it was evident they now had a good and prosperous concern, and nothing showed it more than the increase set forth in their report. In the last three years the consumption of current had more than doubled, from 23,822 units to over 55,000. As to the agreement with the Corporation, the Directors had safeguarded the interests of the Company, and in the meantime they took the profits, and money expended upon the capital account since the date of the contract would be repaid by the Corporation.

IMPERIAL TRAMWAYS COMPANY (LIMITED).—The annual report of the Directors of this Company to Dec. 31 last states that the construction of the Middlesbrough, Stockton and Thornaby electric tramways was commenced on Sept. 1, and the permanent way, extending to 15 miles of single line, was practically completed at the end of February. Satisfactory progress is also being made with the buildings of the power station and depots as well as the electric equipment, and it is anticipated that the completed system will be opened for public traffic within the present half-year. Dividends at the rate of 6 per cent. per annum on the Preference and Ordinary shares are recommended. The Directors are giving consideration to a suggestion made by shareholders, that having regard to the improved value of the Company's assets, arrangements should be made for the Ordinary shares to be written up to their former nominal value of £10 each. A reprint of the Directors' report recently issued by the London United Tramways Company (in which the Imperial Company is largely interested) is given, and states that a Bill to authorise the extension of about 11 miles of tramways and the use of electric traction thereon has been deposited. In Hammersmith the extensions provide for a line from the terminus of the Central London Electric Railway at Shepherd's Bush through Brook Green to the Broadway, Hammersmith, and two cross-town lines to link up the Company's Acton and Chiswick main lines, and also the doubling of the Goldhawk-road branch. The consent of the Hammersmith Vestry has already been given, and the Highways Committee of the London County Council recommend that body also to consent, subject to certain conditions. Important extensions of the Company's system outside the County of London are also proposed—viz., an extension of the Acton line through Ealing to Hanwell, and an extension from Kew Bridge through Brentford to Hounslow, with a cross-town branch connecting Brentford and Hanwell. The consent of the Acton Council has been given to the first extension and to the use of the overhead trolley system of electric traction on the existing lines and extensions. The Ealing Council refused their consent on the plea that they do not want tramway lines in their district; but they agree that, if they ultimately approve, it will be for an electric tramway. The Hanwell Council had not dealt with the Company's proposals. It is also proposed to authorise connecting lines across the new Kew Bridge, and to double the line to Richmond. The consents of the Brentford and Hounslow Councils have been given to the extensions coupled with the overhead system of electric traction, but the Richmond Council and Kew Bridge Committee have not yet finally considered the proposals. In conclusion, the Directors state that they believe the local authorities are beginning to recognise the great advantages which accrue to any district through which an efficient electric tramway system is put into operation.

LIVERPOOL DISTRICT LIGHTING COMPANY (LIMITED).—The general meeting of this Company was held last week, Mr. A. H. Holme presiding. The Chairman said the Company was now in a position to supply electricity from two stations. That at Waterloo was complete with machinery embodying the latest improvements, and they had orders to supply 635 lights. The plant was capable of extension so as to supply 3,600 lights. The station at Gateacre was finished so far as the building was concerned, but owing to the engineering strike they had been unable to obtain permanent plant. There was a large demand for electric current in the neighbourhood, the present orders being for 454 lights. The two stations were thus supplying 1,100 lights. They were paying expenses, and he had no doubt it would not be long before they paid a dividend. At present the charge for electricity at Waterloo and Gateacre was 8d. per unit. Liverpool had reduced its price to 6d., but if the Company obtained a large number of customers they would be able also to reduce the charge. They had considered the question of wiring premises free of initial cost, but so far they could not see their way to do so.

LUDWIG LOEWE AND CO. (BERLIN).—This Company has declared a dividend of 24 per cent. for the past year, the same as in 1896.

ROBEY AND CO. (LIMITED).—After writing off £5,825 for depreciation there was a net profit of £25,209 on the year's working of this Company. Deducting debenture interest and adding the sum brought forward from last year, there is an available balance of £18,545, and a dividend at the rate of 5 per cent. per annum has been declared, the same rate as in 1896. £4,000 has been carried to reserve and £770 carried forward. A very satisfactory report indeed. Messrs. Robey and Co. do not appear to have been seriously affected by the strike.

SIEMENS AND HALSKE (VIENNA).—The Vienna businesses of Messrs. Siemens and Halske, together with the various Austro-Hungarian branches of that firm, are to be formed into an independent company.

SMELTING CORPORATION (LIMITED).—A prospectus of this Company which is formed with a capital of £600,000, and has an influential Board of Directors, is to be issued in a few days.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION (LIMITED).—The ordinary general meeting of the shareholders of this Company will be held at Winchester House, London, E.C., on Monday, 21st inst., at 12 noon. The transfer register will be closed from the 20th to the 30th inst. inclusive.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed Wednesday, the 23rd inst., as a special settling day in the further issue of 10,000 £10 (£2 paid) Ordinary shares (Nos. 30,001 to 40,000) of the County of London and Brush Provincial Electric Lighting Company (Limited), and have ordered the same to be quoted in the Official List. The Committee has also been requested to appoint a special settling day in and to grant a quotation to £200,000 Three and a-Half per Cent. First Mortgage Debentures of the Westminster Electric Supply Corporation (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 11 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,996.

WILLANS AND ROBINSON (LIMITED).—The registers of transfers and members of this Company will be closed, prior to the ordinary general meeting, from the 16th to the 30th inst. inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Mar. 12	3,279	- 28	...	...	...
Bristol Trams & Carriage	„ 11	2,260	+134	10	23,396	+ 3,446
City & South London Ry.	„ 13	1,077	+ 46	11	11,796	- 10
Dover Tramways	„ 12	100	...	27	2,980	...
Dublin United (Southern)	„ 11	381	- 11	11	3,976	- 330
Liverpool Overhead Rly.	„ 13	1,330	+ 50	11	14,824	+ 813
Sheffield Tramways	„ 13	884	+ 38	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price March 9.		Price Wednesday, March 16.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 19. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.					£ s. d.			
£19,126	£10	8/0	Central London Ordinary	10¼	11	10¼	10⅜	2 11 1	June and December	10⅜	10¼
143,106	10	1/9⅜	Do. (£6 paid)	6⅜	7	6¼	6⅜	2 13 4	„ „	6⅜	6⅜
£630,000	Stock	1¾%	City and South London Railway Con. Ordy.	67	69	65	68	2 15 2	January and July	68⅛	67⅜
8,419	£10	5%	Do. 5% Perpetual Preference	15	16	15	16	3 2 6	„ „	..	..
£ 35,701	Stock	4%	Do. 4% Perpetual Debenture	138	140	138	1 0	2 17 2	May and November	..	..
540,000	Stock	3%	Waterloo and City Ordinary	13½	14	136	139	2 3 2	June and December	139	..
87,500	10	3½%	Liverpool Overhead Railway Ordinary	10¼	10½	10¼	10⅝	3 0 2	February & August	—	—
10,000	10	5%	Do. 5% Preference	15½	16¼	15¼	16⅛	3 1 6	„ „	—	—
125,000	Stock	4%	Do. 4% Debenture	108	110	108	110	3 11 5	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price March 9.	Price Wednesday, March 16.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 12. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£923,960	Stock	19/6	Anglo-American	59 61	59 61	4 18 4	Feb., May, Aug., Nov.	--	--
£3,038,020	Stock	30/0	Do. Preferred	108 109	108 109	5 10 4	" "	108½	108
£3,038,020	Stock	5/0	Do. Deferred	11½ 12	11 11⅛	--	" "	12 11/16	--
£37,400	£100	4%	*African Direct Telegraph (Red)	100 104	100 104	3 16 11	January and July	103	--
£25,000	10	--	Amazon Telegraph	6½ 7½	7 8	--	" "	--	--
130,000	10	3/0	Brazilian Submarine	16¾ 17¼	16¾ 17¼	4 1 2	Mar., June, Oct., Dec.	17 1/16	16¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112 116	112 116	4 6 2	June and December	--	--
10,000,000	$100	$2½	Commercial Cable Capital Stock	187 192	187 192	4 3 6	Jan., Apr., July, Oct.	189½	--
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	106 108	106 108	3 14 1	" "	107½	106¾
16,000	10	6/0	Cuba Submarine	7 8	6½ 7½	9 6 8	February and August	7½	7
6,000	10	10%	Do. Preference 10 per Cent.	14½ 15½	14½ 15½	6 9 0	" "	15	14½
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 8 11	April and October	--	--
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	10⅝	--
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞ 106⅞	103⅞ 106⅞	4 4 11	January and July	--	--
60,710	£20	3/0	Direct United States Cable, 1877	10⅜ 11½	10⅜ 11½	5 15 7	Jan., Apr., July, Oct.	11½	11 1/16
400,000	£10	2/6	Eastern	17⅜ 18½	17⅜ 18½	3 11 3	" "	18½	17½
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18½ 19½	18½ 19½	3 1 6	" "	19½	--
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	129 132	123 131	3 2 0	May and November	129	--
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100 103	100 103	4 17 1	February & August	--	--
250,000	10	2/6	Eastern Extension	18¾ 19½	18¾ 19½	3 13 8	Jan., Apr., July, Oct.	19½	18¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	130 133	128 131	3 1 8	February & August	130	--
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99 103	99 103	4 17 3	January and July	--	--
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99 103	99 103	4 17 3	" "	100½	--
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102 105	102 105	3 16 2	February & August	--	--
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞ 111⅞	108⅞ 111⅞	3 12 1	May and November	--	--
180,227	10	1/9	Globe Telegraph and Trust	11⅜ 12½	11⅜ 12½	3 17 7	Jan., Apr., July, Oct.	12⅜	1 1/16
180,042	10	6%	Do. 6 per Cent. Preference	17½ 18½	17½ 18	3 6 8	" "	17½	--
150,000	10	5/0	Great Northern of Copenhagen	29 30	29 30	3 6 8	January, April, July	29½	--
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	100 103	100 103	4 17 1	March & September	--	--
17,000	25	12/0	Indo-European	52 56	52 55	4 10 11	May and November	54½	53½
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	106 109	106 109	5 10 1	March & September	--	--
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105 108	105 108	3 13 5	June and December	--	--
11,839	8	4/0	Reuter's	8 9	8 9	4 8 11	April and October	--	--
3,381	£100 Cert.	--	Submarine Cables Trust	139 144	--	--	" "	--	--
15,609	10	6/0	West African Telegraph	4½ 4¾	4 5	5 0 0	--	--	--
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	101 104	101 104	4 16 2	March & September	--	--
30,000	10	--	West Coast of America	¼ ¾	¼ ¾	--	--	--	--
£150,000	100	4%	* Do. 4 per Cent. Debentures	105 107	105 107	3 14 9	June and December	--	--
88,321	10	1/0	West India and Panama	½ ¾	½ ¾	--	May and November	⅝	--
34,553	10	6/0	Do. 6 per Cent. 1st Preference	8 8½	8 8½	7 1 2	" "	8	--
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5 7	5 7	8 11 5	" "	6½	--
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105 108	105 108	4 12 2	January and July	--	--
64,256	15	3/0	Western and Brazilian	11½ 11¾	11½ 12	2 10 0	May and November	11⅝	11 3/16
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½ 8	7½ 8	3 15 2	" "	--	--
33,129	7½	1/6	Do. Deferred Ordinary	3¾ 4½	4 4½	--	" "	4 1/16	3¾
£382,230	--	4%	Do. 4 per Cent. Debenture Stock	106 109	106 109	3 13 9	June and December	108	107
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105 110	105 110	6 7 10	Feb., May, Aug., Nov.	--	--
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100 105	100 105	5 14 3	March & September	--	--
			TELEPHONES.						
44,000	£5	4/0	Chill Telephone (fully paid)	3 3½	3 3½	5 14 4	August	--	--
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1 1/16 1 1/16	1 1/16 1 1/16	--	July	--	--
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2 2½	2 2½	8 0 0	October	--	--
484,597	5	3/0	National	6½ 6¾	6½ 6¾	4 8 11	February & August	6¾	6½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	16 18	16 18	3 6 8	" "	17½	--
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	15 17	15 17	3 10 7	" "	--	--
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	5¾ 6¼	5¾ 6¼	4 0 0	" "	6	5¾
1,329,471	Stock	3⅛%	* Do. Debenture Stock, 3⅛% (red.)	104 104	102 107	3 6 0	June and December	--	--
171,504	1	0/4	Oriental	⅝ ¾	⅝ ¾	6 13 4	April and October	--	--
58,000	5	5/0	United River Plate	4 4½	4 4½	5 11 1	July	--	--
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	106 109	106 109	4 12 7	June and December	106½	--
			ELECTRICITY SUPPLY COMPANIES.						
£200,000	5	4½%	Birmingham Electric Supply (fully paid)	10½ 1 3/16	10¾ --	--	March	--	--
50,000	£10	20/0	City of London Electric Lighting (fully paid) xd	28 29	26 27	3 14 1	February & August	28⅝	27
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid) xd	17½ 18½	17½ 18½	3 4 10	January and July	18¾	--
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129 134	129 134	3 14 3	June and December	132½	131½
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	13½ 14⅛	13½ 14½	2 8 6	February & August	14½	13⅝
20,000	5	2/1	Do. 4½ per Cent. Preference	6 6½	6¼ 6¾	3 6 8	" "	6¾	--
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	-- --	-- --	--	January and July	--	--
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	11½ 12	1 1/16 11⅞	3 3 10	March	11⅞	--
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	115 117	115 117	3 17 5	June and December	--	--
£30,000	£10	--	County of London & Brush Prov. Ord. (fully paid)	14⅜ 15½	14⅜ 15½	--	--	15⅜	15⅛
20,000	£10	6/0	Do. 6% Cumulative Preference	15⅜ 16¼	15⅜ 16¼	3 13 10	March & September	16 3/16	--
10,000	£5	--	House-to-House Electric Lighting Supply Ord.	11 12	11 12	--	--	11⅜	11⅛
10,000	£5	7%	Do. 7 per Cent. Preference	11⅜ 12½	11⅜ 12½	2 17 2	March & September	12½	11⅜
111,000	£5	--	London Electric Supply Ordinary	4 4½	4 4½	--	--	--	--
48,050	£5	--	Do. Preference	6⅜ 7¼	6½ 7	--	--	--	--
49,900	10	5/0	Metropolitan Electric Supply Ordinary	20½ 2 3/16	20½ 21½	2 11 2	April and October	21⅜	20⅞
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	20 21	20½ 21½	--	" "	--	--
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117 121	117 121	3 13 6	June and December	119	--
6,452	10	12/0	Notting Hill Electric Ordinary xd	20 21	19½ 20½	2 18 6	March	20½	20⅜
275,000	1	--	Rand Electric	1 1/16 1 1/16	1 1/16 1 1/16	--	--	--	--
£125,000	Stock	5%	River Plate Elec. Lt. Tr'c'n, Ltd., 5% 1st Mor. Deb.	90 95	90 95	5 6 6	--	--	--
150,000	$100	$2	Royal Electric Company of Montreal Shares	145 147	145 147	--	--	--	--
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105 107	105 107	4 4 1	April and October	--	--
19,980	5	11/0	St. James and Pall Mall Electric Ordinary	18½ 19½	18½ 19½	3 14 4	February & August	19½	18½
20,000	5	3/6	Do. 7 per Cent. Preference	10 11	10 11	3 3 6	" "	11	10⅝
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	107 110	107 110	3 13 1	June and December	--	--
67,900	5	8/0	Westminster Electric Supply (fully paid)	17½ 18½	17½ 18½	3 4 10	March & September	18	17½
			ELECTRIC MANUFACTURING, &o., COMPANIES.						
90,000	£3	5%	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	--	--	2 1/16	1⅞
90,000	2	1 2/3	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	4 16 0	--	2⅜	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110 114	110 114	3 18 11	February & August	--	--
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102 105	102 105	4 3 2	June and December	--	--
20,000	£10	--	British Aluminium Ordinary	-- --	-- --	--	--	--	--
20,000	10	--	Do. 7% Cumulative Preference	-- --	-- --	--	--	--	--
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	9 10	9 10	5 0 0	June and December	9½	--
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	110 113	110 113	4 0 0	" "	--	--
200,000	1	--	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	--	--	--	--
28,130	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	2½ 2¾	2½ 2¾	--	--	--	--
£52,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	86 91	86 90	5 12 4	January and July	--	--
99,261	5	1/6	Edison and Swan United ("A" Shares) (£3 paid)	2½ 3	2½ 3	5 10 0	February & August	--	--
17,139	5	2/6	Do. (£5 paid)	4 5	4 5	5 10 0	" "	4½	--
£200,000	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.)	103 105	103 105	3 16 2	June and December	--	--
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅝ 2⅞	2⅝ 2⅞	3 13 1	February & August	2⅞	--
16,343	2	7/-	Do. 7 per Cent. Cumulative Pref.	3½ 3⅝	3½ 3⅝	4 3 4	August	--	--
91,156	1	10/0	Elmore's Patent Copper Depositing	½ ¾	½ ¾	--	--	--	--
12,500	10	18/0	Henley's Telegraph Works Ordinary xd	23 24	22½ 23½	4 3 4	February & August	--	--
3,000	10	7/0	Do. 7 per Cent. Preference xd	19 20	18½ 19½	3 11 10	" "	--	--
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 3	" "	113	--
80,000	£10	15/0	India Rubber, Gutta Percha, &c., Works	21½ 22½	21½ 22½	4 8 11	" "	22½	21⅜
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	104 108	104 108	3 14 6	March & September	106⅜	--
£7,350	10	12/0	Telegraph Construction and Maintenance xd	37 40	34 39	4 12 4	March and July	40	37½
£ 50,000	100	5	* Do. 5 per Cent. Bonds (red.) 1899	102 105	102 105	4 15 8	January and July	--	--
£75,500	£5	3/6	Willans and Robinson Ordinary	8 8½	8 8½	4 2 4	April and October	8⅝	--
£72,500	£5	3/0	Do. 6% Cumulative Preference	7 7½	7 7½	4 0 0	" "	7½	7
£100,000	Stock	4½%	* Do. 4½% First Mort. Debs.	106 108	106 108	3 18 6	May and November	108	106½

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

A REMARKABLE report, a digest of which will be found in another column, has been drawn up by Mr. F. H. MASON, U.S. Consul-General at Frankfort, on the subject of American competition in Europe. Among other claims advanced on behalf of the United States, it is alleged that not only is that country steadily capturing the bulk of the iron and steel industry of the world, but that the only hope European nations have of retaining any portion of their engineering manufacturing trade lies in their adoption of American machine-tools and other labour-saving devices, together with American methods. Notwithstanding the high rate of wages paid in the United States, it is contended that iron and steel, whether unfinished or in machinery, can compete with British and Continental articles on their own ground. For example, "Bessemer pig iron"—whatever that may be!—is stated to cost from 10s. to 15s. per ton less than that made in Great Britain. Indeed, we know that steel rails of American make are being sold in this country cheaper than our home manufactures—it is stated, at a profit; and the influx of American electrical plant and machinery is too well known to our readers in touch with the practical side of electrical engineering to need detailed illustration.

MODERN civilisation, with its steam power, its electrical power transmission and its telegraph system, cannot fail to produce a radical change in the relative industrial importance of different continents and countries. Conditions, which half a century ago raised an almost insuperable barrier against export trade from the interior of a vast continent, have disappeared, and other conditions have taken their place and to a certain extent tell against the favoured monopolists of industry in bygone days. Thus the very elements of material civilisation which were discovered and fostered by British enterprise have aided other countries in their effort to rival our commerce, and have been the main instruments in opening up and developing the industrial capacity of foreign lands. But it does not follow that, because we are now seeking to maintain against competition the industrial position we created during a monopoly, we are under any necessity to lose ground. No change in the elements of material civilisation can deprive us of our national pluck and enterprising spirit. All that can happen is that our enterprise and pluck will be directed along modified channels. Our great fault, as a nation, is excess of conservatism; and the incubus of numerous and important vested interests conspires with that fault to throw obstacles in the way of radical changes in our industrial methods. Our engineering manufacturers are, however, awakening to the fact that such changes are imperative; and, whether by the importation of American labour-saving apparatus and American ideas, or by rousing ourselves into activity to devise such apparatus for ourselves, the retention of that supremacy in engineering industry which Great Britain has hitherto held can only be ensured by falling into line with the new order of affairs, and adapting ourselves more perfectly to a palpable change in our commercial environment.

THE Paper on "The Cost of Generation and Distribution of Electrical Energy," an abstract of which was read last evening before the Institution of Electrical Engineers by Mr. ROBERT HAMMOND, is a voluminous compilation, largely consisting in tabulated data of the financial working of electric supply concerns of the United Kingdom. The subject is one that opens up a labyrinth of possible points for discussion, and we hope to comment upon the Paper in detail as soon as we are able to give our readers an account of the discussion upon it.

MR. OLIVER HEAVISIDE'S masterly series of articles on "Electromagnetic Theory" touches this week upon a subject of special interest, whether to students of theory or to engineers and practical electricians—namely, on the propagation of electric waves and their attenuation in the process. The discussion of this subject is materially assisted by a number of diagrams, in which the attenuation of the wave from various causes and in several stages of its progression are pictorially presented, and it is possible that this form of illus-

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tration may lend additional attractiveness to the article in the eyes of those who profess to be alarmed at "mere equations." Starting with the fundamental fact that the elements of any form of electromagnetic wave travel at the same speed, and alternate similarly, Mr. HEAVISIDE reviews the various conditions affecting the time-variations of the voltage and the distortion and attenuation of the wave itself. We commend the article, as indeed Mr. HEAVISIDE's entire serial, to all who are interested in long-distance and oceanic telephony and high-speed telegraphy over wires involving the consideration of capacity and inductance as well as leakage and line-resistance.

DR. FLEMING's lecture at the Royal Institution yesterday afternoon was chiefly devoted to consideration of the relation between the magnetic properties of ferromagnetic bodies and their temperature. Among the many experiments with which the discourse was illustrated, two call for especial notice on account of their more than usual beauty. The first of these was designed to illustrate the fact that the temperature at which iron passes from the ferro- to the paramagnetic condition is not the same as that at which the opposite transition occurs; and it depended upon the existence of a thermoelectric action between magnetic and non-magnetic iron. A piece of steel wire was included in the circuit of a mirror galvanometer, one small part of the wire being heated by a flame. While the flame was stationary no deflection of the galvanometer needle took place, but whenever the flame was caused to travel in either direction along the wire the difference in temperature between the junction passing from the ferromagnetic to paramagnetic state and the junction undergoing the reverse process upset the thermoelectric balance, and caused a current.

THE second experiment was even more beautiful, and displayed, incidentally, marvellous ingenuity in compensating for all the disturbances that tended to spoil it—compensation which, however easy in a laboratory, is replete with difficulties in a large lecture-room. It was designed to show that the temperature of recalescence is a critical temperature in the magnetic properties of ferromagnetic substances. A steel wire was arranged beside a compensated magnetometer, the wire being magnetised by a spiral around it and heated by a current through it. Two spots of light indicated respectively the changes in length or temperature and in the magnetisation of the iron. The important point brought out clearly by the experiment was that the recalescence point, as indicated by the transient reversal of motion of the pyrometer spot, coincided exactly with the passage from ferromagnetic to paramagnetic state, or the opposite, as shown by the magnetometer.

WHENEVER, in this matter-of-fact country of ours, a public educational institution becomes so popular that the demand for admission to its privileges exceeds the available accommodation, it is customary to adopt one of three remedies—either to extend the borders of the institution or to raise the standard of the entrance examination, or to exclude all sorts and conditions of students until vacancies arise. Whichever of these methods is adopted it is always impartially carried out. In Germany they do things differently. The Committee of Council on Education have received, through the Foreign Office, a communication from Her Majesty's Ambassador at Berlin to the effect that no further applications for admission to the mechanical engineering department of the Technical High School at Charlottenburg, near Berlin, can be received after April 1st next from persons not of German nationality, as the increase of students in that department has been so great that the accommodation is overtaxed.

Free Wiring.—The Norwich Electricity Company have joined the ranks of supply concerns who have adopted the "free" wiring system, charging their customers 8d. and 4d. per unit, instead of 7d. and 3½d. The Company are also supplying motors on the three years hire-purchase system.

Cable Interruptions.—

	Date of Interruption.
Latakia—Cyprus	Feb. 10, 1898
Saïgon—Hong Kong	Feb. 28, 1898
Gibraltar—Tangier	Mar. 19, 1898
Lorenco Marques—Durban	Mar. 19, 1898
Cayenne—Pinheire	Mar. 24, 1898

Institution of Electrical Engineers.—Too late for insertion in our usual notices of meetings we have received intimation that a Students' meeting of the Institution of Electrical Engineers will be held next Wednesday, at 7:30 p.m., when Mr. M. R. Gardner will read a Paper on "Electrical Instruments."

Appointment.—We have pleasure in announcing the appointment of Mr. R. T. Glazebrook, F.R.S., to the post of Principal of University College, Liverpool. Mr. Glazebrook's contributions to modern physical science are so well known to our readers that, though of prime importance and merit, they need no recapitulation by us on this occasion. The appointment is one to which Mr. Glazebrook will do abundant credit.

A Severe Magnetic Storm.—The *Daily Weather Report* of March 16 records a severe magnetic storm observed at the Kew Observatory on 14th, 15th and 16th inst. It is said to have been severer than any experienced since August, 1894. The extreme amplitude of the disturbance was:—horizontal force, 0·0050 C.G.S. units; vertical force, 0·0057 C.G.S. units; declination, 1min. 26sec. In eight minutes, from 10:40 to 10:48 p.m. on the 15th, the horizontal and vertical components exhibited falls of 0·002 and 0·003 C.G.S. units respectively. The most rapid change of declination occurred some 30 minutes later.

Obituary.—Sir John Tilley, K.C.B., who was secretary to the General Post Office from 1864 to 1880, died last Friday after a long illness. He entered the General Post Office in 1829 as a boy, and rose step by step, being appointed assistant secretary in 1848. The deceased knight was 85 years of age.—We regret also to announce the death, on Monday morning, of Colonel H. C. S. Dyer, who was prominently connected with the firm of Sir W. G. Armstrong, Whitworth and Co. His name will be particularly familiar to our readers through his having been Chairman of the Employers' Federation during the recent engineering strike.

The Post Office and Telephones.—In the House of Commons, on Thursday last week, Sir Mark Stewart asked the Secretary to the Treasury, as representing the Postmaster-General, whether it was the practice of the Post Office to substitute a telephone for a telegraph where the guarantors have signed an agreement with the Post Office for a telegraph service; and, if it were so, would he state the reasons. Mr. Hanbury said in reply that the hon. member was no doubt aware that it has been judicially decided that the definition of telegraph includes a telephone. In agreements of the kind referred to there was no provision as to the particular form of instrument to be used. The guarantee for a telegraph extension was based on the most suitable method of serving the office, and if a telephone was used it was because it offered advantages over other forms of telegraph apparatus, either in regard to initial cost, maintenance, or working.

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Tests of a Combination Incandescent Lamp Filament.—Herr R. Langhans has sent to the *Elektrotechnischer Anzeiger* particulars of tests on combination lamp filaments prepared according to his process. An analyis by J. W. Richards gave the following results of tests on two samples :—

	per cent.		per cent.
Carbon	30·5	...	34·9
Silicon	38·1	...	22·2
Other non-volatile constituents	22·5	...	26·7
Volatile constituents (in hydrogen at red heat)	7·4	...	15·5
	98·5	..	99·3

Prof. W. E. Ayrton, he goes on to say, sent his assistant, Mr. Medley, to Berlin to learn accurately Langhans' process and to produce some lamps himself by its means. Eight of these lamps were accurately tested, and Prof. Ayrton reports as follows : (1) The mean life is up to the present 606 hours, but, as three of the lamps are still burning, this value will increase ; (2) the mean consumption of power has been up to the present 2·92 watts per English standard candle-power ; (3) the mean fall in candle-power from the commencement of the test amounted to only 3·8 per cent.—One of the lamps, which has already burnt more than 600 hours, has still the same candle-power as on the first day it was used. This lamp had an efficiency of 2·72 watts per candle after 600 hours, its mean efficiency having been 2·68 watts per candle during that period.

The Lighting of Buffalo.—We learn from our American contemporaries that the Buffalo General Electric Company, at present supplied under contract with 3,000 H.P. from the Falls, has decided to build a new power-house at Buffalo, on the completion of which the old power-house will be given up and the use of steam power discontinued. Extra cables are to be run from the Falls to Buffalo (26 miles) on the pole line of the Buffalo Railway Company. The current is to be transformed at Buffalo from the line pressure of 11,000 volts to 360 by means of eleven 250 kilowatt air-blast stationary transformers, and afterwards, by means of frequency transformers from the 25∿ (per second) frequency at which the power is generated to that of 60∿ per second. The transformed current is to be used to operate 15 synchronous motors, each motor driving two 125-light Brush arc machines, also two rotary converters to supply the direct current power circuits, while a portion of the power is used as high pressure alternating current for inside arc lighting, &c. The Buffalo Company now supplies 2,862 arc lights, and it is expected that the installation of the new plant will be completed and the town lit from the new source within six months' time. We understand that the "frequency transformers" are of 400-kilowatt capacity, and are simply motor-generators ; but we must confess our inability to appreciate the point of transforming, at a necessary loss, the frequency of the current before use in operating the continuous-current plant unless it is intended to ultimately use alternating arcs for the outside lighting, for which purpose the use of current at 25 ∿ frequency is, of course, out of the question.

The Legalisation of Electrical Units in Germany.—A Bill is to be brought before the Reichstag for the legalisation of certain electrical units, to wit, the ohm, the amper (*sic*), and the volt. We are indebted to the *Frankfurter Zeitung* for the following particulars of the measure : The ohm is defined as the resistance of a column of mercury 106·3cm. long, and 1 sq. mm. section, at the temperature of melting ice, the mass of the column being 14·4521 grammes. The "amper" does not differ from our variety with two e's, being defined as the current depositing 0·00118 grammes of silver per second from an aqueous solution of silver nitrate, and the volt is defined in terms of the ampere and ohm. The Bundesrath is empowered to determine under what conditions the deposition of silver in the definition of the ohm is to take place, to fix names for the units of electrical quantity, work, power, capacity and induction, and for fractions of the various electrical units, and to determine in what manner the values of current, E.M.F., work and power of alternating currents are to be calculated. The use of any other units in instruments for the measurement of electrical energy supplied industrially is *verboten*, under penalty of a fine not exceeding £5 or four weeks' imprisonment, and the Bundesrath is empowered, after consulting the Physikalisch-Technische Reichsanstalt, to decide to what extent deviations in accuracy are to be allowable. The Physikalisch-Technische Reichsanstalt is to produce mercury standards of the ohm, and to provide for their control and safe keeping in various places. Standards of solid metal are to be checked yearly by comparison with the mercury standard. The Reichsanstalt is also entrusted with the duty of maintaining standard cells and standard resistances for the determination of the other units, and of performing official tests and standardisations, &c.

Street Railways in Massachusetts.—Our New York correspondent sends us the following interesting figures from the twenty-fifth annual report of the Board of Railroad Commissioners of the State of Massachusetts. It is interesting to compare these figures with those for previous years, given in Mr. Philip Dawson's recent Paper (see *The Electrician*, Jan. 28, 1898, p. 449), especially because, as pointed out by Mr. Dawson, of all the United States, Massachusetts is the one most closely resembling England in the habits of its people and in its local conditions. There are 93 railways in the state, 10 more than in the previous year, and 148 miles of single track have been added to the system by new construction, making the total mileage 1,516 (single-track measurement). Of this, 1,428 miles are operated by electricity, a gain of 186 miles over the previous year. An interesting fact in this connection is that the number of miles operated by animal power at the time of the report was only 12. The cost of construction of main track per mile ranges from about £2,000 in the country towns to over £19,400 in the city of Boston. Fifty out of the 93 companies paid dividends ranging from 2 to 10 per cent., and 43 companies declared and paid no dividends ; the highest dividend was 10 per cent. and the average 6·91 per cent. There are 6,908 electric motors in use, an increase of nearly 1,000 over the previous year. The ratio of number of passengers killed to total number carried was about 1 to 31,000,000, and the passengers injured 1 to 246,000, the total number of passengers carried being about 309,000,000.

Telephony in Germany.—In view of the growth of the German electric tramway lines, and the extensive use of the single-wire system for the telephones in that country, it is to be wondered at that the tramway and telephone interests have not come more into collision. An incident of the kind is reported from Elberfeld. The telegraph administration have protested against the running of the Neviges-Velbert electric light railway, as it disturbs the telephone traffic in the district. They request the company which owns the line to place the telephone lines between Elberfeld and Neviges (a distance of some five miles) underground. It is certainly high time that the German telegraph administration decided to adopt metallic circuits, and to place them underground in the towns, for at present the service is far from perfect, and it is notably bad in the manufacturing district of Rhenish Prussia and Westphalia, at the centre of which Elberfeld is situated. But an endeavour to compel the electric railway and tramway companies to do the work for them is not to be commended. The telephone administration in Germany do not treat their subscribers well either in the matter of instruments. It has decided to supply subscribers with only one receiver instead of two. If the subscriber wishes to have a second receiver, he must buy it for ten shillings from the administration, and they will "keep it in order" for him for a consideration. It is true that one German instrument of the pattern used by the administration, weighing as it does 1½lb., is bigger than two English ones, but yet the rule appears hardly fair. If the subscriber wishes a bell different to that offered him he has to buy it, and a desk instrument, in place of the usual wall set, cost five shillings a-year extra. If he objects to having the bell, battery box, and transmitter on the same wall, he has to pay a supplementary charge for the use of his own second wall. The only redeeming feature, in fact, of the German telephone service is its very low subscription rate.

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Alternate-Current Motors.—At the ordinary meeting of the Institution of Civil Engineers on February 22, Mr. L. B. Atkinson read a Paper on "The Theory, Design and Working of Alternate-Current Motors." The Paper was principally devoted to consideration of asynchronous motors. The author classified alternate-currents motors as follows:—(1) "Conductive Motors," in which the energy was conveyed to the armature through brushes. These might be series wound, shunt wound, or separately excited; in the latter case the phase of the E.M.F. producing the exciting current differed by a quarter period from that producing the armature current, thus forming an example of the application of multi-phase currents to alternate-current motors. (2) "Inductive Motors with brushes, having one inductive electric axis and one magnetic axis." In these the energy was supplied to the armature not through the brushes, but through the air gap; these motors in the simplest form had, however, a commutator for short circuiting the coils so as to produce a proper distribution of current in the armature. A modification of this class furnished a third class. (3) "Inductive Motors with brushes," in which there were "two reciprocal inductive electric and magnetic axes." The brushes might then be dispensed with, giving rise to a class of (4) "Inductive motors without brushes, having short circuited coils and two reciprocal inductive electric and magnetic axes," the modern induction motor. The author proceeded to examine in detail the theory of such motors, and showed how, by means of a diagram, its properties might be determined. It was then pointed out how in such a motor when running the supply on one phase might be eliminated, and the motor would remain self-exciting, furnishing itself a magnetising current in phase with the supply current, thus forming the modern monophase induction motor. The supply might be on any number of phases, to the same number of magnetic systems, provided that a proper relation existed between the two. The use of asynchronous motors as generators was next touched upon, and the author showed that the various motors explained might be used as motor generators, in which case not only the pressure but the phase of the current might be changed. In the second part of the Paper the author dealt with the design of alternate-current motors, and showed the necessary conditions to produce the proper distribution of currents in the armature and of the magnetic field, and further gave a formula for determining the proper loading of the armatures, and from this showed how all the other dimensions of a machine for any given power might be derived. The wave form and frequency as affecting alternate-current motors were discussed, and examples were given showing to what extent the necessary conditions were realised in practice. In the third part the author dealt with the practical construction and working of asynchronous motors, and taking each class described, illustrated them by examples so far as they existed, and tests where these were available. This part was illustrated by curves and data relating to a large number of different classes of motors. Curves were also given showing the relative weight of continuous-current motors, single-phase motors, two-phase motors and three-phase motors.

The Berlin Tramways.—On March 1st the Great Berlin Tramway Company opened the first section of its lines which has adopted the "mixed" system of electric traction in place of horse traction. The system is to be adopted over the whole of their lines, and the transformation is to be effected within the next three or four years. The *Elektrotechnische Zeitschrift* of March 10th has an interesting article on the scheme, explaining how it is that the German capital will be one of the last towns in the Fatherland to have a complete system of electric tramways. At the outset the Tramway Company could only consider the matter of electric equipment if it entailed a prolongation of their concession, and the Municipality on their side demanded a *quid pro quo* from the Company. The chief difficulty in the way of a conclusion was that an overhead system was tabooed in the principal streets. A slotted conduit system had the disadvantage of extreme expense and the necessary disturbance of traffic for a lengthy period, apart from its technical difficulties. However, something had to be done in view of the Berlin Exhibition in 1896, and that year the Municipality and the Great Berlin Tramway Company agreed that the line to Treptow should be built, using partly overhead and partly underground distribution. This line and a line built by Messrs. Siemens and Halske from the centre of the town to the Exhibition (also partly on the overhead and partly on the underground system) were opened in 1896 as a trial. Since then the combined accumulator and trolley system had been a financial and technical success in Hanover and Dresden, while the slotted conduit had been very troublesome in Berlin, and the Company prepared a scheme involving the use of accumulators in the busier and handsomer streets and of a trolley wire elsewhere. This project obtained the consent of the Kaiser, and the Company lost no time in commencing the electrical equipment of their lines. On the section opened on March 1st accumulators are used for nearly half its length, but, when the equipment of the whole 186 miles of track is completed, only 26 miles, or about 14 per cent., will be without trolley-wire. The section already finished runs from the Alexanderplatz to the Spittelmarkt (about one mile) with an overhead wire, then for the next two miles to Bülowstrasse batteries are used, and a return is made to the overhead wire for the last 1½ miles to the terminus at Schöneberg. To afford sufficient flexibility it has been determined to use one size of battery for all sizes of car, the battery being chosen of such proportions that it is capable of carrying a heavily-loaded car twice over the longest accumulator section. The cars on the Alexanderplatz-Schöneberg line are four-axle cars, weighing 16 tons loaded, the battery contributing 2·6 tons towards this total weight. They are 33ft. 5in. long., and have 28 seats, and standing room for 12 passengers. Current is supplied from the Mauerstrasse station of the Berlin Electricity Works. The motors, two in each car, are series-wound, designed for 25 H.P., and to give a maximum of 35 H.P. Each car contains 200 three-plate cells, whose capacity suffices to propel a car and trailer 4·4 miles. There are no regulating cells, and a series-parallel controller is used to regulate the speed of the motors, the cells always remaining in series. The *Elektrotechnischer Anzeiger* reports that considerable trouble has been experienced through cars running off the rails at one point.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) **FRIDAY, March 25th.**

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Circulation of the Residual Gaseous Matter in a Crookes Tube," by A. A. Campbell Swinton; (2) "On Some Improvements in the Roberts-Austin Recording Pyrometer, and Notes on Thermo-electric Pyrometers," by A. Stansfield.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Internal Governor Friction," by H. O. Eurich.

MONDAY, March 28th.

SOCIETY OF ARTS.

8. p.m. Cantor Lecture III., on "The Thermo-Chemistry of the Bessemer Process," by Prof. W. N. Hartley, F.R.S.

WEDNESDAY, March 30th.

SOCIETY OF ARTS.

8 p.m. Sixteenth Ordinary Meeting. Paper to be read: "Telegraphy Across Space," by Prof. Silvanus P. Thompson, F.R.S.

THURSDAY, March 31st.

ROYAL INSTITUTION.

3 p.m. Tyndall Lecture V., on "Recent Researches in Magnetism and Diamagnetism," by Prof. J. A. Fleming, F.R.S.

FRIDAY, April 1st.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read, "Mechanical Refrigeration," by J. T. H. Burrell.

ROYAL INSTITUTION.

9 p.m. Evening Discourse, "Liquid Air as an Analytic Agent," by Prof. Dewar, F.R.S.

SATURDAY, April 2nd.

INSTITUTION OF JUNIOR ENGINEERS.

11 a.m. Visit to the Thames Ironworks, Blackwall.

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday noon.

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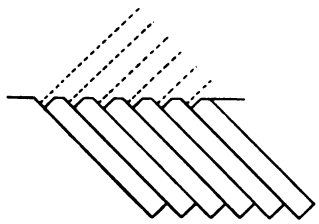
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Spark Discharges.—In continuing his researches on the secondary spark potentials of an induction coil, A. Oberbeck has traced some interesting peculiarities of positive and negative charges on electrodes of various shapes. On plotting the distances apart as abscissæ, and the differences of potential as ordinates, these peculiarities are brought out in a striking manner. When the electrodes are two spheres the slope of the curve gradually decreases, until at 10cm. the potential remains constant at 30,000 volts for some distance. In the case of blunt points the same thing happens at 7cm., with 20,000 volts. Afterwards the potentials increase simply as the distance apart. When two points are used, and one of them is put to earth, the negative discharge potential increases rapidly as the distance, but the positive potential, at first higher than the negative, actually decreases at 5cm. and passes through a minimum of 48,000 volts, increasing rapidly after that. If all these vagaries are to be explained, the actual process of discharge must be closely investigated. The only phenomenon which gives some clue is that of the brush discharge. This requires only one point, whereas a spark requires two. When the sparking distance is short, no brush discharge takes place, and there is no difference between positive and negative discharge potential, if the charge accumulates slowly. But at greater distances, the presence of the brush discharge, whose propagation in air depends upon its sign, produces differences between positive and negative spark discharges.

[Oberbeck, *Wied. Ann.*, No. 2, 1898.]

A Spectroscope without Prisms or Gratings.—A. A. Michelson has brought out another striking innovation in the shape of a spectroscope in which the errors due to faulty ruling of gratings are eliminated by a very simple means. The author remarks that "the resolving power of a diffraction grating is proportional to the product of the total number of lines by the order of the spectrum observed. But little effort seems to have been made to increase the *order* of the spectrum observed." If the light of a very high order of spectra—say, the hundredth—is to be evoked, the grating space must be of the



order of a hundred waves, or say twenty to the millimetre instead of a thousand. The difficulties in the way of such ruling are great, but instead of ruling the grating may be made up of a number of plates arranged in step-by-step order, as shown in the diagram. Here the difficulty would be the joining of the separate plates in such a way as to have always the same distance between them. By using the same arrangement for transmission instead of reflection this difficulty is avoided. The surprising thing is the smallness of the number of plates required to give results which are comparable with those of the best gratings. With only twenty elements 5mm. thick the resolving power would be 100,000, which is about that of the best gratings. The experiment was actually made with but seven elements, placed between a collimator and an observing telescope. The images were so distinct that the broadening of the lines in the Zeeman phenomena was easily observed. The overlapping of the other spectra can be eliminated by a preliminary analysis.

[Michelson, *Amer. Jour. Sc.*, March, 1898.]

Nature of Cathode Radiation.—It will give pleasure to certain British and Irish physicists to see that the discoverer of the "Lenard Rays" has arrived at a conclusion respecting the nature of cathode rays which is nearly identical with their own. P. Lenard has made a variety of new experiments with extremely exhausted "observation spaces," and found that in every case the rays behaved like moving negatively-charged matter endowed with inertia. When the cathode rays, after emerging from the aluminium window, impinge upon a plate connected with an electroscope, a negative charge is at once indicated. This charge, it should be stated, is observed even when the aluminium window is put to earth, and the gas in the observation space is so highly exhausted as to be unable to convey even a strong electric discharge. When the rays pass midway between two condenser plates the condenser loses none of its charge, even if that is high. When the condenser is uncharged the beam proceeds in a straight line. When the condenser is charged the beam is curved in such a manner that its hollow side is turned towards the positive plate, and the phosphorescent patch is displaced in that direction by an amount which varies with the strength of the field. The rays which are more subject to magnetic deflection are also more subject to electrostatic deflection. Their speed of propagation is about one-third of that of light. These results are very valuable and significant.

[Lenard, *Wied. Ann.*, No. 2, 1898.]

Damping of Resonators.—Besides the damping action of resistance and radiation, Tesla supposed that he had discovered a source of loss of energy in a generation of a kind of "electric sound-waves," and that this source of error could be eliminated by immersing the resonator in a continuous medium like oil. S. Lagergren has followed up the damping effects in a number of cases, and has only succeeded in tracing the two first-named damping actions. No energy was communicated to the molecules of the surrounding air. As regards the damping through the generation of joulean heat, it may be correctly calculated from the old electrodynamical theories. At small voltages the resonator wire is not perceptibly heated, so that the ordinary temperature may be made the basis of calculation. As regards damping by radiation, the Hertzian resonators may be divided into two species: open (rectilinear) and closed. These two species exhibit distinct differences of behaviour, both in the magnitude and the laws of damping. The simplest laws and the strongest damping are found in the rectilinear resonators. As the capacity increases, the damping of all resonators diminishes. But when the connection between the length of the wire and the amount of radiation comes to be examined, it is found impossible with the data at present available to unravel the complicated relations existing between them.

[Lagergren, *Wied. Ann.*, No. 2, 1898.]

Magnetic Torsion.—The phenomenon of magnetic torsion, discovered by Wiedemann and studied by Smith, may be described in a few words, as follows: An iron wire, twisted by a given force and placed along the axis of a solenoid, undergoes an additional twist in the magnetic field. The magnetic torsion always has the same sense as the initial torsion, and disappears with the latter. G. Moreau has further studied the phonomenon, and has observed some very simple laws which may be applied to the measurement of magnetic fields, to the investigation of the residual torsion of the magnetic metals, and the laws of coulomb. The laws discovered are the following: At any point of a twisted wire outside the magnetic field the magnetic torsion is proportional to the initial torsion at the point considered and to the square of the field (if not too strong) and independent of the diameter of the wire. Along the wire the magnetic torsion is a maximum at the boundaries of the field, and falls to zero at some internal point. The laws governing the distribution of the effect over the elements of the twisted wire were tested for soft iron and for tempered steel. As regards independence of the diameter, that is only approximately true, since at torsions about 90deg. there is a notable diminution of the magnetic twist in the thicker wires.

[Moreau, *Jour. Phys.*, March, 1898.]

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MESSRS. MAVOR AND COULSON'S ELECTRICAL ENGINEERING WORKS.

On Friday last a number of electrical engineers and prominent citizens of Glasgow visited the dynamo factory of Messrs. Mavor and Coulson (Limited), at Glasgow, the occasion serving to inaugurate the extensive group of workshops recently erected and equipped by this firm. The works are situated at 47, King-street, Mile-end, Glasgow, and have been erected on ground purchased from Messrs. Clark and Co. (Limited), who formerly used the site for their Mile-end Thread Works. The works are one and a-half miles distant from Glasgow Royal Exchange. The manufacturing business was formerly carried on in their premises in Orr-street, Bridgeton, which premises, together with the machine tools there, were held on lease. During the tenancy of these works patterns were developed and standardised, and methods of production systematised. At the expiry of their lease last year the Company was therefore in a singularly favou rable position to undertake the design and equipment of a new factory for their specialities in electrical machinery and accessories. In the general arrangement of the works and selection of machinery, the directors have had the advantage of an intimate knowledge of the most recent American and continental practice, and of their own special requirements. The result

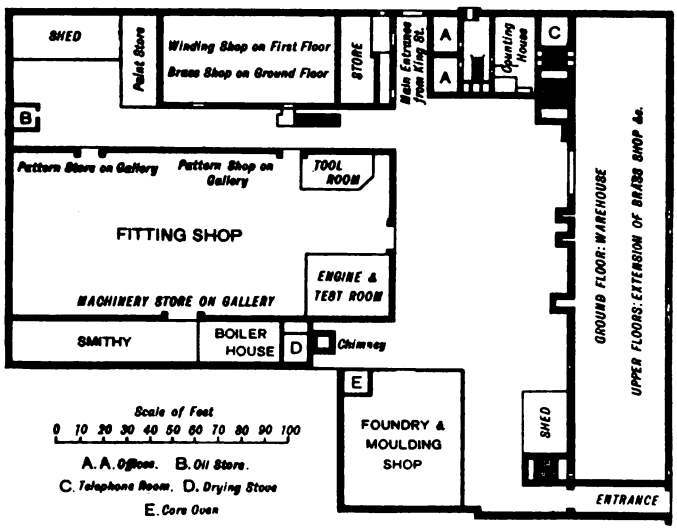

FIG. 1.—Plan of Messrs. Mavor and Coulson's Dynamo Works, at Glasgow.

has been the building and equipping of a factory, which is the only one of its kind in Scotland; and, in facilities for the rapid, economical and accurate production of high-class electrical machinery, is not surpassed by the best and most recent factories in the country.

To electrical engineers and manufacturers generally these works present two salient features of interest; firstly, in the fact that the workshops are entirely driven by electric motors, and secondly, in the adoption of what is substantially modern American practice in the methods of machining and in the types of machine tools employed.

The general arrangement of the workshops and various departments is shown in the scale plan in Fig. 1. The existing buildings formerly used for the thread factory and stores have been partially utilised for the new factory. The ground formerly occupied by the engine and boiler house, wood stores, bobbin shop, packing case warehouse, &c., has been cleared, and a spacious new shop and smithy, brass foundry, and moulding shop have been erected. The machine shop or "A" department, illustrated in Figs. 2 and 3, is 160ft. long by 75ft. wide, and is covered by a single span steel roof, glazed all over and supported by 14in. brick walls, and cast-iron columns carrying the crane girders, which are spaced at 40ft. centres. The lofty roof gives a spacious and airy workshop, while its steel and glass structure and the side windows in the walls provide exceptionally good and uniform lighting. The heating is effected by cast-iron pipes supplied with exhaust steam from the engines. On either side of the space swept by the 10-ton traveller is erected a gallery, occupied on one side by the pattern-making and carpentry department and on the other by the store for finished stock. The design is to ultimately use these galleries for light machine tools, and accommodate elsewhere the two departments mentioned. The large centre bay is floored with granolithic, and the two side bays under the galleries are floored with double-pine planking laid on joists. The machinery in "A" department is driven by 10 continuous-current electric motors. None of the shafting is driven direct from the steam engine, with the exception of a short length on the testing engine. The advantages gained by the use of electric motors in this department may be summarised as follows:—

The machinery is arranged solely with reference to facility and speed in carrying out the manufacturing operations, and there is no restriction as to position arising from the necessity of accommodation to the driving arrangements such as must exist with engine-driven line shafts. Electric motors will run in any position or direction, and may be fixed to floor, walls, columns, or ceiling. The sub-division of the driving power by means of these motors greatly reduces the quantities and weights of shafting, bearings, pulleys, and belting, and there is little loss of power due to running such apparatus while not transmitting useful work. While the machines are being adjusted, or when, from various reasons, they are not actually in operation, their whole driving mechanism is at rest. The exclusive use of light, short shafting leads to a great reduction in wear and tear; and the wonderful absence of noise is of immense advantage, as it not only makes the conditions of labour more comfortable for the workmen, but greatly simplifies supervision and management. For the shaft driving shunt-wound motors are employed, while the crane is fitted with a series-wound motor for each of the three motions. These motors are all controlled by water resistances, and are very readily handled.

A special and most noteworthy feature in the metal-working departments is the extensive use of milling machines and other special appliances for labour-saving. While such appliances do not in any sense dispense with the necessity for skill on the part of the workman, they permit of the use of a class of labour more easily available than that of a fully-trained and equipped all-round tradesman. The machines and tools are arranged with a view to the utmost accuracy in work without the necessity for individual measurements by the operator, the machines themselves being provided with measuring devices in which dimensions can be read off with ease and accuracy down to $\frac{1}{2000}$in. The use of such machinery necessitates a separate department, with special appliances for making new tools and for keeping the working tools in order. This is provided in the tool room (Fig. 4), in the north-west corner of the main shop, where a staff of skilled men are constantly employed in these operations. The antiquated practice of keeping a machine standing while the operator is grinding his tools or awaiting their formation by the tool smith is thus entirely abolished. Tool rooms are quite common in the United States engineering workshops, and have been adopted by some of the leading firms in this country, but, so far as we are aware, Messrs. Mavor and Coulson are the first of British electrical manufacturers to adopt this special department. It is found, by-the-way, that the use of highly-finished and accurately-made machinery is a valuable education to the men operating it, the tendency being to assimilate the character of the work produced to that of the machinery producing it, and to keep the shop and all its surroundings up to a high standard of cleanliness and order. These tendencies inevitably reflect their characteristics upon the finished product.

We may here refer to some of the machine tools found in the "A" department. In Figs. 5 and 6 are shown respectively a large horizontal milling machine cutting key-seats in a shaft, and a horizontal boring machine employed in facing up the pole-faces of a dynamo carcase. Of special interest is the

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FIG. 2.—Messrs. Mavor and Coulson's Machine and Erecting Shop.

FIG. 3.—West Bay in the Machine Shop, showing Arrangement of Motors for Electric Driving.

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machine shown in Fig. 7, which was specially designed for the purpose of milling out the slots in the cores of slot-wound armatures. The cores are built up of circular discs, and are slotted afterwards—a striking contrast to the method adopted

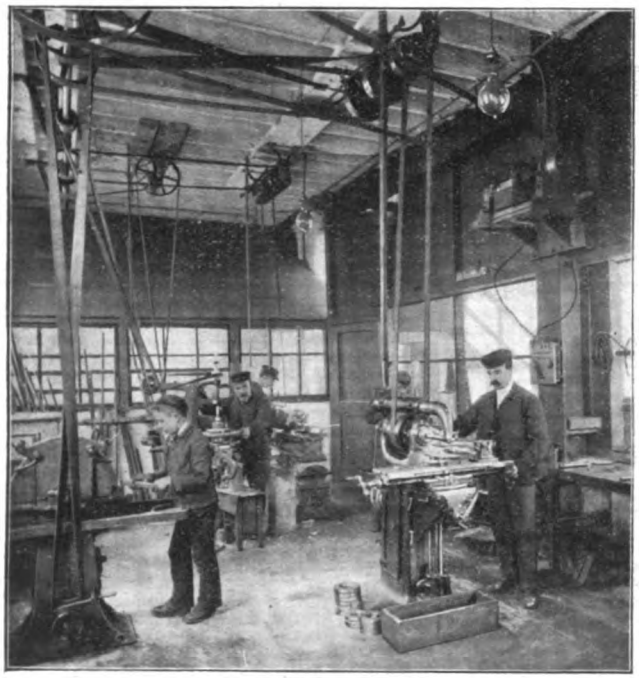

FIG. 4.—The Tool Room: An Interesting Innovation.

universally throughout America, and largely in this country, of notching the laminations previously to assembling them on the shaft. It is claimed that by the milling process more accurate alignment and better surface are obtained, and that the operation does not destroy the insulation of the laminæ.

Entering from the fitting shop is the smithy and boiler-house. In the smithy is fitted one 3cwt. steam hammer and three forges, the forge blower being driven by an electric motor.

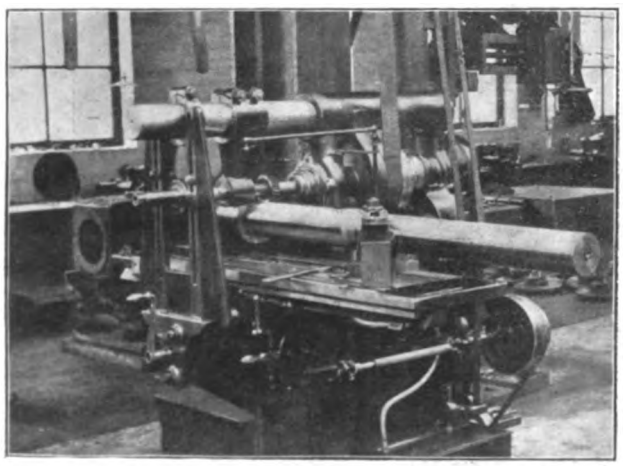

FIG. 5.—Horizontal Milling Machine, shown Cutting Key-seats in a Shaft.

The brass shop occupies a position of the ground floor. It is fitted with turret lathes, milling machines, multiple drills, &c., for the production of large quantities of brasswork for use on switchboards and on the various appliances connected with the wiring and installation of electric light and power. In this department, as in "A" department, advantage has been largely taken of the most modern improvements in American machine design, and the result is an immense improvement in the economy and accuracy of the product.

The winding shop (Fig. 8) is accommodated in the same building as the brass shop, but on the upper floor. Into this department are delivered the armature cores and magnet formers from "A" department, to be wound with copper conductors. There is little machinery in this department, the greater part of the work being performed by hand. The magnet wire is wound on the formers on a group of lathes driven by an electric motor. A light overhead travelling crane, operated by hand, is provided for handling parts in process of manufacture. It is capable of lifting two tons, and sweeps the whole length of the shop. After completion of the winding the armatures and magnet-coils are lodged in a drying stove until the moisture is thoroughly expelled from

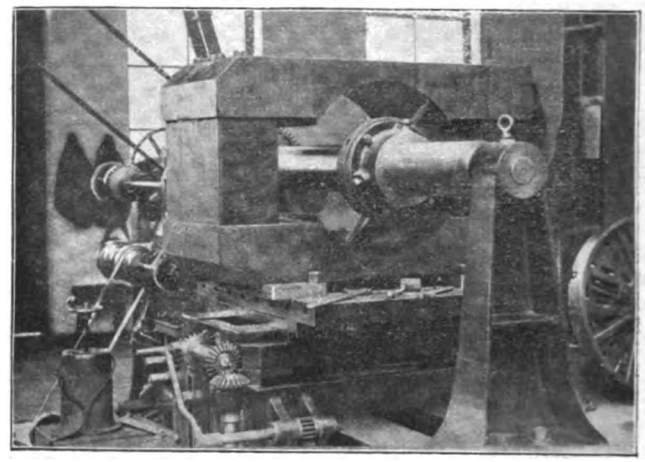

FIG. 6.—Horizontal Boring Machine, Boring Magnets.

the insulating materials. This stove is situated over specially-constructed flues between the main boilers and the chimney.

In the brass foundry are made all the brass and a few light iron castings. It is provided with six moulding furnaces and a core drying oven. For cleaning and cutting off the castings a group of cutting-off saws, emery grinders, and scratch brushes are driven by a 4½-H.P. electric motor, coupled direct

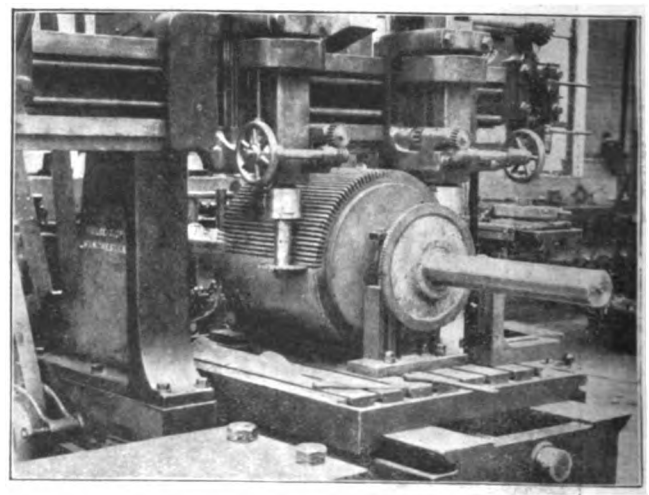

FIG. 7.—Duplex Slot-milling Machine, showing Messrs. Mavor and Coulson's Method of Slotting Armature Cores.

to a short counter-shaft. A "Cyclone" dust collector, with fan driven by the motor, is arranged to draw the dust from the emery grinders, and deposit it in a receiver. This appliance, together with the motor and a portion of the foundry, may be seen in Fig 9. By means of this ingenious collector the men are saved from breathing the metallic particles, and the metal is saved for re-melting. Plate moulding has been recently introduced into this department with very successful results.

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In conclusion, a short description must be given of the electric generating and lighting arrangements. The generating plant, shown in Fig. 10, comprising boilers, engines, and dynamos, for the production of electric power for driving and lighting the works, and for testing the finished manufactures, is situated at one end of the main machine shop. The electric lighting installation for the works and offices consists of 230 16-c.p. lamps, 30 Sunbeam 150-c.p. lamps, and 6 arc lamps of 2,000 c.p. each. There are in all 15 motors, of 85 H.P. aggregate. Two boilers are supplied for the steam generation at 160lb. pressure. The smaller boiler is just capable of undertaking the present work, but a Babcock and Wilcox boiler, evaporating 2,280lb. of water per hour, has been recently added to provide for extensions. The electric current is generated by two dynamos, each mounted on the same bedplate with and coupled direct to a high-speed single-acting engine. The output of each combined set is 40 E.H.P. From the steam dynamos the conductors are led to the main switchboard, from which point the whole of the distribution is carried out on the Company's well-known "C.C." concentric system of wiring, in which the positive or live conductor is entirely enclosed in the negative conductor, which is uninsulated and connected to "earth." The lighting and power are supplied from the same system, but on different circuits. Each circuit is controlled by a switch on the main switchboard, on which are also placed ammeters and voltmeters to indicate the amount of power being used. Adjoining the steam dynamos is the testing table, on which all machines are temporarily run before despatch.

FIG. 8.—Armature and Field-magnet Winding Shop.

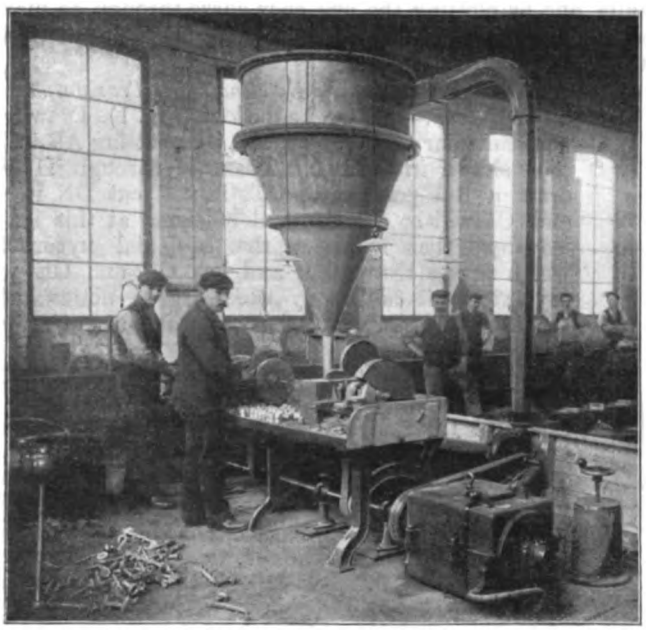

FIG. 9.—One end of the Foundry, showing Method of Electrical Driving and the "Cyclone" Dust Collector.

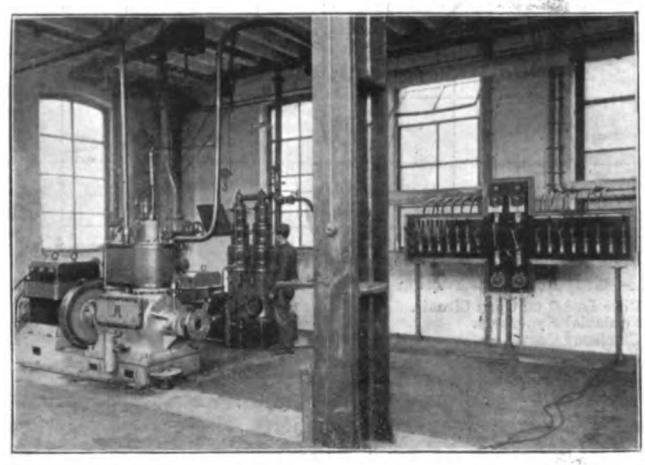

FIG. 10.—Electric Generating Plant for Driving Messrs. Mavor and Coulson's Workshops.

Apropos of the electric lighting of these works, it may be of interest to remark that the firm of Mavor and Coulson were the pioneers of electric lighting in Glasgow, and their early work in this direction formed the nucleus of the existing splendid installation owned by the Corporation of that city.

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THE EFFICIENCY OF THE ALTERNATING CURRENT TRANSFORMER.

BY ALEXANDER RUSSELL, M.A.

The following graphical method of finding the efficiencies of a transformer at all loads is simple and gives very accurate results. It applies to alternating current transformers, both of the closed and open iron circuit types, and by its use the labour of testing a transformer is greatly simplified. From the construction given below, it will be seen that the efficiency curve is compounded from an equiaxial (rectangular) hyperbola and a straight line. In some drawing offices flat pieces of wood cut into the shape of these curves are used for studying indicator diagrams, &c., and these can be conveniently used for drawing the hyperbolas. If these are not obtainable, the curves can be very quickly drawn on sectional paper by calculating points on them, or they can be drawn by several graphical constructions.*

The data required to construct the efficiency curve are—(1) V_1, the effective primary volts; (2) W_0, the watts expended on the primary when the secondary is open circuited; and (3) $R + S\frac{n_1^2}{n_2^2}$, where R and S are the resistances of the primary and secondary circuits respectively, and $\frac{n_1}{n_2}$ is the ratio of the primary to the secondary windings. For convenience we shall write Q for $R + S\frac{n_1^2}{n_2^2}$.

Graphical Construction for the Efficiency Curve of a Transformer.—Draw (Fig. 1) two lines, OT and OE, at right angles

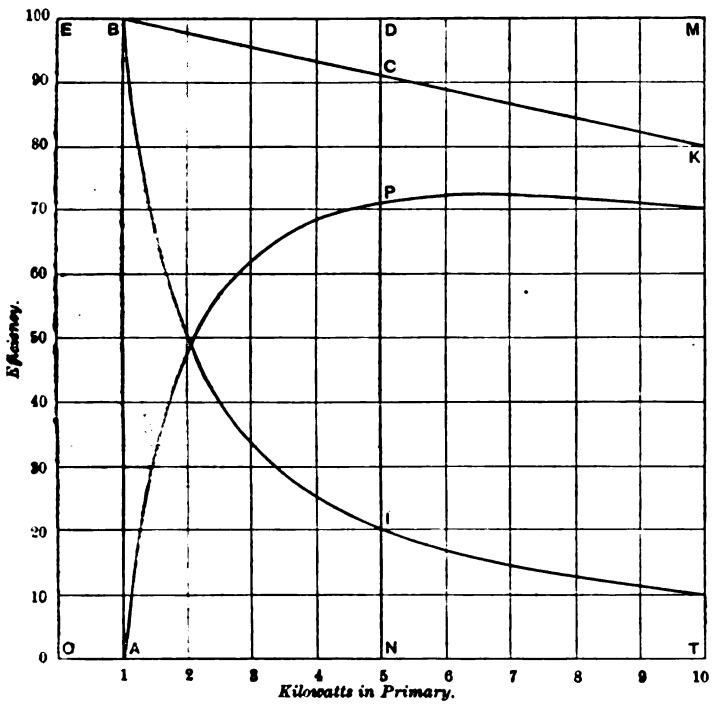

FIG. 1.—Graphical Construction for the Efficiency Curve of a Transformer.

OA Core Losses on Open Circuit. BI Equiaxial Hyperbola. AP Efficiency Curve. $MK = \frac{100\left(R+S\frac{n_1^2}{n_2^2}\right)}{V_1^2}(W_1 - W_0)$ PN = Efficiency when Load is ON. = CN − IN.

to one another and measure loads in kilowatts on the primary along OT and percentage efficiencies along OE. Mark off $OA = W_0$ and draw AB equal to a hundred on some convenient scale. Through B draw an equiaxial hyperbola BI, having OT and OE as its asymptotes. Let OT be the maximum load and draw TM equal to AB, and make MK equal to $100\frac{Q}{V_1^2}(W_1 - W_0)$ where W_1 equals $1{,}000 \times OT$, and is the maximum power given to the transformer in watts. Join BK.

* See Molesworth's Pocket Book, 23rd Ed., p. 658; and "Practical Electrical Engineering" Vol. I., p. 169.

Then the efficiency curve AP is got by making PN = CN − IN. It follows that CP equals IN.

In Fig. 1 the losses have been greatly exaggerated in order to accentuate peculiarities in the shape of the efficiency curve. In modern transformers MK is about 2 per cent. of MT and OA is about 2 per cent. of OT. A study of this diagram is instructive, as it shows the effect that the various losses have on the efficiency of the transformer.

The Maximum Efficiency.—It is shown algebraically below that the efficiency is a maximum when CD = IN. (In this case C is the middle point of PD. This can also be proved directly from the figure.)

Effect on the Efficiency of a Variation of the Ohmic Resistance.—This practically only varies the inclinations of the line BK to BM. Hence diminishing the resistance increases the efficiency at every load but makes the maximum efficiency come at a heavier load.

Effect of the Hysteresis and Eddy Current Losses in the Core.—Diminishing these losses (W_0), keeping the resistance constant increases the efficiency. The new equiaxial hyperbola has smaller axes and fits more nearly into the angle EOT. It is also easy to see that the maximum efficiency comes at a lighter load.

Effect of Varying both Copper and Iron Losses.—If we wish to increase the efficiency at a load below the load at which the efficiency is a maximum, a given percentage diminution of iron is more effective; at higher loads diminishing the copper loss has more effect on the efficiency.

Effect of Temperature on the Copper Losses.—In the above construction it has been assumed that the resistance of the copper remains constant. Owing to the rise of temperature the resistance of the copper is from 10 to 15 per cent. more at full load than at no load. To take this into account, however, is only necessary at high loads, for even at the maximum load the error introduced into the determination of the efficiency by neglecting this rise of temperature is only from 0·1 to 0·3 per cent. We have merely to increase MK by 10 or 15 per cent. and draw a curve through the new K touching BC at B.

It is a very instructive exercise to take a tabulated list of the efficiencies of a given transformer at various loads, and see how they agree with the efficiencies got by the graphical construction. Another use of the curve is to test experimental results, and by plotting the efficiency curve through as many points as possible to see if the core loss has been accurately measured.

Graphical Construction for the Efficiency of a Transformer at a Given Load.—Let ON be the load (Fig. 1). Draw ND perpendicular to OT, and join OD, cutting AB in H (not shown in figure). Then, if through H we draw a line parallel to OT, it will cut DN in I, and CI will be the required efficiency at this load. To prove that I lies on the equiaxial hyperbola which passes through B and has OT and OE for asymptotes it is merely necessary to notice that ON IN = OA AB, which follows almost at once from Euclid I., 43.

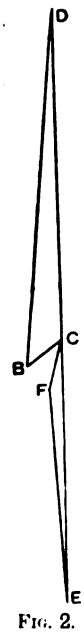

FIG. 2.

Algebraical Investigation of the Efficiency of a Transformer.—In Fig. 2 let the sides of the triangle BCD represent the E.M.F.s in the primary circuit of the transformer (see *The Electrician*, Vol. XXXVIII., p. 726), and let $BD = V_1$ = the effective value of the applied E.M.F., $BC = RA_1$, and CD the back E.M.F. Let CE be the E.M.F. in the secondary circuit, then CD and CE will be in the same straight line. Since in practice BC (RA_1) at full load is only about one per cent. of BD (V_1), it follows that the difference of phase between BD and CE—*i.e.*, between the primary and secondary E.M.F.s—will be almost exactly 180deg. Let $EF = V_2$ = the potential difference at the secondary terminals, and let $CF = SA_2$. Let the angle $DBC = \phi_1$ and the angle $FCE = \phi_2$, then $\cos\phi_1$ is the power-factor of the primary circuit, and $\cos\phi_2$ is the power-factor of the secondary circuit. If the secondary circuit is non-inductive, then $\phi_2 = 0$, and its power-factor is unity.

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If there is no magnetic leakage we must have

$$CD = \frac{n_1}{n_2} CE.$$

Also $\cos CDB = 1$ (the error due to this assumption is almost infinitesimal).

Hence $$V_2 + SA_2 \cos\phi_2 = \frac{n_2}{n_1}(V_1 - RA_1 \cos\phi_1). \quad . \quad . \quad (1)$$

Again, since the magnetising turns remain practically constant, we have

$$A_2 \cos\phi_2 = \frac{n_1}{n_2}(A_1 \cos\phi_1 - A_0 \cos\phi_0); \quad . \quad . \quad (2)$$

$$\therefore \quad A_2 \cos\phi_2 = \frac{n_1}{n_2}\frac{(W_1 - W_0)}{V_1}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Where W_1 is the power expended on the primary and W_0 the power in the primary on open circuit.

From (1) and (3) we easily deduce that,

$$V_2 = \frac{n_2}{n_1}\left\{V_1 - \frac{RW_1}{V_1} - \frac{n_1^2}{n_2^2} S \frac{W_1 - W_0}{V_1}\right\}$$

$$= \frac{n_2 V_1}{n_1}\left\{1 - \frac{QW_1}{V_1^2} + \frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2}\right\}, \quad . \quad . \quad . \quad (4)$$

where $$Q = R + S\frac{n_1^2}{n_2^2}.$$

Thus the efficiency

$$= \frac{W_2}{W_1},$$

$$= \frac{V_2 A_2 \cos\phi_2}{W_1},$$

$$= \left\{1 - \frac{QW_1}{V_1^2} + \frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2}\right\}\left\{1 - \frac{W_0}{W_1}\right\},$$

$$= 1 + \frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2} + \frac{QW_0}{V_1^2} - \frac{QW_1}{V_1^2} - \left(1 + \frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2}\right)\frac{W_0}{W_1},$$

$$= \left\{\left(1 + \frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2}\right)^{\frac{1}{2}} - \frac{1}{V_1}\left(QW_0\right)^{\frac{1}{2}}\right\}^2,$$

$$- \left\{\left(1 + \frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2}\right)^{\frac{1}{2}}\left(\frac{W_0}{W_1}\right)^{\frac{1}{2}} - \frac{1}{V_1}\left(QW_1\right)^{\frac{1}{2}}\right\}^2.$$

Now the only variable in this expression for the efficiency is W_1 and hence the efficiency is a maximum when the second term vanishes, that is when

$$W_1 = V_1\left\{\frac{\left(1 + \frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2}\right)W_0}{Q}\right\}^{\frac{1}{2}}$$

This may also be written

$$QA_1^2 \cos^2\phi_1 = \left(1 + \frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2}\right)W_0.$$

And the maximum efficiency $= \left\{\left(1 + \frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2}\right)^{\frac{1}{2}} - \frac{1}{V_1}(QW_0)^{\frac{1}{2}}\right\}^2.$

In the commercial transformer $\frac{n_1^2}{n_2^2} S \frac{W_0}{V_1^2}$ can be neglected as it is a very small quantity, generally much less than 0·001, hence we may use the following formulæ:

$$\text{Efficiency} \quad = 1 + \frac{QW_0}{V_1^2} - \frac{Q}{V_1^2} W_1 - \frac{W_0}{W_1}. \quad . \quad . \quad . \quad . \quad (5)$$

This is a maximum when

$$W_1 = V_1\sqrt{\frac{W_0}{Q}} \text{ or } A_1 \cos\phi_1 = \sqrt{\frac{W_0}{Q}}, \quad . \quad (6)$$

and the maximum efficiency

$$= \left\{1 - \frac{1}{V_1}(QW_0)^{\frac{1}{2}}\right\}^2. \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Equation (5) justifies the geometrical construction given above.

Examples.—The following numerical examples of the application of the above formulæ are chosen at random from amongst the experimental data given in Dr. Fleming's classical Paper on "Experimental Researches on Alternate Current Transformers," read to the Institution of Electrical Engineers on November 24, 1892.

(1) In a three-kilowatt Swinburne "Hedgehog" transformer $W_0 = 121$, $Q = 53{\cdot}38$, and $V_1 = 2{,}400$, Dr. Fleming found that when the load was 0·621 kilowatt the efficiency was 79·1 per cent., and that when the load was 1·932 kilowatts the efficiency was 92·8 per cent. If we use formula (5) above we find that the efficiency at these loads is 80·1 and 92·1 per cent. respectively.

The maximum efficiency occurs when $W_1 = 2{,}400\sqrt{\frac{121}{53{\cdot}38}}$ = 3·614 kilowatts and this efficiency

$$= \left\{1 - \frac{1}{2{,}400}\left(53{\cdot}38 \times 121\right)^{\frac{1}{2}}\right\}^2 = 93{\cdot}4 \text{ per cent.}$$

This particular transformer was not a good specimen of its class, as both Q and W_0 are too high.

(2) In a 20 H.P. Ferranti transformer $W_0 = 230$, $Q = 6{\cdot}26$, and $V_1 = 2{,}400$.

The maximum efficiency is therefore

$$= \left\{1 - \frac{1}{2{,}400}\left(6{\cdot}26 \times 230\right)^{\frac{1}{2}}\right\}^2 = 96{\cdot}9 \text{ per cent.}$$

and it has this efficiency when the load is 14·54 kilowatts. The observed efficiency at this load is given as 96·6. Again, when the load on the primary is 0 646 kilowatt the observed efficiency is 63·2, and the calculated is 64·3.

The following table shows the effect a variation of the copper and iron losses would produce in the above transformer:—

Load in kilowatts.	Real efficiency.	No iron loss.	No copper loss.	Copper and iron losses each reduced one-half.	—
0·646	64·4	99·9	64 4	82 2	Percentage efficiencies
16·8	96·8	98·2	98·7	98·4	

16·8 kilowatts is a greater load than that for which the transformer has been designed; but it illustrates the very slow falling-off of the efficiency of a transformer after it has attained its maximum value.

Testing Transformers.—In order to know how a transformer will work on the mains of a given supply station it is necessary to know, amongst other things, the magnetizing current it will take and the core losses when there is no load on the secondary. Now both of these depend on the shape of the wave of the applied E.M.F., and this shape is by no means constant, but depends on what machines are running at the central station. They also depend on the frequency, and this has been known to vary. Hence for a particular transformer there are in practice a series of curves of efficiency depending on the shape of the wave and the frequency.

To calculate the effect of a variation of the frequency is easy, and the core losses with waves of different shape can be got experimentally.* The variations due to this cause in the values of the core losses and the magnetizing current may sometimes vary 10 or 15 per cent. Manufacturers ought therefore to state the alternator used to magnetise their transformers during their tests. Another point that has to be attended to is whether the transformer will age or not, as in some cases the core losses will increase for some months after the transformer has been placed in the circuit. Hence some engineers ask the manufacturers to state a maximum for the watts required to magnetise the transformer after it has been in use for six months.

* For a complete and valuable experimental research on these variations see "Experimental Tests on the Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses of Transformers," by Messrs. Stanley Beeton, C. Percy Taylor and James Mark Barr, published in the *Journal* of the Institution of Electrical Engineers, Vol. XXV., p. 474.

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The drop in volts due to leakage is very small in modern transformers. It can be calculated from the formula

$$V_2 - \left\{V_2^1 + \left(S + R\frac{n_2^2}{n_1^2}\right)A_2\right\}$$

where V_2^1 and V_2 are the potential differences at the secondary terminals on open circuit and at full load respectively. To test the insulation resistance of the transformer it is customary to apply an E.M.F. equal to twice the primary E.M.F. between the coils for half an hour, the secondary being connected with the iron case or core. If no odd noises are heard, a test for five minutes would probably be sufficient. It is necessary to know also the resistances of the coils of the transformer at a given temperature, and the maximum difference of temperature between the coils of a transformer at full load and the surrounding objects. If full information is forthcoming on the above points, then it is easy to compare the relative merits of two transformers.

ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Bedford (Municipal)	March 4	Notting Hill (Company)	March 11
Clerkenwell (Company)	March 18	Richmond (Company)	March 4
Dover (Company)	March 11	Wandsworth (Company)	March 18

This week we publish statements and analyses of the accounts for 1896 and 1897 of two municipal electric supply undertakings, viz., those of Huddersfield and Kingston-upon-Thames. These two concerns, although differing from one another in many important respects, have several features in common. They are approximately of the same age; similar systems of electrical generation and distribution occur in the two; and in both cases there is a considerable revenue from public lighting. On the other hand, the Huddersfield works have the advantage over Kingston in an enormously greater plant-capacity and actual lamp-connection. Incidentally we may refer to the superiority of the former over the latter concern, in the completeness and lucidity of the accounts. Few electric supply undertakings publish more meagre accounts than those of Kingston.

Huddersfield Municipal Electric Supply Works.

Although no very startling improvement is shown by comparison of the 1897 accounts of the electric supply department of the Huddersfield Corporation with those of the previous year, the general progress has been good. Among the most notable features are an increase in the number of public lamps, by the addition of 18 new arcs and 54 incandescent lamps, and in the total lamps connected, the number of these latter having risen from 28,983 to 41,702, or about 44 per cent. The rapid growth in the demand for current has necessitated considerable extensions of works, raising the capacity of the generating station from 800 to 1,140 kilowatts, and involving in the aggregate a capital outlay during the year of £11,297. 6s., more than half of which sum (£6,413. 7s.) has been spent on new mains.

These extensions have evidently resulted in an improved condition of working, for a decided *fall* is observable in the total costs per unit sold, although the more important items in the works-costs per unit sold have increased slightly, bringing up the aggregate of these items. Apparently, therefore, the improvement in the demand for current has not resulted in any better or more advantageous load-factor, the plant having worked at no higher engineering efficiency; and the chief advantage has been in the fixed charges being divisible between a much greater number of units sold. As regards revenue a decided fall has occurred in the revenue per unit sold, as well as in the earning-power per kilowatt-capacity. No doubt this has been brought about by the reduction in the lowermost of the two charges for supply on the Wright system; for there has been a decided increase in the number of units sold per lamp connected. Although the percentage of total costs to gross revenue has fallen from 45·6 to 45·2 per cent., through causes already enumerated, it is satisfactory to notice that the working profit for the year has risen appreciably, viz., from about 7 to over 7¾ per cent. of the capital expended. This gross profit has been appropriated to the payment of interest on loans, and of an instalment of the capital borrowed, the suplus of £1,618 being set aside against depreciation. This is the first occasion on which a sum has been set aside for depreciation in the Huddersfield accounts; and we hope that, on the one hand, the example of certain other concerns will be followed in setting aside annually sufficient for this purpose, and, on the other hand, many municipal authorities who have not yet commenced a depreciation fund will follow Huddersfield and do so.

Kingston-upon-Thames Municipal Electric Supply Works.

Gradually and steadily the electric supply department of the Corporation of Kingston-upon-Thames is working its way out of the depths of a rather heavy deficit into the satisfactory region wherein it will no longer have to look to the rates for means to wipe the deficit out of existence. Last year the deficit was only £792, whereas in the previous year it amounted to £1,326, a fall from nearly 6 to under 2¾ per cent. of the capital expended. One more such a year of working and the concern will practically be free; and there seems no reason why, with the greater business brought about by extensions of lamp connections, &c., it should not show a balance on the right side and begin to hold up its head. Still, even then there will remain the serious business of getting rid of the burden of its capital charges, a problem rendered but infinitesimally smaller by the fact that there remained at the end of last year a balance of £44 for the purpose. A municipal concern, morever, should not only be able to repay instalments of principal, clear of all assistance from rates, but it should also make provision against the wearing out of its stock-in-trade and the prospect of having to adopt at some future date more modern types of machinery. It is somewhat premature, therefore, for the engineer of the Kingston-upon-Thames works to look forward to "reducing the rates of the borough generally," as he does in his report.

During the past year the number of lamps connected has risen from 6,825 to 9,200, the latter figure being in excess of the available plant-capacity. To meet the increase in load new plant is being installed, which will add 200 kilowatts to the capacity of the works, bringing the lamp-capacity up to 15,000. The capital expended during the year 1897 amounted to £12,928, and there is an available balance of capital unexpended of £5,066.

A considerable increase is to be observed in the working profit for the year, which has risen from 1·28 to 2·87 per cent. of the capital expended. This happy result is due partly to an increase in the revenue, owing to the augmented sale to consumers and partly to sundry economies in the generation and distribution expenses. Notwithstanding the reduced tariff in 1897, the revenue per unit sold has substantially increased—a fact which would seem in this instance to point to a large proportion of the consumers not having yet appreciated the beauties of the "maximum demand" system of charging. We observe that the revenue from public lighting has been stationary, and this department has made little or no progress during the past year. Experiments, however, are being made with a small number of glow-lamps for street-lighting purposes. The following table sets forth the progress of the works since their inauguration :—

Year.	Number of consumers at end of year.	Additional consumers during year.	8-c.p. lamps connected to mains at end of year.	8-c.p. lamps connected during year.	Units sold to consumers.
1893-4	77	...	4,000	...	44,642
1895	99	22	4,800	800	67,447
1895	129	30	6,825	2,025	88,620
1897	163	34	9,200	2,375	126,835

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	HUDDERSFIELD.		KINGSTON-UPON-THAMES.	
Undertaking Worked by	Corporation of Huddersfield.		Corporation of Kingston-upon-Thames.	
Date of Commencement of Supply	1893.		1893.	
System of Supply	Alternate-current transformer sub-stations.		Alternate-current transformer sub-stations; [also house transformers.	
Chief Engineer	A. B. Mountain.		J. E. Edgcome.	
YEAR ENDED DECEMBER 31st.	**1896.**	**1897.**	**1896.**	**1897.**
QUANTITIES—				
Units generated	455,715	632,046	—	—
,, **SOLD (TOTAL)**	**304,163**	**438,848**	**155,681**	**194,268**
,, sold to consumers	291,089	395,539	88,620	126,835
,, sold for public lighting, &c.	13,074	43,309	67,061	67,433
,, used on works	13,485	17,704	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	**11·43**	**11·6**	**17·3**	**21·6**
Maximum supply demanded	430 kilowatts	636 kilowatts	—	—
Number of public lamps	4	22 arc, 54 glow	36	36
Connections to mains in 8-c.p. lamps	28,983	41,702	6,825	9,200
CAPACITY OF PLANT IN 8-C.P. LAMPS	**26,600**	**38,000**	**9,000**	**9,000**
CAPACITY OF PLANT IN KILOWATTS	**800**	**1,140**	**300**	**300**
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	**£100,000 / £125**	**£100,000 / £87·7**	**£23,772 / £79·25**	**£41,766 / £139**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	100,000 / 125	100,000 / 87·7	23,772 / 79·25	41,766 / —
RECEIVED (TOTAL)	**58,000 / 72·5**	**69,000 / 60·5**	**23,772 / 79·25**	—* / 139
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	58,000 / 72·5	69,000 / 60·5	23,772 / 79·25	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**42,000 / 52·5**	**31,000 / 27·2**	**nil / —**	**nil / —**
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	42,000 / 52·5	31,000 / 27·2	nil / —	nil / —
REPAID (TOTAL)	—* / —	—* / —	—* / —	—* / —
RESERVE OR SINKING FUND	**7,379 / 9·22**	**9,256 / 8·12**	**nil / —**	**nil / —**
DEPRECIATION FUND	— / —	1,618 / 1·42		
EXPENDED (TOTAL)	**58,117 / 72·7**	**69,415 / 60·9**	**23,772 / 79·25**	**36,700 / 122**
Lands and buildings	11,406 / 14·3	11,556 / 10·14	5,000 / 16·70	—* / —
Plant	23,213[a] / 28·9	27,073[d] / 23·7	9,532 / 31·80	—* / —
Mains	20,849 / 26·1	27,262 / 23·9	9,240 / 30·80	—* / —
Miscellaneous	2,649 / 3·31	3,524 / 3·09	— / —	— / —
BALANCE OF CAPITAL ACCOUNT	**−117**[b] / **−0·146**	**−415**[b] / **−0·364**	—* / —	5,066 / —
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	**£6,864 / 5·41d.**	**£9,061 / 4·96d.**	**£3,013 / 4·64d.**	**£3,929 / 4·85d.**
Revenue from supply	6,225 / 4·91d.	8,098 / 4·43d.	2,172 / 3·35d.	3,045 / 3·76d.
,, meters, &c.	309 / 0·244d.	458 / 0·250d.	81 / 0·125d.	104 / 0·129d.
,, public lighting	211 / 0·167d.	435 / 0·238d.	720 / 1·11d.	720 / 0·89d.
,, sale of lamps, &c.	120 / 0·095d.	69 / 0·038d.	40 / 0·062d.	60 / 0·074d.
,, miscellaneous sources	nil / —	nil / —		
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£3,130 / 2·47d.**	**£4,097 / 2·24d.**	**2,712 / 4·18d.**	**£3,062 / 3·78d.**
WORKS COSTS	**1,780 / 1·41d.**	**2,785 / 1·52d.**	**2,303 / 3·55d.**	**2,459 / 3·04d.**
Generation of electricity	*1,520 / 1·20d.*	*2,379 / 1·30d.*	*2,035 / 3·14d.*	*2,205 / 2·72d.*
Fuel (including cartage, &c.)	614 / 0·484d.	901 / 0·493d.	1,164 / 1·79d.	1,314 / 1·62d.
Oil, waste, water, stores	61 / 0·048d.	105 / 0·057d.	142 / 0·219d.	155 / 0·192d.
Wages at station	688 / 0·543d.	874 / 0·478d.	605 / 0·933d.	625 / 0·772d.
Repairs and maintenance at station	157 / 0·124d.	500 / 0·277d.	124 / 0·191d.	111 / 0·137d.
Distribution of electricity	*220 / 0·174d.*	*330 / 0·181d.*		
Wages, &c.	60 / 0·047d.	73 / 0·040d.		
Repairs, renewals of mains, &c.	160 / 0·126d.	257 / 0·141d.	268 / 0·413d.	254 / 0·314d.
Public lighting	*40 / 0·032d.*	*75 / 0·041d.*		
Attendance	40 / 0·032d.	75 / 0·041d.		
Renewals				
MANAGEMENT AND PROPERTY CHARGES	**1,350 / 1·07d.**	**1,312 / 0·718d.**	**409 / 0·630d.**	**603 / 0·745d.**
Royalties	*nil* / —	*nil* / —	— / —	— / —
Rent, rates, taxes	*317 / 0·250d.*	*311 / 0·170d.*	*80*[a] */ 0·123d.*	*100*[c] */ 0·124d.*
Management	*1,033 / 0·815d.*	*1,001 / 0·548d.*	*329 / 0·507d.*	*503 / 0·622d.*
Salaries	698 / 0·551d.	716 / 0·392d.	237 / 0·365d.	378 / 0·467d.
Stationery, &c.	106 / 0·084d.	89 / 0·049d.	29 / 0·045d.	37 / 0·046d.
Establishment charges	215 / 0·170d.	187 / 0·102d.	63[b] / 0·097d.	88[d] / 0·186d.
Law charges, &c.	14[c] / 0·011d.	9[c] / 0·005d.	— / —	— / —
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	**£3,724 / 6·95%**	**£4,964 / 7·78%**	**£301 / 1·28%**	**£867 / 2·87%**
Sum carried to Depreciation Fund	— / —	1,618 / 2·58%	— / —	— / —
Sum carried to Reserve or Sinking Fund	1,410 / 2·66%	1,589 / 2·49%	826 / 3·5%	837 / 2·77%
Net interest on loans (incl. Debenture charges)	1,880 / 3·51%	2,191 / 3·44%	802 / 3·4%	824 / 2·70%
BALANCE FROM LAST ACCOUNT	— / —	**434 / 0·681%**	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	**434 / 0·81%**	nil / —	— / —	— / —
Deficit	— / —	— / —	*1,326*[e] */ 5·67%*	*792*[e] */ 2·60%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	45·6%	45·2%	90%	77·8%
Expenditure per kilowatt capacity	£3. 18s. 3d.	£3. 11s. 10d.	£9. 0s. 10d.	£10. 4s.
REVENUE PER KILOWATT CAPACITY	**£8. 11s. 10d.**	**£7. 19s. 0d.**	£10. 0s. 10d.	**£13. 6s.**
Expenditure per 8-c. lamp capacity	2s. 4¼d.	2s. 2d.	6s.	6s. 10d.
REVENUE PER 8-C.P. LAMP CAPACITY	**5s. 2½d.**	**4s. 9¼d.**	6s. 8d.	**8s. 9d.**
Price charged for lighting, per unit	6d.[e] − 4½d.[e]	6d.[e] − 2d.[e]	6d.[f] − 4d.	6d.[f] − 1d.[f]
Price charged for power, per unit				
Price charged for public lighting, per lamp	£52. 15s. 0d.	£15. 10s. 7d.[f]	£20	£20

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MUNICIPAL TELEPHONY.

The result of the recent Government inquiry into the telephone service in Glasgow has at last been made public. The Secretary to the Post Office has forwarded to the Town Clerk of Glasgow a copy of Sheriff Jameson's Report to the Treasury, and has notified that "... the Postmaster-General is advised that the Corporation in the present state of the law has no power to carry on the business of a telephone exchange, either within or outside the limits of the municipality, and in these circumstances he is precluded from assenting to the wishes of the Corporation by issuing a licence." It is hard to perceive why an expensive inquiry, lasting over a period of 11 days, and involving the examination of no fewer than 84 witnesses, should have been necessary merely to enable the Duke of Norfolk to obtain advice as to a question of law, and it is disappointing that no expression of opinion has been obtained from the Post Office authorities as to the correctness or otherwise of Sheriff Jameson's conclusions. In spite of the exhaustive inquiry therefore, and in spite of Sheriff Jameson's able report, things telephonic in Glasgow continue to be at a deadlock, exactly as they were before the inquiry was instituted. Sheriff Jameson, in summing up, says that the reasonable solution of the matter would be that the Corporation should, as other large municipalities have done, grant to the National Telephone Company facilities for laying a metallic-circuit underground system of wires. But the Corporation has emphatically stated that it will never allow the Company to do so. Sheriff Jameson evidently regards as irrevocable this refusal to adopt "the most reasonable solution," and suggests two other alternatives by which the city possessing such an unreasonable representative body may yet be blessed with an efficient telephone service. One alternative is that the Post Office should itself establish a competing exchange in Glasgow, and the other is that the Corporation should be granted a licence, "provided that they are able to satisfy the Postmaster-General that financially their scheme is sound, and that they have the means of carrying

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it out." Possibly the POSTMASTER-GENERAL considers that he has had sufficient experience with regard to the financial results of competing exchanges, and the degree of convenience of these exchanges to the general public, to justify him in ignoring the first recommendation, and in replying, as he has done, to the second. It is especially to be regretted, however, that a statement has not been obtained as to the present opinion of his Department on the broad question of municipal telephony, for his communication to the Glasgow Corporation does not necessarily imply that he will assume the same attitude towards similar application for licences by other municipalities, and notably by the London County Council.

Sheriff JAMESON'S report, of which we publish an abstract in another column, deals well and impartially with the matter under inquiry. The course of the inquiry itself was fully reported. Considering first whether the service is efficient, so far as it goes, he expresses the opinion that the service is not efficient—an opinion that must be shared by all who are familiar with the service or have read the evidence given during the inquiry. He asserts, with justice, that the inefficiency is mainly due to the want of complete metallic circuits and to the overhead system, both of which defects the Company is anxious to remedy if the Corporation will give them the necessary permission. But there are, notwithstanding, a considerable number of complaints not attributable to this cause only, and these, in Sheriff JAMESON'S opinion, might be remedied to a considerable extent by more thorough supervision in the switchrooms, and more prompt attention to complaints against the operators. We are in this inclined to agree with the writer of the report, for we still hear complaints of the service in London, many of which are clearly traceable to carelessness on the part of operators. In the metropolis the metallic circuits in use throughout, and the employment of the most modern types of instruments, have rendered speaking as nearly perfect as one could desire, and "cross-talk" is scarcely ever experienced. Moreover, the ingenious system of junction working now in use, combined with the liberal number of junction wires between most of the exchanges, should reduce to a minimum the time taken to obtain a connection. But subscribers still frequently experience the annoyance of being switched on to a wrong number, or being called up in error, and the operators are often accused—whether fairly or unfairly we know not—of replying "engaged" instead of waiting for a free junction line. It would seem that it should need but a slight modification in the system of supervision to give the subscriber greater facilities than at present for complaining immediately, to a responsible person, of such little delinquencies on the part of the operators, in such a way that the fault or mistake could be traced directly to its origin. Instructions how such complaints should be made might be rendered more prominent than they are now, and the result of these measures would probably be the weeding-out of the more careless and dilatory operators and a consequent improvement in the service. There is one other technical point which we think must contribute to the inefficiency of the Glasgow system, viz., the use of the call wire. On a network to which only well-mannered and intelligent subscribers are connected—as, for instance, that of the officials at the head office of the National Telephone Company in London—the call-wire system works admirably and has many points in its favour; but when subscribers not only fail to ring off, but "all speak at once," "bawl," apply office rulers to their transmitters, and use such language as to make operators hysterical, it does not appear advisable to give some 40 or 50 of them a simple means of access to the same wire at the end of which an unlucky girl is condemned perpetually to listen.

Replying to the second question in his instructions, Sheriff JAMESON considers that the service is adequate, and that the number of call offices is sufficient. Thirdly, he holds that the rates are not unreasonable. He arrives at this view after studying the table of rates in force in various foreign countries, given in the appendix to the report of the Parliamentary Committee of 1895, and after pointing out the dissimilarity between the conditions obtaining in Stockholm and Glasgow. In considering this question he did not have before him the cost of establishment and maintenance of the National Telephone Company's system in Glasgow, as he had ruled that he was not entitled to make an inquiry into this or to accept it as evidence. The fourth question is: Is the inefficiency due to the refusal of facilities by the Glasgow Corporation, and is such refusal reasonable? An answer to the first part of this is already contained in the answer to the first question as to the efficiency of the service. As regards the second part we will quote: ". . . the way in which some of the Corporation speak of the streets as the patrimony of the city of Glasgow is absurd, whether regarded from the point of view of law or of fact"; " . . . such refusal is not justified on the grounds of policy or otherwise, unless it be thought that the Corporation are justified in their refusal because they desire to establish a telephone system of their own, and to place the National Telephone Company at an enormous disadvantage in competing with them for the patronage of the public." We have already given the conclusions under the fifth head: "Is it expedient to grant the Glasgow Corporation a licence"? The writer of the report, were it not that the Corporation had made up its mind not to be "reasonable" enough to grant the underground facilities asked for, would have recommended the refusal of a licence for the following reasons, with all of which we cordially agree: A telephone service exists for the benefit of a limited number of citizens only, and is, therefore, not an object to which the "common good" ought to be applied. Whether this is so or not, an extension outside the borough boundaries, which would, of course, be essential to a complete system, would be illegal unless a special Act of Parliament were obtained. On general grounds of public convenience it is inexpedient to have two telephone systems and two telephone authorities within the same area. The establishment of a second telephone system would render the acquisition of the telephones by the Government in 1911 (when the National Telephone Company's licence expires) more difficult and more expensive; and, finally, the Corporation have not produced satisfactory evidence that they could finance and work the proposed system without the risk of putting a new and serious burden upon the ratepayers.

The inconvenience of municipal telephone exchanges in connection with trunk working has not been mentioned. Suppose, for instance, Glasgow and London were each provided with a municipally-controlled exchange system run on economical lines, and that Glasgow could hear London when communication was established, but that spoken messages in the other direction were unintelligible: London would blame Glasgow's transmitters, and Glasgow would blame London's receivers; there would be reports by telephone committees, which reports would be duly "referred back" several times; there would then follow much correspondence, many recriminations, and a delay in remedying the defective service. Neither would the engineers of the Post Office, we think, welcome the necessity for designing new switching arrangements to effect an efficient connection of the new exchange systems with the trunk lines; a further complication in the trunk-junction connections is far from desirable. In considering the whole question of the advisability of a municipal

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telephone service, one more point remains to be mentioned. There has been considerable friction of late between the various electrical committees of Glasgow Corporation. Would the addition of a third electrical department tend to make matters run easier? And what attitude would a smaller municipality, owning a single-wire telephone service, show towards tramway and electric supply companies? Municipal telephony is an experiment that might have been tried many years ago, but it is now too late. In the present state of telephonic progress, especially in view of the extension in the use of trunk lines, it will undoubtedly be better to submit patiently to the dual control of the Post Office and National Telephone Company until the year 1911, when the latter's licence expires, and when it is to be hoped that the entire administration of the telephones of the United Kingdom will be retained by the Government. Such agitations as the one in Glasgow will in the meantime, however, serve a useful purpose in keeping our telephone service up to the mark.

ELECTROMAGNETIC THEORY.—CIV.*

BY OLIVER HEAVISIDE.

(*Continued from page 556*).

All the elements of a given arbitrary wave, say a positive wave, travel at the same speed, and attenuate at the same rate. To illustrate, if A, B shows the curve of voltage at a certain moment, then a, b will show what it becomes a little later, the time interval being the distance Aa (or Bb) divided by v.

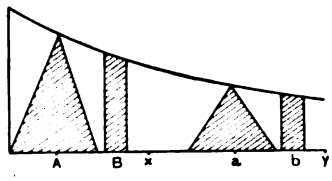

FIG. 1.

Similarly a circle will shrink to an ellipse. Note that this shrinkage does not count as distortion at all. The variations of voltage (and of current, since $V = LvC$) as the wave passes any point x, are identically repeated when it passes y further on, only reduced in size. If the voltage is impressed at the left end, according to $f(t)$, then it makes $f(t - x/v) \times \epsilon^{-Rx/Lv}$ at any later point x.

Now consider the initial state $V = 2V_0$ constant on the left side and zero on the right side of the origin, without any C. What results is to be found by dividing the initial state into two equal parts, one with positive current, making $V_0 = LvC_0$, the other with equal negative current making $V_0 = -LvC_0$, and then moving the first to the right and the second to the left, at speed v. In the figure, the upper dotted line shows the

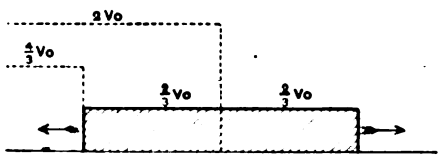

FIG. 2

initial state, and the lower dotted line what it attenuates to at the later time making $\epsilon^{-Kt/S} = \frac{2}{3}$. The shaded region shows the electromagnetic wave $V = LvC$ spreading both ways. The dotted part of the curve of voltage has no magnetic force associated with it. The voltage is there attenuating by leakage only, but at the same rate as the V and C in the wave.

§ 420. Next suppose R/L to be increased a little, K/S remaining the same. Then ρ, or $R/2L + K/2S$, is made greater than K/S. New $\epsilon^{-\rho t}$ is the wave attenuator, and $\epsilon^{-Kt/S}$ the leakage attenuator. It follows that, with the same initial circumstances as in the last case, the attenuation at the wave front is greater than at the origin of the wave. So, instead of the horizontal straight line of V in the last case, the curve of V must fall to the right and rise behind. The thick line shows the curve of voltage at the moment making $\epsilon^{-Kt/S} = \frac{2}{3}$, and

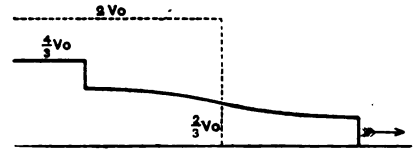

FIG. 3.

$\epsilon^{-\rho t} = \frac{1}{9}$. At the origin, V at every moment is equal to half the V behind the wave; at the particular moment in question this is $\frac{2}{3}V_0$, and there is additional attenuation along the wave to the right, making V at the front be $\frac{4}{9}V_0$. The general characteristic as the wave spreads and V attenuates all over is the greater attenuation at the wave front than at the origin.

The case is quite altered if, instead of increasing R/L, we reduce it, taking the distortionless case as initial standard. For we shall now make ρ less than K/S. The remarkable result is that the attenuation at the forward wave front, and in the forward wave generally, is less than at the origin, and in the region behind the wave occupied by V without any C. In the diagram the same attenuation by leakage alone is

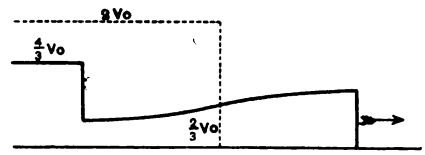

FIG. 4.

shown, and the same value at the origin, but at the forward wave front V is $\frac{8}{9}V_0$.

Next pass to the two extremes partially indicated. One is $K = 0$, the other $R = 0$. If $K = 0$, we have $\rho = R/2L = \sigma$ as well. With the same initial state there is no attenuation behind the wave region, and the voltage at the origin

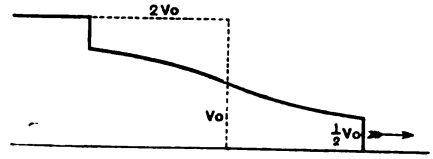

FIG. 5.

remains steadily at $V = V_0$. In the case illustrated, the value of $\epsilon^{-\rho t}$ is $\frac{1}{2}$, and the thick line shows the curve of voltage. The constancy of V at the origin enables us to regard the wave proceeding to the right as being impressed by a steady voltage V_0.

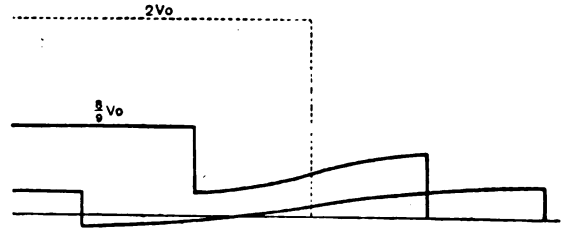

FIG. 6.

At the other extreme we have $R = 0$, $\rho = K/2S = -\sigma$; that is, there is attenuation by leakage only, and σ is negative. Two moments of time after the first moment are considered, and the

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corresponding two stages of the voltage curve are shown. When $2V_0$ has fallen to $\frac{8}{9}V_0$, the voltage at the origin is $\frac{4}{9}V_0$, and at the forward wave front $\frac{2}{3}V_0$. And at the later moment, when this wave front has gone twice as far, the initial $2V_0$ has attenuated to $\frac{2}{9}V_0$, and at the origin we have $\frac{1}{9}V_0$, and at the forward wave front $\frac{1}{3}V_0$. On the left side of the origin V has become negative in a portion of the wave. The ultimate limit of this is easily seen; the place of zero voltage moves towards the origin as the wave spreads and attenuates.

§ 421. From the previous curves may readily be derived those representing how a charge initially confined to a limited region splits and spreads. For if upon the state $V = V_0$ from $x = -\infty$ to 0, we superimpose the state $V = -V_0$ from $-\infty$ to $x = +a$, the resultant is simply V_0 between $x = 0$ and a. So shift the curve of V arising from the full $+V_0$, through the distance a to the right, and take the difference of the new and old curve to represent the V arising from V_0 in the length a. It may be any length. If chosen infinitesimal the result will show how a point charge splits and spreads. But then the curve requires magnification. On the other hand, if a be chosen large, we do not get clear representation of the waves, owing to overlapping. So take a of a moderate size, as in Fig. 7. This

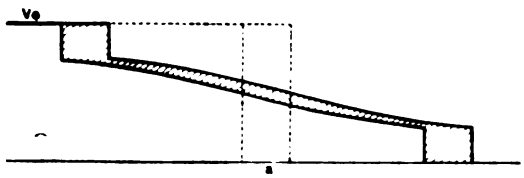

Fig. 7.

is the case of no leakage. The difference of the two curves shows what we want. Bringing it down to the base line, Fig. 8 arises. It shows the two waves running away from

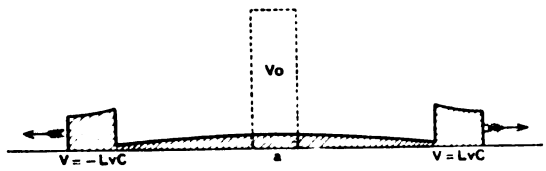

Fig. 8.

one another. They are not quite pure waves, because they are of finite depth. Between them is the diffused electrification cast behind by the two heads as they travel; that is, it is the double tail formed by the superposition of the tails of the two waves. The complete area of two heads and the double tail is the same as the area of the original rectangle, shown dotted. At any rate, it ought to be so, and by the look of it, is not far wrong. As the heads attenuate to zero, the curve of V approximates towards the curve of diffusion in Fourier's theory.

When σ is negative, the intermediate V is negative instead of positive. In Fig. 9 the case $R = 0$ is illustrated, or

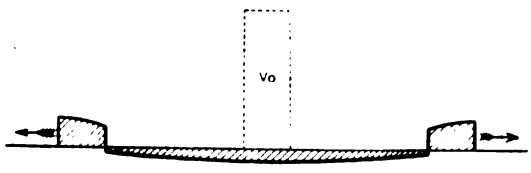

Fig. 9.

$\sigma = -K/2S = -\rho$. The moment of time is such that $\sigma t = -1$. I have roughly calculated that the value of ϵ^{-1} being ·3678, the amount of electrification in each of the two heads is about ·184Q, and in the complete tail —·116Q, if Q is the amount originally given. The electrification has therefore decreased from Q to (·368 —·116) Q or ·252Q. This calculation is done for an initial condensed charge, but will not be greatly wrong under the circumstances.

So far relating to the V-waves arising from initial V_0, the C-waves due to initial C_0 may be readily deduced. In brief, the C due to C_0 is the same function as the V due to V_0 with the sign of σ changed. This means that if a first case concerned a given R and K, and a second one is made by interchanging their values, then V/V_0 in the first case is the same as C/C_0 in the second, if the distributions V_0 and C_0 are similar and equal.

So the V/V_0 curve in Fig. 3, where R is in excess, or σ is positive, also represents the C/C_0 curve when K is in excess, making σ negative. Similarly Fig. 4 shows the C/C_0 curve when R is in excess. And Fig. 8 shows the C/C_0 curve arising from a central distribution of C_0, when R is zero (σ negative), with persistence of momentum now instead of electrification, whilst Fig. 9 shows the corresponding C/C_0 curve when σ is positive.

We may make similar interchanges of L and S. The $\epsilon^{-\rho t}$ factor remains the same when R/L and K/S are transposed, whereas σ is reversed.

§ 422. There remain for consideration the curves of C due to V_0 and of V due to C_0. These are alike. Not only that, but they are similar when σ is positive or equally negative. The

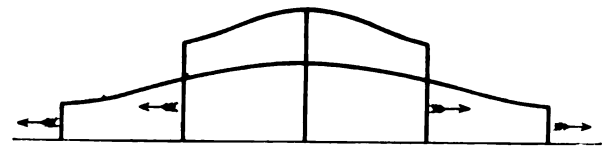

Fig. 10.

general type is shown in Fig. 10. Let initially there be $2V^0$ on the left side of the origin. Then

$$C = \frac{V_0}{2Lv}\epsilon^{-\rho t} I_0\left[\sigma(t^2 - x^2/v^2)^{\frac{1}{2}}\right]$$

is the formula for C. Here $\rho = \sigma(1 + K/S\sigma)$, so, taking σ positive, we require to give ρ a greater value, unless K is zero. Say $\sigma t = 1$, then $\epsilon^{-\rho t}$ must not be greater than ϵ^{-1}. So $\frac{1}{3}$ is a good value to take, and in the figure are shown the curves of C when $\sigma t = 1$ and 2, the corresponding values of $\epsilon^{-\rho t}$ being $\frac{1}{3}$ and $\frac{1}{9}$. The voltage at the origin is $V_0\epsilon^{-Kt/S}$.

From these curves, by taking differences as before, we can derive the curves showing the current due to initial V_0 through a certain distance. Two stages are shown in Fig. 11. The

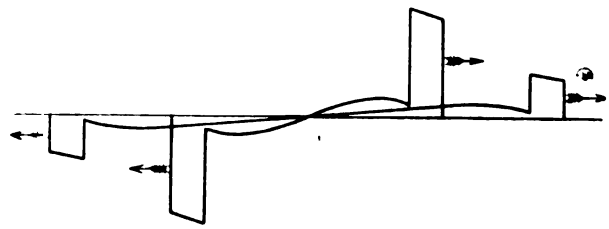

Fig. 11.

current is positive in the wave going to the right, and negative in the one going to the left, and the diffused current between them is positive and negative also. The positive wave appears to have a positive tail; the negative a negative tail. This appears anomalous, but it is a mixed up case. It is the negative part of the intermediate current that represents (in a great measure) the tail of the positive wave, whilst the positive part represents that of the negative wave, as will be more plainly seen presently.

(To be continued.)

Niagara Power Plant Extension.—The interior of the power station of the Niagara Falls Power Company is, says the *Electrical Engineer* of New York, now the scene of great activity, men being at work installing the new turbines and Westinghouse generators which are to be added to the plant in order to increase the capacity from 15,000 H.P. to 50,000 H.P. Dynamo No. 4 will soon be in operation, thus giving the Power Company an additional 5,000 H.P. to meet the heavy demand made on them for current.

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TEMPERATURE COEFFICIENTS OF MAGNETS.

The results of an interesting investigation, made by Mr. J. R. Aahworth to ascertain what kinds of iron and steel are least liable to a change of magnetic intensity under moderate fluctuations of temperature, were recently communicated to the Royal Society by Prof. Schuster. Specimens of steels containing severally tungsten, manganese, cobalt, and nickel, also specimens of cast irons, of different blends of pig irons, and of different percentages of carbon, were procured from a number of different English and Scotch firms. The size of these specimens was in general about 15cm. long and 1cm. or 2cm. thick, and the course of an experiment was as follows:—The rod or bar in its normal state, or after being hardened or annealed as occasion required, was magnetised between the poles of a powerful electro-magnet excited by a battery of twenty-six storage cells. The magnet was then fixed rigidly in a horizontal tube, through which a stream of cold water and steam could be alternately passed. The tube and its contents were placed at a convenient distance from a sensitive dead-beat magnetometer and at right angles to the magnetic meridian. The deflections of the magnetometer needle were read by the usual mirror and scale, and from the readings were deduced directly the temperature coefficient and the total irreversible loss of magnetism. The process of heating and cooling the magnet was continued until the intensity fluctuated between two nearly constant values corresponding to the temperatures of the cold water (10 or 20°C.) and steam (100°C.). The coefficient a was then calculated by inserting these values in the equation $I_{t'} = I_t(1 - a(t' - t))$. The author found that the temperature coefficient is generally least in the hardest irons and steels, and is particularly small in hardened cast iron. Certain hardened nickel steels had very small negative coefficients, *i.e.*, underwent an increase of magnetic intensity with increase of temperature. Experiments were also made with pianoforte wire, lengths of 12cm. each being cut from a coil of the wire and tested after various treatments. Magnetised in the normal state this material gave a negative coefficient. When heated to bright redness and chilled rapidly or slowly the coefficient became positive. As it was thus possible to change the sign of the coefficient, an attempt was made to find the particular temper which would give a zero coefficient. Lengths of the wire were heated severally in oil to 200deg. and 260deg., and in air to a temperature producing a film of oxide, and rapidly chilled in water. The coefficient still remained negative, and of nearly the same magnitude. But when heated to dull redness and quenched, the coefficient was very nearly reduced to zero. Heated to higher temperatures and quenched, the coefficient became positive. In some steels it was also found possible to change the sign of the temperature coefficient by alteration of the ratio between the length and diameter of the bar. Some relations between this "dimension ratio" and the self-demagnetising factor, temperature coefficient and permanent loss of magnetism after alternate heatings and coolings were also investigated. Experiments are in progress with the object of procuring a steel with a zero coefficient, but adjusting the temper and dimension ratio. The complete Paper, with curves and tables, is published in No. 382 of the *Proceedings* of the Royal Society.

POLYPHASE LIGHTING AND POWER DISTRIBUTION IN OIL WORKS.

The following short description of a moderate-sized three-phase plant is abstracted from an article in *The Electrical World*, of New York, and is interesting as showing the suitability of the multiphase systems for the distribution of light and power in places such as oil works, gaseous mines, and places where sparking cannot be permitted to occur. At Bayonne, New Jersey, on the Kill von Kull, is situated the oil refining works of the Tide Water Oil Company. Owing to the inflammable nature of the material worked with, it is necessary to generate power in many places where the slightest spark would be likely at any time to start a serious conflagration. The method in use for many years was the destribution of steam, from four or five boiler houses scattered through the works, to engines placed at the points where power was desired. This involved a serious loss by condensation, but no better system was available until the development of the induction motor made it possible to transform electrical into mechanical power without the slightest possibility of sparking. About two years ago a small multiphase power-distribution system was put in, and its work has been so highly satisfactory that the officers in charge are enthusiastic in its praises. The problem is somewhat different from that of long-distance transmission plants, in which polyphase machinery is generally used, as the greatest distance of transmission is only some 2,000ft. The generating plant consists of an upright American engine, built by the American Engine Company, of New Jersey, with cylinder dimensions of 15in. by 15in., capable of generating 150 H.P. at 180 revolutions per minute. The engine is fitted with a piston-valve and Spalding-valve motion, by which a reciprocating rotation of the valve-rod and valve is superposed on the ordinary valve motion, the angular advance of the rotation being controlled by the shaft governor, thereby giving the action of a double valve with but one valve and valve stem.

Belted to this engine is a 75-kilowatt 8-pole 60 ∿ G.E. 3-phase alternator, to which in turn is belted a 3-kilowatt bipolar Edison type exciter. The switchboard is fitted with a three-pole single-throw main switch, exciter and field rheostats, and three T-H current indicators, one in each of the three main leads. On each of the three panels of the switchboard is a T-H pressure indicator, equipped with a three-position plug switch, by which any one of the indicators can be thrown on any one of the three sides of the system. A ground detector is also fitted with a plug switch, by which its primary can be connected between the ground and any one of the three main 'bus bars. Six circuits run from the power house to the different parts of the yards, the power house being at a nearly central point. Three of these circuits are two-wire for lighting purposes only, and the other three are three-wire for both lighting and power. The machine and line voltage is 550 volts between any pair of the three lines. For lighting service, single-phase transformers are mounted on the different buildings and connected across any two of the three wires, ordinary care being taken that the various transformers shall be fairly uniformly distributed between the three sides of the system.

Fifteen motors are in use, the largest of which is 30 H.P. and the smallest 2 H.P., the aggregate capacity being 129 H.P., besides which some 1,600 lamps are wired to the circuits. The motors drive hoists, pumps, boiler shop, tramway, carpenter shop, and do a variety of other work. They are all of the General Electric manufacture, and of the induction type, with primary fixed circuits and secondary rotors. In positions where an inflammable mixture of oil vapours and air is not likely to exist, the rotors are fitted with an internal starting resistance which may be short-circuited by a hand lever acting through a collar on the motor shaft. For more dangerous positions the short-circuited secondary winding, pure and simple, is used; such motors being fitted with clutches or tight and loose pulleys, so that they may be started without load. They are, however, guaranteed to start with 10 per cent. of the full rated running torque. The largest motor, 30 H.P., drives by a belt four hoisting drums, which are used for loading and unloading ships at the wharf, pulling cars up and down the wharf, and for various purposes for which a strong pull is desired.

All the motors are equipped with switches operating under oil, the switch consisting of a small three-part commutator capable of rotation from a position in contact with diametrically opposite brushes to an intermediate position of open circuit. The motors are fused in boxes placed outside the buildings.

Of the lighting system, the equipment of what are known as the can-filling and freezing rooms is the most interesting. In the former, rectangular oil cans are filled up by two machines at the rate of 48,000 per day, and spread out on the floor of a large room about 80ft. by 100ft. in size, where they are allowed to lie for a short time while being watched for leaks. A strong light is necessary in this room, and a forest of piping descends from the ceiling to a height of about 8ft. from the floor, where incandescent lights are placed at intervals of about 8ft. in every direction; 97 lights are used in this room, each mounted in an air-tight enclosing globe on the extremities of the heavy gas pipe conduits. Just above each lamp there is inserted in the pipe a cast-iron box with a bolted cover, in which is placed a cut-out. Rubber-covered wire is used, each wire of the circuit being also further enclosed by an insulating tube within the gas pipe protection. In this way all possible danger of a spark occurring in the open air is avoided.

At the time of a fire which occurred in one of these rooms, the building was closed up and filled with live steam until the fire was practically smothered, when openings were made through which nozzles were directed and the rest of the fire drowned out. The lights burned steadily through and after this treatment. The yard is thoroughly equipped with a 30-station Gamewell fire-alarm system and a Strowger automatic telephone exchange, with 25 instruments. In the two years during which the multiphase system has been in operation the generating machinery has been run 23 hours and 40 minutes out of the 24 hours, 365 days in the year, and has never been shut down for any trouble whatever in the electrical system. The operation has been so satisfactory and the cost of power so greatly reduced over the old system, that it is the intention of the superintendent and engineer in charge of the works to extend the system by the addition of another engine, dynamo and more motors.

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THE THEORY OF ALTERNATING CURRENTS.*

BY W. G. RHODES, M.SC.

This Paper is divided into two parts. Part I. deals with a method of finding the steady values of alternating currents in any circuits or systems of circuits, without having to perform integrations of differential equations which may be somewhat complicated. It is assumed, however, that the electromotive forces and electric currents can be represented as simple sine (or cosine) functions of the time. The method consists in applying the fact that if a simple harmonic function is differentiated twice in succession the result is proportional to the original function. By the application of this principal the determination of the steady values of the currents is reduced to solving a set of simultaneous *simple* equations. After introducing the method by solving some simple problems, it is applied to the following :—

(*a*) The determination of the equivalent resistance R, reactance and impedance I, of a parallel circuit of n branches, taking into account mutual induction, when each branch may contain resistance, capacity and self-induction.

The rest is written—

$$R=\frac{A_0C}{C^2+p^2B^2},\qquad L=\frac{A_0B}{C^2+p^2B^2},\qquad I=\frac{A_0}{\sqrt{C^2+p^2B^2}},$$

L being the equivalent self-induction, where A_0, C, B are certain functions of the resistances, capacities, and mutual inductions of the several circuits.

(*b*) The determination of the currents in the n circuits of an air core transformer having one primary coil and $n-1$ secondary coils.

In addition to solving the problem, the conditions for resonance in the primary circuit are obtained and discussed, and special attention is given to the case of a transformer having only one secondary coil.

(*c*) The determination of the outputs of n alternators working in parallel on a non-inductive external circuit.

Part II. is devoted to the construction of the effects of higher harmonics in E.M.F.s and currents on the values of the impedance and reactances of circuits. The problems considered in Part I. are again discussed on the assumption that the impressed potential difference is of the form

$$E=E_1\sin(pt-0_1)+E\sin(2pt-0_2)+\ldots+E_m\sin(mpt-0_m).$$

It is also shown that periodic E.M.F.s and corresponding currents can in all cases be represented by simple sine curves having the same root mean square values, and suitable phase positions depending on the time constants of the circuits and on the periodicities of the harmonics present.

* Abstract of a Paper read before the Royal Society.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 4, 1898.*

A 100,000-Volt Testing Set.—An interesting testing outfit is being installed at the power house of the Cataract Construction Company, Niagara Falls, N.Y., by means of which tests may be made at any electromotive force from 1,200 volts to 100,000 volts. The general plan of the apparatus is as follows: a 80-kilowatt 100,000-volt transformer has its high-tension winding divided into four equal sections, which may be connected in multiple for 25,000 volts, series multiple for 50,000 volts, and in series for 100,000 volts, when the primary electromotive force is 2,200 volts. The primary winding is provided with loops brought out to a regulating dial by means of which the voltage per turn of the transformer windings may be reduced to a little less than one-half the normal full voltage given above. This variation is made in steps of about 1 per cent. without interrupting the circuit. It is, therefore, possible to begin at about 12,000 and raise to 25,000, then at 24,000 and raise to 50,000, and then at 48,000 and raise to 100,000 volts. A second transformer is provided which is identical in general characteristics with the first, except that the voltage of the secondary or high-tension winding is one-tenth of the former, permitting in the same way, therefore, variations from 1,200 to 10,000 volts. Both transformers are operated from the same regulating dial and primary switching apparatus. Throw-over switches are provided for changing the dial from one transformer to the other. The apparatus is connected to the line by means of two plug switches of the blow-out type, a four-contact mercury safety switch, normally held open by means of a spiral spring, and an aluminium fuse. The circuit is usually made and broken by the mercury switch, which has resistances connected between the contacts in such a way that no sudden rise in the electromotive force, due to making and breaking the circuit, is possible. The apparatus was manufactured by the Westinghouse Electric and Manufacturing Company, of Pittsburg. The transformers are of the standard self-cooling, oil-insulated type. Measuring instruments are provided in the high-tension circuit for measuring volts, amperes and watts. Each instrument has one terminal connected to the containing case, to prevent false readings due to static effects at the high electromotive forces used. The voltmeter and the shunt coils of the two wattmeters are in series with a german-silver resistance of about 1,800,000 ohms used as a multiplier, this resistance being so arranged that more or less may be cut in the circuit as desired. The resistance coils are non-inductively wound on glass plates, and so mounted as to be exposed to the circulation of air. The outfit is to be used in testing insulators and insulating materials of all kinds required by the Cataract Construction Company in its high-tension transmission service.

Electric Light at the Omaha Exposition.—The illumination of the grounds and buildings of the Trans-Mississippi and International Exposition which will be held at Omaha, Nebr., during the coming summer, will be on a scale of magnificence unexcelled even by the wonderful effects obtained at Chicago, in 1893. The General Electric Company will furnish four 125-kilowatt 2,000-c.p. light Brush arc dynamos of the multi-circuit type; four 12-kilowatt and two 180-kilowatt alternating current high-periodicity dynamos, operating at 1,040 volts, together with 840 kilowatts in transformers of different sizes. Current for various power purposes will be supplied from a generator of 225 kilowatt-capacity operating at from 500 to 550 volts. There will be on the grounds 600 arc lamps of 2,000 c.p. each.

The Walker Company.—Presumably to avoid restrictions imposed upon it by the recent legal decision as to motor suspensions, this Company has brought out a new suspension which ingeniously avoids the limitations. The new arrangement does away with the Walker double-spring suspension, and substitutes therefor a single spring suspension with the spring on the end of the motor frame over the main axle, instead of on the other end as it is on most suspensions and as described in the original Sprague patent. The link between the main axle and the armature shaft is retained to provide for the maintenance of a proper distance between centres of the gears, and the back suspension of the motor on the frame is pivoted in such a way that it can easily oscillate slightly to allow the motor to rise and fall without straining the parts.

Telegraphic Communication from Havana.—As a result of the enormously increased volume of news matter from Havana, arising from the recent destruction of the United States battleship "Maine," the telegraphic facilities at Key West, Fla., which is the nearest United States land station to Havana, have proved entirely inadequate. To meet the extraordinary conditions, the Western Union Telegraph Company has despatched a large force of telegraphists from this city to Key West in order to handle the telegrams more promptly.

The Brooklyn Elevated Railway.—On Feb. 28 the Walker Company were awarded a number of important contracts for the equipment of the lines of the Brooklyn Elevated Railway with electric power. The Fifth Avenue line will be the first to be thus equipped, and the first order calls for 12 motor cars, each fitted with four Walker 80 H.P. motors. Other cars will be ordered until the entire line is equipped. The Sprague multiple unit system will be adopted in connection with the operation of the Walker motors, and the third-rail method of distributing current will be employed.

March 11, 1898.

A Unique Convention.—The North-Western Electrical Association holds two meetings annually in the middle western section of the country, and some very good Papers and discussions are had on these occasions. It is, no doubt, the

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second association of this character in rank in this country, and exerts considerable influence in its own territory. The next meeting of the Association will take place in June of this year, and it is proposed to hold it on board a steamship during a trip of three days from Chicago to Duluth, Minn. Meetings will be held two days on shore after the arrival of the delegates at their destination, making five days in all, at the termination of which the members will be free to return to their homes in any way they please. The trip from Chicago to Duluth is an extremely pleasant one at that time of the year, and will, no doubt, be greatly enjoyed by the members. Stops are preposed at Sault Ste. Marie, where is located the Government ship canal, containing the largest locks in the world. It is also intended to make a stop, in order to enable the delegates to visit the famous Calumet and Hecla copper mines.

Electric Communication between Harbour Defences.—Gen. A. W. Greely, Chief Signal Office of the War Department, has written a letter to the Secretary of War, which has a peculiar interest at this time, when the air is filled with rumours of war. He calls attention to the fact that the fortifications in the harbours of New York, Boston and Philadelphia are not connected with the mainland by any electric signal system whatever, and these important posts of defence can only be reached by messenger. In New York it is true that several posts can communicate with each other over circuitous commercial routes, but such complicated methods, inadequate in peace even, would inevitably break down in case of actual hostilities. In every other country of the world, Gen. Greely states, the entire system of harbour defence for each port is connected electrically, so that not only are intercommunication and the transmission of orders constantly maintained, but the fire control and the direction of the defence rest under one master mind. It seems hardly credible, therefore, that after authorising a system of coast defence costing millions of dollars, Congress should for years refuse to connect the military forts around the great cities of New York, Boston and San Francisco either telegraphically or telephonically. For seven consecutive years the chief signal officer has recommended an appropriation of $20,000 for cables to connect electrically the various fortifications around the harbours named, but no action has yet been taken.

CORRESPONDENCE

PERSONAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having heard that the approaching termination of my appointment has by many people been connected with the recent engine breakdown at these works, I should like to point out that my resignation was accepted by the Electric Lighting Committee nearly a week previous to the accident. The Chairman has kindly allowed me to publish his letter in confirmation of the fact.—Yours, &c., A. W. RANKEN,
Corporation Electrical Engineer.

Electricity Works, Great Yarmouth, March 19, 1898.

[COPY.]
7, South Quay, Great Yarmouth,
19th March, 1898.

DEAR MR. RANKEN: It is a matter of regret to me that the resignation of your position as chief engineer should be in any way connected with the recent accident at the works. As a matter of fact your resignation was accepted on the 28th of February, and the accident occurred on the 5th of March.—Yours very truly, RD. MARTINS,
Chairman of Electric Lighting Committee.

FREE WIRING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In commenting on my free 6-light installation scheme in your "Editorial Notes" of *The Electrician*, of March 18th, you mention that it will be seen from a note elsewhere that the Liverpool District Lighting Company have adopted a similar arrangement on a small scale. On referring to the note on p. 709 under the head of Liverpool District Lighting Company (Limited), it states: "They had considered the question of wiring premises free of initial cost, but so far they could not see their way to do so." An error has apparently crept in here.—Yours, &c.,

THE HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY CO. (Ltd.),
Henry W. Bowden,
March 23, 1896. Manager and Chief Engineer.

SYNCHRONISING ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read the letter from Mr. W. M. Oliver in your last issue with considerable interest. There seems to be a good deal of misapprehension as to the meaning of the expression "distributing the load," and it is curious that Mr. Oliver does not seem to see that to bring forward a case in which one of two alternators in parallel is partly driving the other besides taking all the load has no bearing on the subject of "distributing the load" between two alternators acting as generators.

I do not see that the instance brought forward by Mr. Oliver is "pronounced" or in any way remarkable. As a general rule, with any two steam alternators in parallel, if steam is reduced on one engine only a point will be reached where it is doing no work. Reduce steam still further, and the alternator will be partly driven as a motor, the current taken of course showing on both ammeters. Cut off steam altogether, and if the conditions are suitable, the alternator will still continue running, now as a synchronous motor driving the engine attached to it. But all this has nothing to do with the question originally under discussion, in which it was expressly stipulated that the engines were on their governors with the stop valves full open.

With respect to the other points raised by Mr. Oliver, I am not quite clear as to whether he has misunderstood my explanation, which seems to be the case, or merely differs from it. I note that he also advances an explanation of his own, but I presume that I can hardly be expected to reply to every theory that can be raised on this point.—Yours, &c.,

March 21st, 1898. H. E. M. KENSIT.

COMMUTATION OF CONTINUOUS-CURRENT DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Sayers, I venture to think that the proof given of the relation between the armature field cut and the inductance of the coil commutated is fairly simple to those who choose to follow it. The consideration of a slotted armature is, of course, more difficult; but Mr. Sayers is quite right in supposing that by a similar argument I could prove that the current at the end of a complete cycle in an inductor alternator is the same as at the beginning, which is the generally accepted view of the case.—Yours, &c.,

Birmingham, March 12th, 1898. R. H. HOUSMAN.

LEGAL INTELLIGENCE.

Holophane (Limited) v. The Stewart Electrical Syndicate (Limited).

This case came before Mr. Justice North, and was a motion to restrain the infringement of the Holophane Patent, and from "passing off." The defendants appeared and asked for time to answer evidence, and had agreed in the meantime to keep an account.

Mr. PEILE, for the defendants, said the patent was a singularly complicated one, and its validity was disputed. He suggested the motion should stand till trial or further order, he undertaking in the meantime to keep an account.

Mr. SWINFEN EADY, Q.C., said he could not agree to that, as there was a question of "passing off." He thought after hearing the evidence that his lordship would grant an injunction, even as regarded the patent itself.

Mr. PEILE said that the validity of the patent would shortly come before Mr. Justice Kekewich in an action which was pending.

Mr. EADY remarked that he could not accept an undertaking until the trial, but only until the motion was disposed of.

Mr. PEILE replied that he would give an undertaking until the motion was disposed of.

Order accordingly.

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TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is *now ready.* Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898, and contains about 150 additional pages over last year's book. Supply houses will find the book very reliable and complete for circularising.

Tenders Invited.—The Vestry of St. John, Hampstead (London) require tenders for the supply and erection at the electricity station, Lithos-road, of the following plant:—(1) One or two 350-kilowatt steam alternators, with armatures, switchboard panel connections and resistances; (2) two switchboard panels; (3) two induced draught wet back boilers; (4) feed-water heater, steam and exhaust pipes, &c.; (5) two duplex compound steam feed pumps; (6) a 50-kilowatt direct-coupled exciter (to replace existing 20-kilowatt alternator, which is to be removed and allowed for by the contractor); (7) feed water softener. An advertisement elsewhere gives further particulars, and conditions, forms of tender, &c., may be obtained of the vestry clerk (Mr. Arthur P. Johnson), Vestry Hall, Hampstead, N.W., to whom tenders must be delivered by noon of Thursday, the 31st inst.

——— From our advertisement columns it will be seen that the Corporation of Ashton-under-Lyne invite tenders from firms willing to undertake the free wiring of premises in the Borough. Particulars as to districts in which the mains are laid may be obtained from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 78, King-street, Manchester. Tenders to the Borough Comptroller, Mr. John Neal, Town Hall, Ashton-under-Lyne, by Tuesday, April 5.

——— The Bournemouth Town Council invite tenders for an electrical installation (including cables, conductors, distributing boards, incandescent and arc lamps, and 20 arc lamp standards) for the lighting of the Bournemouth Pier and Pleasure Grounds. Full particulars, with forms of tender, &c., may be obtained from the borough engineer (Mr. F. W. Lacey, M.Inst.C.E.), Municipal Offices, and tenders should be sent in to the town clerk (Mr. J. Druitt, Jun.) by 5 p.m. of Monday, April 4. See advertisement on another page.

——— The Shoreditch Vestry invite tenders for the supply and erection of arc lamps and accessories and also for electric cable. Specifications, &c., can be obtained from the chief electrical engineer (Mr. C. Newton Russell), Electricity Supply Department, Coronet-street, Shoreditch. Tenders must be sent in by noon on Tuesday, April 12. Our advertisement columns contain additional particulars.

——— The Leyton Urban District Council require tenders for the supply and erection of two dynamos, one continuous-current balancing transformer, two gas engines and connections, and switchboards, at the electricity works at Leytonstone. Manufacturers only can tender. Tenders to the Town Hall, Leyton, Essex, by April 4. Mr. R. Vincent is clerk to the Council.

——— The Corporation of Derby invite tenders for wiring their Fore-street yard and premises for the electric light. Tenders to Town Clerk by April 12.

——— The Norwegian State Telegraph Department invite tenders for the supply and delivery of steel brackets, with the accompanying collars ("klaver") and nuts. Tenders, addressed "Telegraf-Directörens Kontor," General Post Office, Christiania, by 31st inst.

Tenders Invited.—The Directors of the Lancashire and Yorkshire Railway invite tenders for stores during the twelve months to April 30, 1899. The stores are listed in an advertisement on another page, and tenders must be lodged with the secretary (Mr. C. W. Bayley), Huntsbank, Manchester, by 10 a.m. of April 4.

Tenders Accepted.—The following tenders have been accepted by the Glasgow Corporation for the supply of additional machinery for the electricity department:—

Messrs. Mavor and Coulson, 900-H.P. engine and dynamo, at £5,775.
Messrs. Laing, Wharton and Down, 700-H.P. engine and dynamo, at £5,064.
Mirrlees, Watson and Yaryan Company, 400-H.P. engine and dynamo, at £1,970; and 200-H.P. engine and dynamo, at £1,265.
Babcock and Wilcox, two water-tube boilers with superheaters, at £2,020.

The plant is to be ready for delivery by the end of August, so as to be available for next winter's demands.

——— The Huddersfield Corporation have accepted the tender of Messrs. Siemens Bros. and Co. for the supply of two sets of generating plant for the electricity department at £13,054. The first set is to be delivered within eight months. The tender of Messrs. Schofield and Taylor, for the supply of an air-pump and jet condenser, has also been accepted.

——— The West Derby Guardians have accepted the following tenders for the supply of electric lighting plant:—

Messrs. Fawcett, Preston and Co., two dry-back return-tube boilers (each to evaporate 4,000lb. of water per hour), £1,075.
Messrs. Scott, Anderson and Beit, three 50 B.H.P. coupled engines and dynamos, one Booster, two feed pumps, one feed-water heater, one switchboard, steam, &c., piping, tanks, &c., £2,085.
Chloride Electrical Storage Syndicate, battery of accumulators of 900 ampere-hours capacity, £440.
Messrs. W. and J. Robinson and Co., wiring of Infirmary, Administrative Buildings, Nurses' Home, &c., £1,411.

——— The Lighting Committee of the Liverpool Corporation have accepted the tender of Messrs. Holme and Green for extending the Oldham-place electricity generating station at £1,281.

——— The St. Pancras (London) Vestry have accepted the tender of Messrs. John Fraser and Sons for the supply of four dry-back marine boilers, superheaters, &c., at £5,160.

Tenders Received.—Messrs. Allingham and Fennell call attention to the omission of their name and tender from the list published in *The Electrician* last week, of tenders for wiring the public buildings at West Ham. This firm submitted a tender for carrying out the work for the sum of £1,139. 15s., and this should be added to the list of those now under the consideration of the West Ham Corporation.

Appointments.—In our issue of the 18th inst. we referred to the fact that Mr. H. R. Burnett, one of the assistant engineers to the electricity department of the Vestry of St. Pancras, had been recommended for appointment as electrical engineer to the borough of Barrow-in-Furness. We gave the salary attached to the appointment as £200 per annum, which was in accordance with the terms of the advertisement inviting applications for the post. We are very pleased to learn from Mr. Burnett that the commencing salary is £225 per annum, and hope it may not be long before we may chronicle a substantial addition to what cannot be considered too liberal a scale.

——— Mr. J. B. Mitchell, the borough electrical engineer at Dewsbury, has been appointed resident electrical engineer at Southend. There were 57 applications for the position.

Appointments Vacant.—The British Electric Traction Company invite applications for the appointment of an electrical engineer to undertake the designing and construction of power houses and electrical equipment of tramways, including the rolling stock, but not the permanent-way construction. Further particulars are given in an advertisement elsewhere. Applications should be addressed to the Managing Director of the Company, Donington House, Norfolk-street, London, W.C.

——— From an advertisement elsewhere it will be seen that the Dewsbury Corporation invite applications for the position of borough electrical engineer. Salary, £250 per annum. Applications to the town clerk (Mr. G. Trevelyan Lee), Town Hall, Dewsbury, by Saturday, April 9.

——— As will be seen from our advertisement columns, the Council of the County Borough of West Ham require a chief assistant for mechanical engineering at their Technical Institute. Particulars may be obtained from the Principal of the Institute, Town Hall, West Ham, E., before the 31st inst. Mr. Fred. E. Hilleary is town clerk.

——— The Edison-Bell Consolidated Phonograph Company (Limited) invite applications for the position of general manager of the Company. The salary will be equivalent to 5 per cent. of the net profits, with a guaranteed minimum of £1,000 per annum. Applications to the secretary *pro tem*, Edison House, Northumberland-avenue, London, W.C.

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Vacancies.—There will be required shortly by the Thames Ironworks and Shipbuilding Company (Limited), of Orchard-yard, Blackwall, London, E., an electrical foreman for Admiralty ship work. Salary, £3 per week. Some particulars are given in an advertisement elsewhere.

——— A technical manager is required for a large cable factory abroad. Some particulars appear in an advertisement elsewhere.

To Let.—An advertisement on another page gives particulars of land to be let on lease or freehold at Watford, Herts., suitable for manufacturing premises, &c. The land adjoins the main line on the London and North-Western Railway.

Plant, &c., Wanted.—A small advertisement on another page calls attention to the requirements of an engineer abroad, for the supply of plant, &c., at prices to enable him to compete with Continental manufacturers.

Dissolution of Partnership.—Messrs. Harry Nunns and Ernest Sykes (trading as Nunns and Sykes), electrical engineers, South Parade, Halifax, have dissolved partnership.

Business Notices.—Mr. F. Winter (sole agent of the Harburg India Rubber C. Co.) has removed from Cripplegate to much larger premises at 8, Redcross-street, London, E.C.

——— Mr. E. J. Clark asks us to state that he has severed his connection with the Electrical Power Storage Company (Limited) as works foreman to undertake the management of the "Hart" Secondary Battery Company (Limited), at Stratford, E.

——— The offices of the Reflector Syndicate (Limited) (Cowper-Coles Patents) are removed from Carteret-street to 39, Victoria-street, Westminster, London, S.W.

Liquidations.—A meeting of the British Electric Installation Contractors (Limited) will be held at 50, Foregate-street, Worcester, on May 2, to receive an account of the winding-up. Mr. W. H. Hill is liquidator.

——— A meeting of the Electrical Advertising Syndicate (Limited) will be held at 164, Gresham House, London, E.C., on April 19, to receive an account of the winding-up. Mr. J. W. Jefferies is liquidator.

The Auer Lamp.—The Austrian Incandescent Gaslight Company of Vienna has purchased Dr. von Auer's patent rights in the newly-invented incandescent electric lamp for Europe, Asia, Africa and Australia for 2,000,000fl. The Americanrights will be otherwise disposed of.

Gas and Oil Engines.—We have received from Messrs. Crossley Brothers (Limited), of Openshaw, Manchester, admirably got-up catalogues of the well-known Crossley gas and oil engines. There is shown a number of the latest patterns of petroleum engines, which are made in a variety of sizes from 4 to 15 effective horse-power. For this make of oil engine it is claimed that the consumption of oil under variable loads is considerably less than in engines of other makes, that the oil tank is open for examination or filling at any time, that the engine is entirely self-contained, that the patented governor fitted to the engine regulates the charges and determines whether the oil is required or not, that all the working parts are accessible, and that any common variety of petroleum oil, which is almost universally obtainable, will work with these engines. Of the Crossley gas engine very little need be said, except that many improvements have been introduced in the latest type of these efficient machines. There is illustrated in the list a single cylinder engine built on Crossley's new scavenging patent, which is claimed to give increased power and economy without affecting simplicity of design. These engines are made of 30 and 40 nominal horse-power. For electric lighting work there are new designs of high speed gas engines for which it is claimed that an absolutely steady light can be relied upon without going to the extra expense of fly-wheeling the dynamo, a double-cylinder engine of 220 I.H.P. built on the new scavenging patent is also illustrated, and a fine example of the combined Otto gas engine and pumps for use for town water supply, on sewage works, &c. The illustrations in both lists are of exceptional merit.

Commercial Ozonisers.—The Electric Ozone Syndicate announce that they are now constructing commercial ozonisers which give up to 150 grammes of ozone per kilowatt.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 16 to 22, with the ports of destination :—

Argentine—Buenos Ayres, £65; Rosario, £123; *Australasia*—Auckland, £11; Brisbane, £90; Fremantle, £7,201; Sydney, £82; Wellington, £75. *Belgium*—Antwerp, £401; Ostend, £53; *Canada*—St. John (N.B.), £172. *Ceylon*—Colombo, £92. *Denmark*—Copenhagen, £12. *Egypt*—Alexandria, £212 telegraph material). *France*—Boulogne, £22. *Holland*—Amsterdam, £160; Flushing, £31. *Hong Kong*—£180. *India*—Calcutta, £1,158. *Italy*—Genoa, £55. *Palestine*—Jaffa, £20. *Portugal*—Oporto, £10. *Russia*—Libau, £243; Reval, £1,200; St. Petersburg, £20. *South Africa*—Cape Town, £1,285; Delagoa Bay, £27; Durban, £145; Port Elizabeth, £1,616. *Spain*—Barcelona, £1,985 (including £46 telegraph wire); Cadiz, £20. *Straits Settlements*—Singapore, £66,296 (including £66,280 telegraph material). *Sweden*—Gothenburg, £341; total £83,403, against £2,2634 in the corresponding week last year (March 17 to 23).

Art Metal Work.—We have received from Mr. Chas. Escaré a catalogue of electric light fittings in art metal, the bulk of which are of the Louis XV. and Louis XVI. periods. Some of the designs are very choice.

Roller Bearings.—The Roller Bearings Company (Limited), of 1, Delahay-street, Westminster, S.W., forward a well illustrated catalogue of roller bearings. The illustrations and particulars relate to various forms of these bearings for use with different classes of machinery. The applicability of these bearings to electric railways and tramways is forcibly shown in several of the illustrations, and in connection with the Liverpool Overhead Electric Railway (which has adopted roller bearings) it is pointed out that the Company is enabled by their use to add an additional carriage to the train, the starting effort requiring 80 per cent. less power than formerly. Several electric tramcars are illustrated, showing the special suitability of roller bearings for this class of vehicle. An imposing list of users of the Company's manufactures is given, and has a special interest for electric railway and tramway undertakings.

Machine-Tools, &c.—Messrs. Geo. Richards and Co. (Limited), of Broadheath, near Manchester, forward a handy octavo list of machine-tools and appliances and a second list in similar form of wood-working machinery. A very large number of the firm's special manufactures in this branch of engineering work are in use in all parts of the world.

Trade Lists.—The International Trading Company, of 35, Queen Victoria-street, London, E.C., send lists Nos. 1, 2 and 4, of continuous-current dynamos and motors; rails, regulators and resistances; and arc lamps, lanterns, &c., manufactured by the Chemnitz Electrical Company (Limited), for whom they are sole agents in this country. The Chemnitz Company have had a long experience in the construction of this class of plant and apparatus, and in the arc lamp and lantern branch have recently added considerably to the types and designs at the disposal of their clients. An improved form of arc lamp-regulator mechanism has been designed with a view to making the lamps specially suitable for export.

Aberdeen.—Prof. Kennedy's report on the proposed extension of the electric lighting system has been presented. Prof. Kennedy expresses an opinion in favour of supplying current for all purposes from one station. The question of supplying current to the West End is fully dealt with in the report, and three methods are tabulated as follows :—

	Transformer system.	Booster system.	Direct system.*
Estimated cost	£6,000	£5,200	£5,750
Efficiency at full load...	79 p.c.	73·5 p.c.	80 p.c.
Efficiency at ¾ load.....	76 p.c.	79 p.c.	84·5 p.c.
Efficiency at ½ load.....	71 p.c.	85 p.c.	89 p.c.

* With drop of 110 volts at full load.

Current for tramway working could also be supplied from the same station. As to the erection of a refuse-destructor, the cost of providing one to deal with the combustion of about 40,000 tons of refuse per annum would be £16,000, and this might give steam enough for from 300 to 400 H.P. net under reasonably favourable conditions. If the Lighting Committee decide on the erection of a destructor, it would be well first to consider if it could not possibly be placed so near the present station that steam from the destructor could be taken to the engines there.

Aluminium.—A recent report of the United States Geological Survey states that the production in the States of aluminium, which was only 83lbs. in 1893, amounted to 1.300,000lbs. in 1896. The imports into the States in 1895 ware 25,294lbs. and in 1896 689lbs.

American Competition in Europe.—Some very interesting information on the subject of American competition in Europe is given in a report by the Consul-General of the United States at Frankfort, Mr. F. H. Mason. Mr. Mason states that the year 1897 forms an epoch in the industrial and commercial relations between the leading European countries and the States, the remarkable fact of the year being the enforced recognition of the truth that in several important lines of manufacture—notably those of iron and steel—the sceptre of economical production, combined with the payment of the highest rate of wages for labour, has passed from the old world to the new. Needless to say, Mr. Mason deals with the subject from what may be termed a Continental rather than a British standpoint. For instance, he refers to the "old world system of 12 hours' toil, frugal living and

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low wages," and compares these conditions with the improved position of the artisan class in America. He urges that it has been clearly demonstrated that under intelligent management highly-paid labour, especially when employed to use complicated machinery, is, after all, the cheapest, and that in the race for supremacy the people of the old world have been in many cases left behind by those who have reduced economy of labour to an exact science. In certain branches of industrial work Mr. Mason brings some really important and astounding facts to prove his case, notably in the shoe trade, where he shows that the United States operative, earning £3 per week, produces a pair of shoes for 1s. 8d., against 2s. 5d. in Germany, where the operative earns only 16s. per week. The moral pointed by Mr. Mason has a bearing upon the electrical industry. It is, he urges, frequently asserted that the tariff imposed by the United States upon European imports precludes the possibility of successful competition between the manufacturers of Great Britain and those of the States; but this, according to Mr. Mason, is far from the truth. He points out that the cost of producing "Bessemer pig-iron" in the States is from 10s. to 15s. per ton less than in Great Britain, and that this fact has enabled the steel manufacturers of Pennsylvania to underbid their English competitors for the supply of rails for the underground railways in London, and further to secure an order for 8,000 tons of steel rails for the British East Indian Government. Similar arguments are brought to bear upon the recent contracts given out to makers of American electrical machinery for the equipment of street railway enterprises in this country and on the Continent, as well as in South America, Australia and South Africa. Mr. Mason calls particular attention to the greatly extended use of American machine tools by the manufacturers of Great Britain and the Continent, and certainly makes a strong point in his claim that these tools are found to be well made and of the highest up-to-date perfection of labour-saving device. He further contends that, but for the use of this labour-saving machinery of American design and manufacture, the competition between the makers of European countries and the States would be much keener, to the disadvantage of the former class. Mr. Mason goes so far, as we read his remarks, to imply that the Government of the States, or at any rate the manufacturers of this advanced type of labour-saving machinery, would be well advised to put a curb upon the output, as it is from the use of this machinery that the most serious check to American industrial advancement is to be feared. In connection with the details of manufacture Mr. Mason points to the facilities offered by the United States Government to inventors of simple mechanical improvements which present no claim of elaborate theoretical novelty, and he says that until recently it has been a matter of surprise that such facilities should have been offered, but it is now seen that the ultimate sum of these small improvements is the design and building of machinery of the highest efficiency and on the most simple mechanical basis. The report is mainly written with the object of pointing to Germany as an important market for American-made machinery and articles of domestic use, and the writer regards the outlook for the American inventor and manufacturer as exceedingly promising.

Anglo-Roman Lighting Company (Limited).—This Company supplies Rome with both gas and electric current, and at the recent meeting in Rome it was announced that the consumption of gas during the year 1897 had decreased about 1 per cent., but the applications for electric current had considerably increased, especially for the lighting of private apartments. The meeting, called to approve the new convention between the Company and the municipality of Rome, which extends the Company's concession for about 25 years, in return for a reduction in the price of gas and electric current, was adjourned to the 26th inst.

Argentina.—The Telegraph Department have decided to construct a new telegraph line from Coronel Suarez to Saavedra (a distance of about 70 kilometres) and to extend the Tuyu branch, about 30 kilometres, at an estimated cost of $22,000.

The Public Lighting Department of the Buenos Ayres Municipality recently reported in favour of the acceptance of the tender of the City of Buenos Ayres Electric Light Company for public lighting. It is stated, however, that the Mayor intends to refuse all tenders and to call for new ones.

Birmingham.—The Electrical [and General Trades' Exhibition now being held at Bingley Hall, was inaugurated on Monday, and remains open until the end of next month. The Exhibition is organised by Mr. George Stanley, who has had considerable experience in enterprises of this character. The Lord Mayor of Birmingham (Councillor Beale), performed the opening ceremony and was supported by the leading townsmen. The Exhibition is more extensive than those previously held under the same auspices in Birmingham, and the electrical exhibits are numerous and attractive. The show has been looked forward to for some time past by the manufacturing classes in this thriving Midland centre, and the numerous examples of the application of electricity to every-day needs prove an attraction to thousands of visitors daily.

Bournemouth.—The Town Council are inviting tenders for an electric light installation for the pier and lower gardens, and application is about to be made to the Local Government Board for sanction to borrow £800, the estimated cost of the work.

Bradford and Leeds Light Railway.—The Light Railway Commissioners have decided to only grant an Order for the construction of a light railway to connect the boundaries of the cities of Leeds and Bradford. Power to construct lines in the districts under the control of the respective City Councils has been refused, as the Commissioners think that the Municipal authorities will consult the public interests in regard to tramway facilities.

Bridgend.—An offer to take over the Council's Provisional Electric Lighting Order is at present under the consideration of the Electric Lighting Committee.

Broken Hill (N.S.W.)—An electricity supply scheme has been prepared by Mr. J. O. Callender for this Municipality. Plant, capable of supplying current to 100 arcs for street lighting, with a margin for private lighting, costing about £12,500 (annual expenditure £2,660), is provided for.

Church Lighting.—The National Electric Free Wiring Company have completed the installation of the electric light at the Palace Gardens Church, Notting Hill, and have the work of wiring St. Barnabas Church, Kensington, in hand.

Clerkenwell (London).—Dr. Evan Jones, Chairman of the Electric Lighting Committee, brought forward a lengthy report on the electric lighting question at the last meeting of the Council, recommending that application be made for a Provisional Order for the district. This course was unanimously approved by the Council.

Croydon.—On the recommendation of the Electric Lighting Committee the County Council have decided to apply to the Local Government Board for sanction to borrow £1,000, the sum to be paid to the British Thomson-Houston Company (Limited) upon the Corporation taking over the works. The Council have also decided to obtain a report from Prof. Kennedy as to the advisability of acquiring that portion of the business of the Crystal Palace District Electric Lighting Company, which is carried on in Croydon, and also as to the cost and best mode of extending the mains up the London road as far as Thornton Heath-road. The Council have sanctioned the provision of water-softening apparatus at the electricity works at an estimated cost of £250.

Dublin.—On Tuesday Major Cardew officially inspected the new section of the electric tramways from Nelson's Pillar to Annesley Bridge. The trams have been running since Sunday under a temporary permit.

Dudley.—A special meeting of the Town Council was held on Tuesday to consider the report of Mr. R. P. Wilson on the proposals to take over the Dudley and Sedgley tramway, to construct a new line from Queen's Cross to Bishton's Bridge, Netherton, and to introduce electric traction on both lines. The Light Railway Commissioners recently made an Order authorising the British Electric Traction Company to construct tramways in the neighbourhood of Dudley, and one of the questions at issue is whether the Company's lines are to be allowed to enter the town. In his report Mr. Wilson estimates that an expenditure of £5,399 would be necessary to put the present track to Hart's Hill in repair, and if the line were to be equipped electrically the Council should adopt the standard gauge. The cost of the reconstruction of the track, on the supposition that the old rails were used again, would be £9,286. If new rails 6in. deep are substituted the cost would be £10,495, and if the rails were 7in. deep £13,150, less £700 in each case by the sale of the old rails. The line from Queen's Cross to Bishton's Bridge would be 2⅛ miles, and the cost of constructing the track would be £10,919 with rails 6in. deep, and with rails 7in. deep £11,452. The cost of electrically equipping the two lines would be £8,250. The absence of railway competition was most favourable to the prospects of the tramway to Bishton's Bridge, and it would be a great boon to the inhabitants of Netherton, Old Hill, and Cradley Heath. Assuming that the Corporation determined to carry out the whole of the work themselves, the total capital expenditure would amount to £49,402. The annual expenditure would amount to £9,516, made up as follows: £5,250, traffic expenses, wages, and power, at 6d. per car-mile, including cost of current at 2½d. per unit; £1,053, maintenance of track, overhead wires, poles, &c. (being at the rate of 2½ per cent. on an outlay of £42,152); £650 maintenance of cars and repairs to same (at the rate of 10 per cent. on £6,500); £2,562, interest and sinking fund (at the rate of 5¼ per cent. on a loan of £50,000). The traffic receipts at 1s. 3d. per car-mile would be £13,425, and this would leave a net profit of £3,908, after allowance had been made for interest and sinking fund. He advised the Corporation to take over the tramways and work them. He estimated that, after allowing for all expenses, the profits would certainly not be less than 32 per cent. on the traffic receipts, and he therefore suggested that the Corporation should stipulate for a toll amounting to 15 per cent. on all tickets sold over their sections of the lines, in addition to the payment of 5⅛ per cent. on the capital expended, and 2½d. per unit for

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power. Under this arrangement the Company would make a profit of not less than £2,300 on a capital of less than £10,000. If the British Electric Traction Company were to construct a line to Cradley Heath the Corporation could insist on supplying them with electrical energy. He should, therefore, advise the Corporation to oppose the decision of the Commissioners before the Board of Trade on the ground that the Corporation were themselves about to construct the line in question. After discussion, the Council decided to carry out the work suggested by Mr. Wilson, and to oppose the Order of the Light Railway Commissioners before the Board of Trade. An electric lighting scheme is also to be carried out by the Council.

Electric Traction in France.—In the course of an interesting discussion on tramway working before the Paris Statistical Society, it was asserted by several speakers that the majority of the tramways in that country could not be worked at a profit until electric traction was introduced. It was further stated that the annual profits of the various tramway concerns in France did not exceed 1 per cent. per annum, but with electric traction on some of the lines excellent results have been recorded.

Electric Traction Statistics.—London's new underground railroad is an electric line more than six miles long, extending under the heart of the City, and now being constructed at at a cost of $15,000,000. The designing engineer was an American; the locomotives, motors, generators, and rotary converters are being built at Schenectady, in this State, the engines at Milwaukee, the air-brakes at Pittsburg, the car-couplers at Chicago, and other appliances in various parts of the United States.—*New York Herald.*

Exeter.—The report of the Electric Lighting Committee presented at Wednesday's Council meeting stated that the arc lamps for street lighting had been delivered, but an electrical expert had reported that they were not capable of being adjusted to meet the requirements of the Council, and the manufacturers undertook to supply fresh lamps within five weeks from the 8th inst. The Council decided to apply to the Local Government Board for permission to borrow £7,000 for additional electric generating plant.

Gainsborough.—The Gainsborough Gas Company will shortly ask Parliament for powers to apply for a Provisional Electric Lighting Order.

German Patents.—It is stated that complaints have been current for some time past that German inventors deliberately patent inventions here but work them exclusively in Germany, with results detrimental to British manufacturers' interests. The Board of Trade has powers, which have hitherto not been exercised, to grant compulsory licenses where the patentee has not worked his patents in this country, and has refused to allow others to do so; and we learn that several large firms have lodged applications with the Board for obtaining compulsory licences.

Glasgow Telephone Inquiry.—The report of Sheriff Jameson to the Postmaster-General on the recent inquiry into the working of the telephone system of Glasgow was issued last week, and proves to be a very bulky document. After referring to the fact that he, throughout the inquiry, refused to allow the question of the cost of the establishment and maintenance of the National Company's system in Glasgow to be discussed, he gives a general description of the exchange system as it works in the Glasgow district, and divides his findings under five heads:—

(1) Is the telephone service, so far as it goes, efficient?

(2) Is the service adequate, and is there a sufficient number of call offices?

(3) Is the price charged for the service reasonable?

(4) If inefficient, is the inefficiency due to the refusal of facilities by the Glasgow Corporation, and is such refusal reasonable?

(5) Is it expedient to grant the Glasgow Corporation a licence?

Finding No. 1 is to the effect that the service is not efficient, the inefficiency being attributed mainly to the want of a metallic circuit, and also to the want of more thorough supervision in the central and junction switch-rooms, and in the arrangement of the outside wires. He refers to the fact that the National Company have from time to time allowed deductions for the period during which the telephones of complaining subscribers have been out of use as justifying his strictures on the Company and its system of working. On finding No. 2 Sheriff Jameson holds that the number of call offices is sufficient for all reasonable requirements, and that the service is as adequate as can reasonably be expected. On finding No. 3 the Sheriff is of opinion that the rates are not unreasonable except for some of the outlying districts. He comes to this conclusion after comparing the rates charged in Glasgow and district with those charged abroad, as set forth in the appendix to the report issued in 1895 by the Select Committee of the House of Commons on the telephone service. As to the cause of the inefficiency above alluded to in finding No. 4, Sheriff Jameson states that he is of opinion that the main cause is that the telephone system is worked by means of an overhead single wire system without an earth return, in a city where there exists so enormous an amount of concentration of wires at one point, greater even than at any one point in London, and where owing to the climate and the system of electric light in one of the underground subways, an overhead telephone system is peculiarly liable to be rendered inefficient. The Sheriff is of opinion that these objections may be overcome by the Company adopting underground twin-wire system, but that it would be most unreasonable to require them to do so. So long ago as Feb. 26, 1896, the National Company applied to the Corporation for assistance in this direction, which was refused, and the opinion here expressed is that the continued inefficiency of the present telephone exchange service in Glasgow is in a large measure due to the refusal of facilities to the Company by the Corporation for the construction of an underground metallic-circuit system. Sheriff Jameson's finding under this head in an excellent example of plain speaking, and certainly justifies the Company in the attitude it has assumed in regard to this matter from the start. We have in *The Electrician* recorded year after year the difficulties experienced by the National Company in this important branch of the telephone service, and from the report before us the unfair attitude assumed by the local authorities of Glasgow appears to have proved the stumbling-block to the efficiency of the service. Sheriff Jameson says: "The objection of the Corporation to give permission to the Telephone Company to lay its lines underground because it is a dividend earning Company appears to me to be quite absurd when it is considered that the operation proposed is really for the benefit of the public and will, in any view, cause the Company a large expenditure. I may further remark that the way in which some members of the Corporation speak of the streets as being the patrimony of the City of Glasgow is absurd, whether regarded from the point of view of law or of fact. My inference from the whole of the evidence is that the true cause of the refusal of the Corporation to allow the Company wayleaves under their streets is that they are resolved, if possible, to establish a telephone system of their own, by means of which they believe they will be able to extinguish the National Telephone Company altogether, so far as Glasgow is concerned, and supply a better and cheaper service. Accordingly, the continued inefficiency of the telephone service is due to this refusal of the Corporation, and, in my opinion, such refusal is not reasonable or justified on the grounds of policy unless it be thought that the Corporation are justified in their refusal because they desire to establish a telephone system of their own." The fifth and last finding, as to the expediency of granting the Corporation a license, is dealt with in a series of paragraphs. Sheriff Jameson says:—"Apart from the difficulty of the situation I should have been prepared to state as my opinion that it is not expedient that the Corporation of Glasgow should obtain a licence to carry on the business of telephony within the Glasgow district for the following reasons:—

a. A telephone service in this country does not exist for the benefit of all classes of citizens, but for a limited number. It is, therefore, not an object to which the "common good" of a burgh ought to be applied.

b. Whether the foregoing proposition be correct or not, it is my opinion that the Corporation of Glasgow are not at present entitled to apply the burgh funds or funds raised on the security of the burgh "common good" to the establishment and maintenance of a telephone system outside of the burgh boundaries. To enable them to do so a special Act of Parliament would be necessary, and it seems inappropriate for the Postmaster-General to grant the licence to do something which at present it is otherwise illegal for the Corporation to do. Perhaps this might be got over by the licence being given under the condition that it should not be available beyond the boundaries of the city of Glasgow till Parliament has sanctioned the proposed action of the Corporation.

c. On general grounds of public convenience it is inexpedient to have two telephone systems or two telephonic authorities within the same area, as this leads to the necessity of members of the public subscribing to both systems, or suffering from delay in the transhipment of messages from one system to the other.

d. Because the establishment of a second telephone system may render the acquisition of the telephones in Glasgow by the Government at the end of 1911 more difficult and expensive.

e. Because up to this time the Corporation have not produced satisfactory evidence that they could successfully finance and work the proposed system without the risk of putting a new and serious burden on the ratepayers of Glasgow. In my opinion the reasonable solution of the matter would be that the Corporation should grant to the Company the same facilities for laying a metallic circuit system underground as the large English municipalities have already done and under similar safeguards. But the Corporation of Glasgow at present state that they will never consent to the Company being allowed to lay an underground system in Glasgow, and it is clear that unless this is done the telephone service in Glasgow will continue to be inefficient, which is a state of matters that ought not to be allowed to continue. The question therefore arises whether, except in the present situation, it would not be expedient, notwithstanding all the objections I have pointed out, that the licence they now ask should be granted to the Corporation, throwing on them the whole responsibility of their proposed undertaking. One way out of the difficulty would be for the Post Office to establish a telephone exchange in Glasgow themselves with an underground metallic circuit system of wires. To do so would seem to be authorised by Clause 18 of the agreement between the Postmaster-General and the National Telephone Company, dated March 25, 1896. If this course does not recommend itself to Her Majesty's Government, then in the interests of

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the public who use the telephones in Glasgow and district, I am of opinion that it would be expedient to grant to the Glasgow Corporation the license they have now requested, provided that they are able to satisfy the Postmaster-General that financially their scheme is sound and that they have the means of carrying it out.

Gourock.—Mr. Munro has submitted his report as to the advisability of establishing electricity supply works in this town, and recommends the Police Commissioners to put down an installation at an estimated cost of £8,600. The scheme provides for the erection of 16 arc lamps.

Hammersmith (London).—The Vestry have decided to apply to the London County Council for a loan of £31,000 for electric lighting purposes

Hastings.—The Town Council had before them on Friday last a lengthy report prepared by the borough engineer (Mr. P. H. Palmer) on the tramway question. Mr. Palmer dealt in his report with the tramways in various towns on the Continent as well as in the United Kingdom, and exhaustively discusses the various systems of traction. The overhead trolley system was, however, recommended for adoption, as being on the whole the most suitable for Hastings; and, to start with, two tramway routes are outlined. The Corporation were recommended to sanction the construction of these lines, the total length of which will be about five miles. Mr. Palmer recommends the adoption of a 3ft. 6in. gauge, and is in favour of supplying current for lighting and power purposes from a central supply station. Procedure under the Light Railways Act was suggested as being the most expeditious. The cost of constructing and equipping the lines was put at £37,350, and the annual cost (including interest and sinking fund) at £6,356. The anticipated annual revenue is £8,424, leaving a profit of £2,068—equal to 5½ per cent. Branch lines could be afterwards constructed as feeders to the main tracks. The Tramways Committee presented a report in which the recommendations of Mr. Palmer were generally confirmed; and, after discussion, this report, with two amendments in favour of the construction of two additional branch lines, was agreed to.

High Wycombe.—Messrs. Hodges and Todd have been appointed consulting engineers to inspect and report upon the electricity supply works now being erected by the High Wycombe Electricity Supply Company, at a fee of 25 guineas.

Horsham.—The Council have decided to apply for a Provisional Electric Lighting Order, and it has also been decided to engage Mr. W. C. C. Hawtayne to prepare an electric-lighting scheme at a fee of 25 guineas.

Huddersfield.—At the last meeting of the Town Council the following resolution relative to electric lighting loans was passed:—"That in order to comply with the requirements of the Local Government Board the sum of £43,715 (being the original loan of £49,500 less £5,785 accumulated in sinking fund) be repaid to the borough fund and re-borrowed from that fund; also that the sum of £5,785, accumulated in the electric supply sinking fund, be paid into the borough fund, and sundry loans covering the amount be repaid, and that the necessary transfer of the investments in connection therewith be made; also that with respect to the £500, being the residue of £50,000 at present unborrowed, the Corporation agree to the issue of the fresh sanction to the borrowing of that sum for the substituted period of 25 years." Alderman Calvert said he thought the Committee could borrow at a cheaper rate than at present. The Local Government Board had assented to the unexpired borrowing powers being transferred, and had agreed to the limit of repayment being extended to 25 years.

Isle of Wight.—The Shanklin and Sandown District Councils have been approached by Edmundson's Electricity Corporation with a view to obtaining sanction to an application for a Provisional Order, and a joint committee of the two Councils has been formed to discuss the matter.

Islington (London).—The Vestry on Friday last decided to extend the electric light mains along St. James-road and to erect 13 arc lamps at an estimated cost of £1,260. The arc lighting is to be extended through Parkhurst-road, thus completing the line of lighting direct to Holloway-road. Mains for public and private supply are to be laid on both sides of the road and 13 arc lamps erected at a total cost of £2,200.

Lecture.—At Bradford last week Dr. Oliver Lodge delivered an interesting lecture to the members of the Philosophical Society on "Electrical Oscillations and their application to Wireless Telegraphy." A hearty vote of thanks was accorded to the lecturer at the close.

Leeds.—A Local Government Board inquiry will be held here on Thursday into the application of the City Council for a Provisional Order to enable them to issue stock for the purchase of the undertaking of the Yorkshire House-to-House Electricity Company (Limited).

Light Railway Scheme.—The adjourned inquiry by the Light Railway Commissioners into the application for power to construct a light (electric) railway from Hendon and Finchley to Hampstead was resumed on Saturday. The Commissioners held that the necessity for the line had not been proved, and declined to grant the Order.

Liverpool.—On the recommendation of the city electrical engineer (Mr. A. Bromley Holmes) the Lighting Committee have decided to reduce the price of electric current from 7d. to 5d. per unit when supplied at a pressure of 230 volts, this charge to be for supplies of 1,000 units and less per quarter; after the first 1,000 4d. per unit. For the lighting of public buildings the charge is to be 4d. per unit, and for street lighting 3d. (as at present). These reductions are to take effect on April 1. The equivalent number of 16-c.p. incandescents used by private consumers have increased during the past month from 63,303 to 71,283. The Committee have also decided to make a further reduction in the price (to 2d. per unit) for electricity used for power. Mains are to be laid along Great George-street and other thoroughfares at the South-end, and a scheme has been approved for laying down the first instalment of electric mains for the tramways, the cost of the work, which is mainly connected with the line from St. George's Church to the Dingle, being estimated at £13,023. As notified elsewhere, Messrs. Holme and Green's tender for the extension of the Oldham-place generating station has been accepted.

London County Council.—At Tuesday's meeting the newly-elected Council considered the recommendations of the Highways Committee, which were set out in our issue of Feb. 26, p. 604, by which, under an agreement to be entered into between the National Company and the Council in relation to the placing of the Company's wires underground, the Company are prohibited during the period of the agreement from charging any larger sum to subscribers to the telephone than is there set out. Considerable discussion arose, and Mr. Beechcroft said he strongly objected to the recommendations of the Committee, and trusted the Council would not agree to them. The two questions which arose on the recommendations were: firstly, whether the Council could legally impose these conditions on the Company, and secondly, whether they were not morally precluded from enforcing them. The terms now offered were a distinct departure from those agreed upon so recently as June last. Further, the Council had no power to make the Company reduce its rates. He was desirous of seeing the Council join hands with the City Corporation and the London Vestries to impress upon Parliament the necessity to hold a full inquiry into the whole telephone question, but he did not consider the Council had any right to attempt to place unreasonable conditions upon the Company in the carrying out of its work. Mr. Benn, who had given notice of certain amendments to the Committee's recommendations, preferred to propose that the report should be referred back in order that the Committee be enabled to report to the Council as to the terms imposed upon the National Telephone Company by the leading provincial authorities for the protection of the streets, and for securing reasonable charges for telephone subscribers. The amendment to refer the matter back to the Committee was approved.

The same Committee presented a report relating to the installation of the electric light at Crossness Sewage Outfall, and recommended that the estimate of £5,500 for this work be approved, and that the Council agree to the installation in accordance with the drawings presented to the Main Drainage Committee at an estimated total cost of £7,000, and also that tenders should be invited for the necessary work. The consideration of this recommendation was, however, adjourned.

On the presentation of the Fire Brigade Committee's report Mr. Frank Smith asked whether it was true that in connection with the wiring of the chief fire brigade station for the electric light, the National Free Wiring Company, who had obtained the contract for this work, were paying wages of from 4d. to 8½d. per hour, instead of from 9d. to 10d., the recognised wage for this class of work. Col. Rotton, chairman of the Committee, undertook to report upon this matter.

A resolution is to be proposed at an early meeting recommending the laying and working by the Council of a tramway from Stratford to Barking, along the top of the northern outfall sewer embankment, and to take into consideration the system of traction likely to be most suitable and economical for working the line.

Manchester.—An interesting article, dealing with the congested state of the traffic in the principal thoroughfares of this city, appeared in the *Manchester Guardian* of the 19th inst. To relieve this congestion the writer favours the construction of two underground circular electric railways; the first to connect the various railway stations in the city (3½ miles), the second a more comprehensive scheme and about 8 miles long.

Marylebone (London).—The Vestry have authorised the Electric Lighting Committee to consider and fully report upon the question of the acquisition of a site for electric lighting and dust-destructor works.

On the recommendation of the Works Committee the Vestry have decided to object to the proposal of the Metropolitan Electric Supply Company to lay low-tension armoured mains from their

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Rathbone-place station along Rathbone-place, Oxford-street, Upper Rathbone-place, Newman-passage, and Newman-street, crossing Oxford-street at Rathbone-place and Newman-street.

Motor Cars in Italy.—A tax of 20 lire is now imposed upon machines and apparatus such as bicycles, motor cars, &c., propelled by electrical or other mechanical means.

Municipal Electrical Association.—The Council of this Association have called a general meeting, to be held at the Westminster Palace Hotel, London, on April 19, at 3 p.m.

Parliamentary.—In the House of Commons, on Tuesday, the following members were appointed to represent the Commons on the Joint Committee of both Houses to consider and report on electrical energy (generating stations and supply), viz.: Mr. Ashton, Lord Balcarres, Mr. Kimber and Sir Leonard Lyell. The peers representing the House of Lords on the Committee are Earl Spencer, Viscount Cross, and Lords Knutsford and Monkswell.

Portsmouth.—The advent of the National Free Wiring Company into this district has led to a petition being presented to the Electric Light Committee against facilities being given to the Company by the Corporation, and it has been decided by the Committee to receive a deputation on the subject. Mr. Alderman Ellis, Chairman of the Committee, is a Director of the National Free Wiring Company. Those connected with installation and wiring work in the borough regard the Company's operations in Portsmouth as unfair competition.

Private Bill Legislation.—The Metropolitan Railway Bill and the question of the opposition raised by the Great Western Railway Company came before the Court of Referees at the House of Commons as to the *locus standi* of the opposing Company. In supporting the right of the petitioners to oppose, Mr. Worsley Taylor, Q C., pointed out that in former Acts it had been clearly laid down that Great Western trains working over the Metropolitan Railway should be under the control of the Metropolitan Railway Company, and that the engines, carriages, &c., should be subject to the approval of that Company. He said that engineers had declared that the proposal of the Metropolitan Company to take powers to work the railway by electricity and to construct generating stations, would necessitate an entire change in the whole system of working, and he submitted that the Court had never before heard of a proposal to alter an agreement made under one set of conditions in order to admit of the operation of an altogether new set of conditions. Mr. Freeman, Q C., arguing against, declared that there was nothing in the Bill touching the Great Western Company. All that was proposed was that the Metropolitan Company might—not everywhere on their system, but over certain lines—use electricity for working their own carriages. The Metropolitan Company desired to improve their system for the convenience and comfort of the public, and they sought powers, in order to render the ventilation of the railway more satisfactory, to use electricity. The system of traction to be adopted was not decided upon, the Company asking for three years in which to make inquiries and test the various systems of locomotion, and the Board of Trade had a voice in the final selection of a method.

The City and South Railway Bill has passed the committee stage in the House of Commons, and has been ordered to be reported.

St. Pancras (London).—Electric light mains are to be extended to Camden-square, at an estimated cost of £628.

Sale.—The Electric Lighting Committee presented a report at the last meeting of the Council recommending the adoption of the electric lighting scheme prepared by Mr. John Shaw at an estimated cost of £22,500. The three-wire continuous current system of supply is recommended, and provision is to be made for the erection of 12 arcs along School-road and part of Northenden-road. The smaller roadways are to be illuminated by 32 and 16 c.p. incandescents. The Council have decided to submit the scheme to an expert.

Self-Propelled Traffic.—The Self-Propelled Traffic Association call public attention to the forthcoming trials of motor vehicles for heavy traffic, which will be held in Liverpool during the last week of May next.

Shoreditch (London).—The Vestry have authorised the substitution of larger cables for those at present in Great Eastern-street, Paul-street, Curtain-road, Old-street and other streets, owing to heavy demand for current.

Southport.—A Local Government Board inquiry was held here last week into the application of the Town Council to borrow £21,178 for electric lighting purposes. The town clerk (Dr. J. Davies Williams) said that the present capacity of the works was 675 units, and the highest output had been 398. The stand-by which they considered necessary was 300 units, so that it was evident the limit of safe supply had been reached. It was proposed to put in plant which would have a total capacity of 1,275 units and a working capacity of 675. On March 31 last they had had an equivalent of 16,760 8-c.p. lamps connected, and at the present time 24,700, and about 2,000 more were awaiting connection. Technical details were supplied by the Mr. C. D. Taite, the borough electrical engineer, who said that they would save about £2,000 by putting down 600 unit plant instead of two 300-unit machines. The new plant would meet their requirements up to about the year 1900.

Swansea.—The British Electric Traction Company, which recently acquired the local tramways, has made an offer to the Corporation to supply electric current for public and private lighting in the town. A sum of £1,000 is offered for the Council's Provisional Order with 10 per cent. of the gross receipts from the sale of current by lighting. At the last meeting of the Council the Mayor announced that the Electric Light Committee had received Mr. Manville's report, while the Borough Surveyor would also report on the dust-destructor portion of the joint scheme. The Committee will shortly hold a special meeting to consider both reports.

Telegraphic Communication between Great Britain and Iceland.—The Great Northern Telegraph Company are, we understand, prepared to lay a cable to the Faroe Islands and Iceland, for which the Danish Government has offered a guarantee. The laying of the cable is, however, dependent on a subsidy from the British Government of £3,000 a year for twenty years. The cost of the cable and laying would be £160,000. There is, however, little likelihood that the British Government will subsidise the line. The matter is to be mentioned in Parliament.

Telegraph Officials in a Tight Place.—During a recent revolt in the Phillipines the officials of the Eastern Extension Telegraph Company, in the station at Bolinao, had an unpleasant experience. The rebels hunted a number of Spanish soldiers into the station and threatened that if they were not given up the whole place should be destroyed and everyone found on the premises murdered. This threat does not appear to have unduly alarmed the English telegraphists, who, with the soldiers, were able to keep the rebels at bay until the relief of a Spanish force came along.

Torquay.—Full particulars have appeared in *The Electrician* concerning the electrical equipment of the electricity supply station at Torquay, which was formally opened on Thursday last by the Mayoress (Mrs. Harrison) switching on the light. A large company was present on the occasion. After the opening ceremony a procession was formed, and the Mayor and Corporation, preceded by its band, marched to the Queen's Hotel, where the Council, its officials and others were entertained at a banquet, the room being brilliantly illuminated by tastefully-designed and arranged electric lamps. The duty of proposing "Success to the electric light undertaking" was entrusted to ex-Mayor Rockhey, who said that the electric lighting question had been before the town for seven years, and they had at last achieved the accomplishment of an object which was to many of them one of great interest and value. Torquay was the first municipal authority in Devon to lay down and complete an electric light undertaking. Replying, Alderman Keswill, chairman of the Electric Light Committee, gave a general history of the undertaking, and anticipated that the Torquay installation would prove as successful an example as that of other towns. He referred in flattering terms to the successful efforts of their consulting engineer, Mr. W. H. Trentham, who had a toast all to himself, and in reply referred to the determined efforts of Alderman Keswill in connection with the latest municipal undertaking of Torquay. The installation had cost about £23,000, and he (Mr. Trentham) could get two or three companies in London who would willingly buy the undertaking for £30,000. They started with a load equal to nearly half their total capacity, the contractors had spared no trouble or expense to make the installation a success; and Messrs. Easton, Anderson, and Goolden, who had supplied the alternators, had put in a plant 20 per cent. better than had been required, and so placing more power at their disposal. They would have started six months earlier but for the disastrous engineering strike. He thanked the town clerk and the borough surveyor for the valuable assistance they had rendered him in his labours.

Walton-on-the-Naze.—Messrs. Lowdon Bros., Dundee, have secured the contract for the construction of an electric tramway on the esplanade. The line will be about two miles in length, and the third-rail system is to be adopted.

Waterloo and City Railway.—It is probable that this line will be opened for traffic on May 2.

Withington (Lancs.).—A sub-committee has been appointed to wait upon the Electric Lighting Committee of the city of Manchester to arrange terms for the supply of current in the district.

Workhouse Lighting.—The Hampstead (London) Board of Guardians have decided to obtain plans and specifications for wiring the workhouse for the electric light.

Smoking Concert.—A smoking concert by the London central branch of the Electrical Trades Union is to be given on Saturday, April 9, at the Clerkenwell New Town Hall, Rosebery-avenue, London, E.C., to commence at 8 p.m.

The last concert of the season of the Electro Harmonic Society takes place this (Friday) evening at the St. James's Hall Restaurant London, W., at 8 o'clock.

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

February 12, 1898.

3,555. C. P. ELIESON and W. S. NAYLOR. London. A combined switch and controller for electromotors.

3,563. F. BROWN. Birmingham. Improvements in or relating to electric arc lamps.

3,569. A. CUSTODIS. London. Improvement in electrical apparatus for indicating or recording at a distance the position of an index hand or analogous movable object.*

February 14, 1898.

3,645. M. BERNSTEIN, Proprietor of the firm of J. F. WALLMAN AND Co. London. Arrangement for transmitting telegraphic messages in contrary directions simultaneously over a single wire.*

3,695. E. WILSON. London. Improvements in magnetic circuits or parts of circuits.

February 15, 1898.

3,731. J. M. MARTIN. Glasgow. Transmitting drawings, pictures, sketches and the like, by telegraph or telephone.

3,749. J. G. A. RHODIN. Manchester. A method of oxidation and bleaching by means of electrolysis.

3,783. C. O. BARROWS and C. H. SMITH. London. A new or improved method of, and apparatus for generating electricity.

3,796. S. H. SHORT. London. Improved means for displacing, dispersing or extinguishing arcs formed in breaking electrical circuits.*

3,802. H. EDMUNDS. London. Improvements in or connected with electrical conductors.

3,805. T. H. MINSHALL. London. Improvements in electrical switch apparatus.

3,806. H. O. SWOBODA. London. Improvements in apparatus for making and breaking electric circuits at predetermined times.

3,808. G. THOMAS-DAVIES. London. Improvements in impedance coils for enclosed arc lamps.

February 16 1898.

3,838. A. WEBB. Manchester. Improvements in electric accumulators.

3,841. F. PALM. Halifax. Improvements in the method of and means employed for connecting electric glow lamps to main conductors.*

3,850. W. GEIPEL, F. M. T. LANGE and W. R. SALTRICK. London. Improvements in holders for electric glow lamps.

3,902. H. BEAN and M. BERTRAND-TAILLET. London. Improvements in devices for protecting electric incandescent lamps from the action of moisture.

3,905. P. G. PASQUET. London. Improvements in suspension devices for electric and other lamps.

3,924. J. KREMENEZKY. London. Improved fastening for the heads of electric glow lamps.

3 925. H. C. GOVER and J. M. MOFFAT. London. Improvements in electric safety fuses and lamp connections.*

February 17, 1898.

3,960. J. WILLIAMS and W. M. WALTERS. Liverpool. Improvements in electric switches.

3,993. A. J. BOULT. London. Improvements in or relating to electric ignition devices for internal combustion engines. (La Société Nouvelle des Établissements Décanville aîné, France.)*

4,002. L. DUQUE. London. A new and improved telephone support and an automatic circuit controller.

4,004. W. R. EDWARDS and S. F. BEEVOR. London. Improvements in switches for altering the speed and direction of revolution of electric motors and for altering the course of the electrical current round field magnets.

4,046. A. B. BLACKBURN, W. L. SPENCE and E. S. W. MOORE. London Improvements in or connected with the distribution of electricity on the three-wire system, with the neutral wire at earth potential.

February 18, 1898.

4,058. E. BANFORD, C. SEDDON and S. JACKSON. Huddersfield. Improved means for use in connection with electric and other suspended lamps and the like for raising and lowering same.

4 075. H. MAXIM. London. Improvements in methods and apparatus for electro-thermally treating materials, more particularly for the manufacture of calcium carbide and other carbides and the reduction of ores.

4,114. F. W. DOLBY. London. Improvements in telegraphic apparatus. (Bruno Fidler, Austria.)

4,121. E. WILSON and H. GODSAL. London. Improvements in telephones, telegraphs, and other forms of electrical signalling.

4,139. C. M. HEPWORTH. London. Improvements in or relating to electric arc lamps.

February 19, 1898.

4,150. T. W. ALLEN and ALLEN AND ADAMSON (LIMITED). Glasgow. Improvements in electrical accumulators or storage batteries.

4,176. M. CATTORI. London. Improvements in the distribution of electricity over electric railways.*

4,202. W. J. H. JONES. London. Improvements relating to the displayal of words or devices by electrical illumination.

February 21, 1898.

4,267. C. OLIVER. London. Improvements in or relating to enclosed-globe electric arc-lamps.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

25,036. DOBELL. Electric batteries.

1897.

907. RABBIDGE. Device to be used as an indicator signal or relay in connection with telephone switchboards and other analogous apparatus.

3,120. THOMPSON (POPE). Incandescent electric lamps and their connections or holders.

4,442. DOBELL. Electric batteries.

5,171. WOOD. Conductors for electric railways and the like.

5,383. WALKER. Primary galvanic batteries.

9,167. SNOW AND COOPER. Electric apparatus for governing engines.

6,962. GUISE. Electro-plating apparatus.

7,212. DIXON. Rheostatic apparatus particularly applicable to the starting of electromotors.

7,645. SIEMENS BROS. AND COMPANY (LIMITED) (Siemens and Halske). Means for preventing installations for electrical transmission of energy, in particular electrical railways, from causing disturbances in telephonic circuits.

7,646. SIEMENS BROS. AND CO. (LIMITED) and LEAKE. Electrical motor generators.

7,823. COWAN and STILL. Electric switches.

7,877 LAKE (Société Anonyme des Horloges Electriques Cauderay.) Apparatus for controlling and registering the time of working of electric lamps.

8,041. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske). Apparatus for transmitting motion to a distance by means of electrical energy.

8,416. DAVY and THOMAS-DAVIES. Electrical switches.

8,674. BROCKIES. Electric switches.

9,166. WERTHER AND SCHÄFFER. Method of and apparatus for erecting overhead electric conductors for railways and tramways.

9,194. MARCH. Heating by electricity.

9,561. HUNTER. Means for controlling carbon-feeding mechaniams for electric lamps.

9,586. LITTLE AND IRELAND. Current-collecting apparatus for electric tramways.

10,051. MASSON. Holders for incandescent electric lamps. (Date applied for under International Convention, September 24, 1896.)

15,933. MILLS. Portable electric lamps.

20,591. LITTLE. Electric tramway and electric transmission of power systems.

21,110. WHEATLEY (Allgemeine Elektricitäts Gesellschaft). Arc lamps with double globes.

23,260. SCOTT. Automatic magnetic-circuit breakers. (Date applied for under International Convention, March 17, 1897.)

26,659. HOLSTEN and the ELEKTRISCHE BOGENLAMPENFABRIK NAECK and HOLSTEN GESELLSCHAFT MIT BESCHKRANKTER HAFTUNG. Automatic cut-out or short-circuiting device for electric arc lamps.

26,727. MENZIES and BELL. Electric brakes for cars.

27,120. MARTIN. Apparatus for electrically-illuminating and displaying letters, numerals, devices, and the like for advertising and decorative purposes.

27,888. BRADLEY. Electric furnaces.

28,882. BARKER (Schoeffel). Electric switches for electric valve-controlling apparatus.

29,055. FELDMANN and HELIOS ELEKTRICITÄTS-ATKIENGESELLSCHAFT. Alternate current meters.

COMPANIES' MEETINGS AND REPORTS.

South London Electric Supply Corporation (Limited).

The ordinary general meeting of the shareholders of this Company was held on Monday, under the presidency of Mr. George Ellis, J.P.

The SECRETARY (Mr. Sidney H. Webster) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: Before moving the adoption of the report and accounts I wish to state that this meeting would have been called at an earlier date but for the fact that there was delay in auditing the accounts consequent upon the illness of the auditor appointed by the Board of Trade—from that enemy of us all, influenza. Directly he recovered he most courteously lent every assistance in his power to the hurrying forward of his audit. The maps which you see on the wall show still more additions to the mains since the report was printed—there are to-day 23 miles of mains laid in about nine miles of streets. Steady progress is being made in all directions. Our station site is practically in the centre of the area of supply and the three acres of freehold land cost under £10,000. A better site for our operations there could not be. Referring to the accounts, there is at this early stage very little upon which to comment. As stated in the print of them which has been sent you, a certain proportion of the administration has been allocated to the cost of land, buildings, machinery, plant and mains. It is usual so to charge part—or sometimes all—of the management expenses of similar industrial undertakings whilst the works of such undertakings are in course of construction, and there can be no revenue, and we have followed this custom with the auditor's approval. A statement has been made that no dividend can be paid till the cost of the Order and expenses, amounting to £47,000, has been paid off. This is not true; the expenditure can be placed to a suspense account. The Board of Trade

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will allow a dividend to be paid so long as a suitable amount is annually set aside for the extinction of the amount. No doubt some of you have been told, and some of you may think, that £47,000 is a large sum for this Order and the expenses. On the face of it, in our present position, I admit it does seem large, but it is not so in fact. I cannot give you the details of that cost—it was in the contract, which could have been seen by anyone before purchasing shares—but I can tell you this—that the Board of Trade insisted upon the capital being underwritten to the extent of £200,000 before they would let this Company have the Order, and that in itself, with the brokerage, absorbed £24,000 of the amount. Other details I cannot give you, but I should like to compare the expenditure with that of two other large companies in London, namely, the Westminster and the St. James's companies, and to say that our Order has not cost us one-half of what theirs has cost them; because in one case they had to redeem their Founders' shares at a cost of £120,000, and in the other case, I believe, at £150,000, whereas £47,000 is the absolute cost to us of this Order. I will now deal with the issue of the balance of the share capital. The facts of the case are these: the shares subscribed for gave us a little over £200,000 to fulfil contracts and carry out works involving an expenditure of about £300,000. In July last we could not get more capital, as the shares were considerably below par, and, as you know, it is illegal to issue shares at a discount. Any offer to the shareholders (which has been suggested should have been made) would still further have depreciated the shares, and have thus added to our difficulties. Your Board had many serious consultations, and at last most reluctantly instructed their engineer to cut down the contracts; but then arose an unforeseen difficulty. We were under an obligation to the Lambeth Vestry to build a dust-destructor capable of burning a certain number of tons of refuse per annum, so that this, the largest contract, could not be reduced. We, however, arranged to cut down the engines, cables and other machinery by one-third; but we did this only as a last resort, as we knew full well that this meant doing away with any prospect of early dividends, but there was at that time no other course open to us. However, on July 29th, Mr. Cook, a gentleman whom the Board knew to be connected with a strong group of financiers, called on the Board and offered to take the 1,530 shares necessary to obtain a Stock Exchange quotation at par—although shares could be purchased in the open market at a considerable discount—conditionally upon our giving him an option at par for the balance up to December 1. We maintain that this was a very businesslike and favourable transaction for the Company. Mr. Cook, however, found some difficulty at the outset in making his arrangements, as so many people had left London for the holidays, and at the next board meeting he asked for a month's grace. This was agreed to, and at the end of that time the cheque was forthcoming, and application for a Stock Exchange quotation was duly made and granted. Subsequently Mr. Cook transferred his option to Mr. Atherton, the gentleman who had some months previously promoted the Company, and he, at the expiration of the option at the end of November, came to the Board and offered to take up and pay for the whole of the shares covered by it if the Board so desired. He, however, made another proposal to the effect that he should then only take up and pay for 12,500 shares out of the 21,659, leaving the balance, namely, 9,159, over until March 1st, and paying to the Company interest at the rate of 4 per cent. on the £18,318. The Board thereupon considered which of these two offers would be most beneficial to the Company, and came to the conclusion that Mr. Atherton's second proposal was the better. Our reasons for adopting this course were: first, that we had no immediate use for the money: and, secondly, that the rate of interest we were getting for our cash on deposit was only 1½ per cent. against the 4 per cent. tendered us. All proper precautions were taken to secure this £18,318, and we obtained from Mr. Atherton a legal instrument, approved by our solicitor, by which he was compelled to take up and pay for the shares on March 1, so that no matter what might be the state of the market on that date, this Company was bound to receive the money—I mean that the option was *not* extended in favor of Mr. Atherton, as some of you have no doubt been led to believe. I have now given you a complete history of the whole affair, which with our knowledge, at that date, was a thoroughly sound business transaction, and we believe it will meet the approval of the proprietors, whose shares, through the strengthening of the Company's finances, have risen in value. As directors we have only to consider the true interests of the Company. With no "quotation," with shares at a discount and insufficient capital at our command to carry out our programme, your directors are satisfied—and we believe you are—that in placing the balance of capital as we did, we acted as men of business in your interests. I trust that it is not necessary for me to assure you that none of your directors have any interest in the allotment made to Mr. Atherton, either directly or indirectly. I now beg to move—

"*That the report of the Directors, together with the accounts to December 31, 1897, duly audited, be received, approved and adopted.*"

Mr. T. H. BROOKE HITCHING (a shareholder) seconded the motion, and referred to some attacks upon the action of the Directors which had appeared in a daily paper. He was a shareholder in most of the electric lighting companies, and considered that their Company was in a far better position than others in which he was a shareholder, and he regarded the attack in question as most uncalled for. Their Chairman was the ex-Mayor of Portsmouth and Chairman of the Electric Lighting Committee there. He noticed that Mr. Fitch, of the St. James's and Pall Mall Electric Light Company—in which he was himself a shareholder—was present, and the £5 shares of that Company were quoted at £18. He was himself the chairman of the Electric Lighting Committee of the St. Marylebone Vestry, and he had so much confidence in this company's engineers—Messrs. Kincaid, Waller and Manville—that he recommended their employment by the Marylebone Vestry, and his recommendation was acted upon. With such a Board and engineers as this company had, he would be very much surprised, and very much annoyed, too, as the holder of 1,000 shares, if it were not a success.

Mr. ARTHUR BROOKE proposed the following amendment:—

"*That the report be received, but not adopted, and that a Committee of five shareholders be appointed, with power to add to their number, to inquire into the formation and past management of the Company, and the relations between the Board and the promoter, and with power to call for books and documents, and to obtain such legal and professional assistance as may be necessary, such Committee to report to a meeting to be called for Monday, the 18th day of April, 1898.*"

After stating that he held 180 shares, he proceeded to argue that the history of the Company showed that its affairs had not been managed in the interests of the shareholders, and that very substantial benefit had been derived by Mr. Atherton, the promoter.

Mr. WHEELOCK—who, in response to calls, said that he regretted holding only 10 shares now—seconded the amendment. Reference had been made by the Directors in their report to his criticism of their management of the business of the Corporation. In his opinion that criticism had been well deserved. He took it that the £46,649 appearing in the balance-sheet was the sum paid to the promoter under the agreement referred to in the prospectus dated March 19, 1897, so that they might fairly assume that the promoter had a good bargain to begin with.

Mr. BRADSHAW inquired whether the Chairman was prepared to give them a little information as to the items forming the total of £47,000.

Mr. HARRY PEARSON—a shareholder and member of the Stock Exchange—said he regarded it as extremely indecent for a man who avowed having sold the great bulk of his shares to continue his endeavour to sow dissention among the shareholders. Mr. Wheelock's contention was nothing more nor less than that the Directors were dishonest. By the action taken by the Directors a quotation was obtained for the shares on the Stock Exchange, and the rest of the money was subscribed, so that there was to be no curtailing and cutting down their contracts, which were now to be carried out in their integrity.

Mr. BROOKE HITCHING inquired whether the mover and seconder of the amendment would not withdraw it.

The CHAIRMAN said it was not necessary for him to go over the arguments of Mr. Brooke and Mr. Wheelock. The latter's charge against the Directors was one of flagrant dishonesty, but he would like Mr. Wheelock to get up and tell him to his face that he was a dishonest man, and then he would know how to deal with him. They were supplying electricity at a profit now. He then put the amendment, for which four hands were held up, and subsequently he put the original resolution, which was carried with only three dissentients.

An extraordinary general meeting was held subsequently, slightly amending one of the Articles of Association.

On the motion of Mr. BROOKE HITCHING, seconded by Mr. ARTHUR BROOKE, a vote of thanks was passed to the Chairman and Directors, and the proceedings terminated.

Norwich Electricity Company (Limited).

The ordinary general meeting of the shareholders of this Company was held at Norwich, under the presidency of Mr. F. W. Harmer.

The Directors' report stated that during the past year 221 new customers had been connected to the mains, compared with 225 in 1896, the total number now being 896; 20 additional motors had been connected, with an aggregate of 60 H.P., being a larger increase in this direction than that of any preceding year; 2½ miles of new mains had been laid, the total length being now more than 12½ miles. The growing demand for current has necessitated the erection of new machinery and an extension of the previously existing buildings at the central station. Notwithstanding the reduction in the price of current for lighting, the revenue derived therefrom was larger than last year, while, owing to increased economy in working, the expenses had not grown in the same proportion. Including £444. 1s. brought forward, and allowing for debenture interest and for depreciation, the net revenue account showed a credit balance of £3,940. 4s. 2d., out of which the Directors proposed a dividend of 5½ per cent., free of income tax, and to place £1,000 to reserve, carrying forward £452. 3s. 4d. To promote the further use of electricity the Directors had introduced a system of free wiring, charging to customers so acquired 3d. and 4d. instead of 7d. and 3½d. per unit. This new departure had been much appreciated, and would probably result in a large extension of the Company's operations. Motors were also being supplied on the three years' hire-purchase system.

In moving the adoption of this report the CHAIRMAN congratulated the shareholders upon its satisfactory character. He said the Company had never yet had a debit balance. At the end of the first year's working they had declared a dividend of 3 per cent., and they had been able to make it a little better each year, while the past year was the best they had had. Twelve months ago the price of current had been reduced 12½ per cent.; but, owing to economy in working and to the fact that they had acquired a large number of new customers, the result of the year's working was even better than that of 1896. The Directors were increasingly satisfied that they had adopted the right system of electricity supply. The price at which they were generating current was considerably below the average of the whole country, even including those of the Midland counties, where coal was much cheaper than at Norwich. The most interesting feature which he had to report was that they did not seem to be getting to the end of their prosperity. They were acquiring new customers at this moment as fast as they were at any period in their history. They had lately adopted a system of "free" wiring, which would probably bring them a considerable amount of new business, which they could not have obtained in any other way

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He thought there was a little misunderstanding as to the amount of rent which they were charging for these fittings, which was not 12½ per cent. on the cost of the instalment, but on the amount of current used. If the lamps were used very little the Company got a very small rent, and on the whole it was not at all an excessive one. The Directors had not only put aside this year a certain amount for depreciation, but also another sum as reserve. The Company had been applied to to supply electricity in Thorpe, and they were now applying to Parliament for an Act to enable them to do so. They had no doubt they could get a profitable business in Thorpe, and they had taken the opportunity of adding some of the other parishes just outside the city boundaries, and though they had no immediate intention of supplying them it might save the expense of going to Parliament hereafter for a new Act. The motion was agreed to.

Sheffield Electric Light and Power Company (Limited).

The annual general meeting of this Company was held on Monday at Sheffield.

The CHAIRMAN Alderman G. Franklin referred to the progress made during the past year. The gross profit was £11,492, and after deducting debenture interest there was a balance of £10,367, out of which the Directors recommended the payment of a dividend at the rate of 12½ per cent., which would absorb £9,464, leaving £902. 18s. to be carried forward. The units metered amounted to 747,067 against 483,427 in 1896, 288,406 in 1895, 192,220 in 1894, and 131,752 in 1893. The lamps wired told the same tale of progress. The figures were all the more remarkable when they bore in mind the fact that on January 1, 1897, the Directors reduced the price of current from 6d. to 5d. per unit, and in July last year it became necessary—in the midst of a conflict between capital and labour, which prevented them from getting machinery which contractors had undertaken to supply to give notice that they were not prepared to take on new consumers. Happily that difficulty had passed away, and the Company were now taking consumers at perhaps as rapid a rate as at any previous period in their history. The best test of the management of the undertaking was not the growth of income, not even the growth of lamps wired or the number of units metered, but rather the cost of generating current. In 1893 the cost was 5·14d. per unit; in 1894 3·8d.; in 1895 3·6d.; in 1896 2·23d.; and in 1897 1·56d. He thought that was a satisfactory state of things, and on the strength of what the Company had achieved, the Directors had caused a notice to be issued that on the 31st of the present month the price of current would be reduced from 5d. to 4d. per unit, a total reduction since 1896 of 33⅓ per cent. Something had been said about the reduction in the price of gas. They knew that gas had been reduced 2d. per 1,000 cubic ft., equivalent to 8 per cent., against 33⅓ per cent. in the cost of electricity. They would, therefore, see that while gas had had 80 years' clear start of the electrical industry, the younger rival—and should he say the more hopeful rival—was rapidly overtaking and collaring gas, even on its own particular ground, that of cheapness. They had only to reflect as to what the price of gas when the gas undertaking was as old as the electric light undertaking was now—when they were paying something like 8s. to 10s. per thousand, and for very bad gas—in order to see the remarkable progress that was being made in electricity at the present time. From the point of view of general health, cleanliness, brightness, and coolness, there was no comparison between electric light and gas.

The CHAIRMAN referred at some length to the remarks recently made by the chairman of the local gas company (Sir F. Mappin) particularly as to the lighting of the Town Hall. He said that a comparison of the cost of electric lighting must be made by comparing it with a similar number of gas lights. One great fact remained: that those who had become customers for the electric light remained customers. Tradesmen and others, who know their business perhaps better than any gas company or electric light manager could teach them, would not pay for anything more than it was absolutely worth to them, and a satisfactory thing to the shareholders of that Company was that no consumers who once put in the electric light took it out again, and those who had it expressed themselves as being perfectly well satisfied with it, and went in for an extended use of it. They had been twitted with a comparison of the charges made at Sheffield with those prevailing at Brighton. What were the facts with regard to Brighton? Two or three years ago Brighton adopted what was called a scientific system of measurement, but he thought most of them would fight shy of any system of measurement by which their electric light, gas, water, or any other commodity would be likely to go up. The system at Brighton was based theoretically upon the call which the consumer could have upon the station, and so a consumer there was charged 7d. per unit for the first hour for every lamp in his house for the whole 365 days of the year. That meant that every lamp must burn one hour per day, summer and winter, autumn and spring, before the consumer could get the benefit of the reduction to a penny a unit. Was not that very much like a sixpence dangling at the end of a string, which turned away when one attempted to get hold of it? If they took into consideration the income of the Brighton station last year, and the number of units metered, it would be found that the Brighton Company got 4·69d., or nearly 4¾d., for every unit of electricity they supplied. So they would see how illusory was that method of charging. At the present time there were 46 miles of pipes under the streets of Sheffield, containing 28 miles of cable, and many of those would be available for future extension to new customers. The difficulties which had to be dealt with during the year 1896 were now happily swept away. He concluded by moving the adoption of the report and accounts, which was agreed to.

An extraordinary general meeting was afterwards held under the presidency of Mr. William Tasker, to consider the terms of the agreement for the sale of the undertaking to the Corporation. Particulars of this agreement were given in our last issue, and on the motion of the Chairman the terms were confirmed.

Direct Spanish Telegraph Company (Limited).

The report of the Directors of this Company for the year to Dec. 31 last states that after providing for interest on and redemption of debentures, there is a balance to credit of revenue of £12,975. 6s. 4d. After adding £5,000 to reserve, the Directors recommend the declaration of dividends for the year 1897 of 10 per cent. on the Preference and 4 per cent. (free of income tax on the Ordinary shares, absorbing £5,486. 4s. Half of this amount was distributed on Oct. 1 last.

Traffic receipts show a decrease of £2,927. 3s. 11d., compared with 1896, an exceptional year. The reductions of rates and the mode of counting words in telegrams, adopted at Budapest, came into force on July 1, 1897, and have, as expected, adversely affected the receipts. The working expenses are £223. 8s. 11d. in excess of those for 1896.

The Company's cables and land lines have continued in good working order. The Directors' report of Sept. 11, 1894, stated that the construction of a new breakwater at Bilbao placed the Company under the necessity of removing the shore end of the Falmouth-Bilbao cable to a point outside the new breakwater, and that the cost of this removal was chargeable to the harbour authorities at Bilbao. The Directors regret that the liability of the harbour authorities was not admitted by the Spanish Courts. The cost of the removal of the shore-end, amounting to £3,514. 5s. 2d., has, therefore been debited to the reserve fund, and it is proposed that the balance of revenue (£2,489. 2s. 4d.) be transferred to reserve towards the payment of this amount, and that the sum (£1,025. 2s. 10d.) required to make up the cost of the removal be repaid to reserve out of future revenue. The reserve fund now amounts to £44,769. 11s. 2d.

Mr. F. Alexander Johnston has been elected by the Directors to a seat at the Board, vacant by the death of Mr. Edmund Etlinger. In commemoration of Her Majesty's Diamond Jubilee a bonus has been granted to all employés in the Company's service.

Willans and Robinson (Limited).

The eighth half-yearly report of the Directors of this Company for the period to Dec. 29 shows that after writing off as depreciation from plant, patents, &c., £5,277. 8s. 4d. (against £4,162. 11s. 4d. last half-year), and paying interest upon debenture stock, the balance to credit of profit and loss account (including £1,859. 13s. 7d. brought forward) is £16,053. 0s. 10d. The Directors propose that the full dividend be paid on the Six per Cent. Preference, and at the rate of 8 per cent. per annum on the Ordinary shares, together absorbing £8,707. 17s. 7d. The amount payable to the original Directors is £1,832. 5s., leaving £5,512. 18s. 3d., of which the Directors propose to carry £2,000 to debenture redemption, and £1,500 to reserve, leaving £2,012. 18s. 3d. to be carried forward.

The Directors feel that the satisfactory results of the half-year's trading, achieved under circumstances not altogether favourable, coupled with the excellent prospects for the future, justify them in recommending a moderate increase in the dividend, which compares with 7 per cent. for 1896.

Applications have been invited from the shareholders for the balance of the unissued 3,000 Preference and 3,000 Ordinary shares.

Metropolitan Electric Supply Company (Limited).

The report of the Directors of this Company for the year to Dec. 31st last states that the capital expenditure has now reached a total of £850,831. 10s. 9d., an increase during the year of £93,795. 16s. 10d. The principal items are mains and apparatus, and the purchase of a site for future extensions. The balance of capital in hand was £29,597. 18s. 10d.

The gross revenue for the year amounted to £138,267. 14s. 6d. against £116,459. 4s. in 1896, an increase of £21,808. 10s. 6d. The cost of generation was in 1896 £52,619. 4s. 9d., and in 1897 £58,604. 5s. 4d., an increase of £5,985. 0s. 7d. The balance to credit of revenue, before providing for depreciation, is £58,721. 10s. The Directors have set aside £15,000 for depreciation, carrying to credit of the net revenue £43,721. 10s., which, with the balance brought forward and other receipts, make a total of £46,947. 3s. 6d. After deducting debenture and share interest and other charges, there appears a balance of £22,989. 6s. 6d.

An interim dividend of 5s. per share on the Ordinary share capital was paid on Oct. 15, amounting to £12,475, and the Directors now recommend that a further dividend of 7s. per share, making a total distribution of 12s. per share for the year (or 6 per cent.). The dividend upon the new shares being for six months only, will be 6s. per share. This will absorb a further £21,215, and leave £1,774. 6s. 6d. to be carried forward.

The number of 8-c.p. lamps supplied increased during the year from 308,000 to 360,000. The present number of lamps connected is 374,000, and the applications show no signs of decrease.

A report from the Company's engineering director shows that the satisfactory condition of the stations, machinery and plant has been maintained.

Eastbourne Electric Light Company (Limited).

The annual report of the Directors of this Company states that the gross profit realised on the working for the year 1897 was £3,619. 7s. 11d., and the net amount available for reserve and dividend (after allowing for interim dividend and £400 carried to depreciation) is £1,838. 9s. 9d. The Directors propose to place £412 to reserve, and out of the balance (£1,426. 9s. 9d.) to pay a dividend at the rate of 10 per cent. for the half-year, making 7½ per cent. for the year, free of income tax; £451. 14s. 9d. is carried forward.

The depreciation fund now stands at £3,025, and the reserve fund at £3,250. The capital account shows considerable outlay in the past year for main extensions and for additional machinery and plant, bringing up the deficit on this account to £5,553. 1s. 1d. The Directors have also to provide for a prospective outlay for the next two years of at east £4,400,

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making the further capital required £9,953. 1s. 1d. To provide sufficient working capital, and to enable the depreciation and reserve funds to be invested in reliable securities instead of in the Company's business, the Directors propose to issue 1,500 Four and a-Half per Cent. Preference shares of £10 each, to be called up as required.

The number of equivalent 8-c.p. lamps in circuit is 19,288 against 16,690 in 1896. The net increase of customers was 56. The whole of the machinery is in good working order, and the mains are generally in a satisfactory condition; but the cables, laid in the first instance in too small pipes, when the electric lighting industry was "in its infancy," and which are being as rapidly as possible replaced, have on one or two occasions caused a little trouble.

Brockie-Pell Arc Lamp (Limited).

The first annual report of the Directors of this Company now issued actually covers a period of 17 months to Dec. 31 last. The Directors regret the result shown by the accounts, which is due principally to the long period taken in equipping the works with the various machines, and making the numerous patterns and special tools required in the manufacture of the lamps. The first 100 lamps, made entirely at the Company's factory, were not completed until the end of July last, so that the business has only been in full swing for a period of from five to six months. These 100 lamps were erected in the principal streets of Glasgow, to replace those of other makers. The orders received have shown a steady increase, and amongst the customers of the Company are several departments of Her Majesty's Government, corporations, vestries, exhibitions, railways, &c. The total number of "Brockie-Pell" lamps supplied to the public in 1897 exceeded that of 1896.

The engineering strike caused a considerable amount of trouble and loss to the Company. Great difficulty was experienced in obtaining delivery of material requiredby the factory, and orders were kept back by customers in consequence.

All the preliminary expenses had been written off, and also a portion of the outlay on furniture and tools. The Directors signed a contract in October last for the sale of the French and Belgian patents for £3,000 in cash, and shares in a company to be formed. £500 has been received on account. Mr. Brockie has taken out several new patents for further improvements in arc lamps and accessories, which belong to the Company, and it is anticipated that they will prove of value, and create an extension of business. The Company has also a considerable interest in a patent granted to Mr. Brockie for an automatic lathe, worked on an entirely new principle, which will probably prove a valuable asset in course of time.

NEW COMPANIES, STATUTORY RETURNS, &c

BRITISH ELECTRIC METER COMPANY (LIMITED).—This Company was registered on March 8 with a capital of £5,000, in £10 shares, to acquire a sole selling agency and an option for an exclusive manufacturing licence in the Bastian Electrolytic Meter and Prepayment Attachment, to enter into an agreement with the Tourtel Gas and General Engineering Company, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The first subscribers are: H. V. Askham, J. M. Tourtel, C. E. Smith, J. B. Birnbaum, A. Laurmon, O. G. Petersen and W. H. Carlisle. The first Directors are: Arthur F. Davies and John M. Tourtel.

CHADBURN'S (SHIP) TELEGRAPH COMPANY (LIMITED).—This Company was registered on March 19, with a capital of £120,000, in £1 shares (of which 60,000 are £6 per Cent. Cumulative Preference), to acquire and take over the businesses of Chadburn and Son (Limited) and Thomas Bassnett (Limited), and to carry on the business of ironfounders, mechanical engineers, patentees and manufacturers of ships' telegraphs, speed indicators and sounding apparatus, nautical instrument makers &c.

COSTA RICA ELECTRIC LIGHT AND TRACTION COMPANY (LIMITED).—This Company was registered on March 10 with a capital of £130,000, in £1 shares, to enter into an agreement with Mr. Minor C Keith, to carry on the business of electric lighting in all its branches in the Republic of Costa Rica or elsewhere, to construct, lease, or otherwise acquire any tramways or light railways in the said Republic, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The first subscribers, each with one share, are: R. Killman, Thomas S. Cocks, F. Chipperfield, J. C. Holliday, F. H. Firth, H. W. White, and W. H. Avery. The prospectus of the Company, inviting applications for capital, was issued this week.

DIRECT TELEPHONE EXCHANGE SYNDICATE (LIMITED).—This Company was registered on March 17 with a capital of £5 000. in £1 shares, to enter into an agreement with Messrs. Heinrich Leupold and Claud Vautin, to construct, equip, work and turn to account any telephone exchanges and electric supply works, and to carry on the general business of a telephone, telegraph and electricity, supply company, in all or any of its branches. The first subscribers (each with one share) are: Philip H. Gardner, J. E. T. Wills, J. T. Hayter, Charles H. Weekes, Charles Hof, B. Steinert and H. Leupold.

ELECTRIC SUPPLY COMPANY OF WESTERN AUSTRALIA (LIMITED).—This Company was registered on March 18, with a capital of £100,000, in £1 shares, to enter into an agreement with the Westralian Electric Lighting and Supply Company Limited for the acquisition of its business, and to act as undertakers for the supply of electricity in Western Australia and elsewhere. The subscribers are: Edmund K. Muspratt, James B. Atherton, J. E. Pearson, W. H. Edwardes, D. L. Chalmers, F. J. Leslie and A. E. Haptie. The first Directors are: Bennett Fitch, Edmund K. Muspratt, John E. Pearson, William H. Edwardes and Thomas Evans.

HART SECONDARY BATTERY SYNDICATE (LIMITED).—This Company was registered on March 15, with a capital of £5,000, in £1 shares, to enter into an agreement with Messrs. Walter Hart and Edwin J. Clark, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and manufacturers of and dealers in electrical apparatus. The first subscribers (each with 150 shares) are: George W. Kidd, Leslie W. Spratt, J. G. Locks, J. G. Abraham, M. Allcock, G. Hay and Samuel W. Hart.

LOVE'S ELECTRIC TRACTION COMPANY (LIMITED).—This Company was registered on March 12, with a capital of £20,000, in £1 shares, to acquire, develop, work and deal with the letters patent for the United Kingdom and various countries other than the United States of America and the Kingdom of Spain, in respect of Love's system of electric traction, and to carry on the business of electrical and general engineers, machinery manufacturers, railway and tramway proprietors, suppliers of electricity and electrical apparatus manufacturers. The first subscribers (each with one share) are: P. W. Goldring, W. E. Elmslie, H. I. Church, J. Perry, J. L. Cooper, H. I. Bethell and A. E. Seamer. The first Directors are: J. C. Love, J. E. Hodges, W. C. Slaughter and Charles E. Phillips.

PREMIER ELECTRICITY METER COMPANY (LIMITED).—This Company was registered on March 10 with a capital of £25,000, in £5 shares, to acquire, develop, work, and deal with any patents, inventions, licences, &c., and to carry on the business of manufacturers of and dealers in electric meters and electric apparatus of all kinds. The first subscribers are: Jacob Atherton, manufacturer; Chas. M. Downie, electrical engineer; J. Downes, W. M. M. Forwood, C. O. Grindrod, A. E. Haptie, and A. Ruckley

"PREMIER" GAS ENGINE COMPANY (LIMITED).—This Company was registered on March 15, with a capital of £100,000, in £10 shares (of which 2,000 are Deferred), to carry on the business of gas engine manufacturers. The first Directors are: Robert Armitage, Robert Mond, William Statham, Alfred E. Wells and Arthur Rollason.

JAMES ROYSTON, SON AND CO. (LIMITED).—This Company has been registered with a capital of £50,000, in £10 shares (of which 2,500 are Five and a-Half per Cent. Cumulative Preference), to acquire the business of wire manufacturers carried on under the style of James Royston, Son and Co., at Halifax, and to develop and carry on same.

H. M. SALMONY AND CO. (LIMITED).—This Company was registered on March 16 with a capital of £25,000, in £1 shares (of which 5,000 are £5 per Cent. Cumulative Preference), to acquire and take over as a going concern the business now carried on under the style of H. M. Salmony and Co., to enter into an agreement with Messrs. Henry M. Salmony and Ernest Rosenberg, and to carry on the business of electricians, electrical and mechanical engineers, manufacturers of and dealers in electrical apparatus, and suppliers of electricity. The first subscribers are: George S. Hein, Fritz Salmony, T. J. Digby, electrical engineer, F. Hudson Minn, electrical engineer, J. Hart, electrical engineer, Henry M. Salmony, electrical engineer, and Ernest Rosenberg, electrical engineer. The first Directors are: Henry M. Salmony, Ernest Rosenberg and Hermann Schwabe.

SHIRRAS, LAING AND CO. (LIMITED).—This Company has been registered with a capital of £30,000, in £1 shares (10,000 Five per Cent. Preference), to acquire the business of electric light engineers, ironmongers, &c., carried on under the style of Shirras, Laing and Co.

LONDON ELECTRIC WIRE COMPANY (LIMITED).—The annual return to Feb. 9 has been filed. The capital is £50,000 in £5 shares, of which 5,000 are Preference; 4,188 Preference and 4.597 Ordinary have been taken up, and 3,860 of each class have been issued as fully paid. The full amount has been called on the remainder.

MADRAS ELECTRIC TRAMWAYS COMPANY (LIMITED).—The annual return to Jan. 14 states that out of a capital of £100,000 in £1 (or 15rs.) shares, 64,704 have been taken up. The full amount has been called, and £67,417. 15s. 1d. received, including £2,713. 15s. 1d. paid on forfeited shares.

MADEIRA ELECTRIC LIGHTING COMPANY (LIMITED).—The 1897 return of this Company was filed on Feb. 9, when 10,537 shares were taken up out of a capital of £15,000, in £1 shares. The full amount has been called and paid.

MALAGA ELECTRICITY COMPANY (LIMITED).—The annual return to Dec. 31 has been filed. The capital is £57,000, divided into 10,000 Ordinary shares, of £5 each, and 7,000 Deferred shares, of £1 each; 9,981 Ordinary and all the Deferred shares have been taken up, and the latter have been issued as fully paid; £5 per share has been called on the Ordinary, and £44,280 has been received, leaving £5,625 in arrears.

MILVER PORTABLE ELECTRIC BATTERY SYNDICATE (LIMITED).—According to the annual return to Jan. 14, the capital of this Company is £22,000, in £5 shares, of which 4,381 have been taken up, and £5 per share has been called.

MORLEY FLETCHER WAVE-POWER SYSTEM (LIMITED).—The annual return to Feb. 21 has been filed. The capital is £20,000, in £10 shares; 694 shares have been taken up, of which 342 have been issued as fully paid. The full amount has been called on the others.

NATIONAL ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return to Feb. 23 has been filed. The capital is £84.943. 15s., divided into 9,050 Ordinary shares of £5 each, 10.850 Ordinary shares of £3. 12s. 6d. each, and 100 Founders' shares of £3. 12s. 6d. each; 10,850 Ordinary and the Founders' shares have been taken up, and £3. 12s. 6d. per share has been called.

SMELTING CORPORATION (LIMITED).—This Company have, during the week, invited applications for 250,000 Ordinary shares of £1 each.

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The Company, which has been formed for the purpose of acquiring the Burnham patents for the treatment of refractory sulphide ores in the United Kingdom, the United States, Canada, Mexico, &c., has a capital of £600,000 in £1 Ordinary shares.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26 1/16d. per oz. (March 24). Consols (2¾ per cent.) 111⅛—111⅜ for money, 111⅜—111⅝ for account; 2⅝ per cent. 105—105¼ (March 24). Stock Exchange Settling Days: Consols, April 1; Stocks and Shares Continuation Days, March 28 and April 13; Ticket Days, March 29 and April 14; Pay Days, March 30 and April 15; Mining Share Carry-over Days, March 26 and April 12.

ALLGEMEINE OSTERREICHISCHE ELEKTRICITÄTS GESELLSCHAFT.—A dividend of 14 gulden per share has been declared by this Company for the past year, being at the same rate as in 1896.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY COMPANY (LIMITED).—The first ordinary general statutory meeting of this Company will be held at Winchester House, Old Broad-street, London, E.C., on Monday, the 28th inst.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The interim report of the Directors to the shareholders of this Company for the half-year ended Dec. 31 states that the works at Loughborough have been fully employed, and the volume of orders received during the half-year has been above the average of the past few years. In consequence of the increasing demand for the Company's manufactures in connection with electric traction, the Directors are largely extending the capacity of the works for the output of motors and cars. Other extensions of the works at Loughborough, rendered necessary by the development of the Company's general business, are in progress. A final settlement of the matters in dispute with the City of London Electric Lighting Company has been effected. The interim dividend for the half-year on the Company's Six per Cent. Preference shares has been declared.

BUDAPESTER ALLGEMEINE ELEKTRICITÄTS GESELLSCHAFT.—The Directors of this Company have declared a dividend of 4fl. per share for the year 1897.

CENTRAL LONDON RAILWAY COMPANY.—Sir Henry Oakley has been elected to the chairmanship of this Company.

CHADBURN'S (SHIP) TELEGRAPH COMPANY (LIMITED).—A preliminary announcement is made in an advertisement elsewhere of the forthcoming issue of the prospectus of Chadburn's (Ship) Telegraph Company (Limited) which is formed to acquire businesses established over half a century. The Board of Directors of the new Company is composed of practical men, and the management remains unchanged. The Company will start with contracts in hand, which include orders for a complete installation of Chadburn's telegraph system upon 32 of Her Majesty's ships. The full prospectus will be advertised next week.

ELECTRIC INSTALLATION COMPANY (LIMITED).—This Company, which was recently formed for carrying out electric lighting installations free of initial outlay, recently issued a prospectus inviting applications for capital.

GUILDFORD ELECTRICITY SUPPLY COMPANY (LIMITED).—What is described as the seventh annual report of the Directors of this Company is issued. It should be stated, however, that the year 1897 is the first completed year of the Company's operations, supply having commenced Nov. 11, 1896. The number of installations connected is 52. The Directors are satisfied with the result of the first complete year's working, and refer to the fact that remunerative business has now been reached, the revenue for the quarter to Dec. 31 showing a profit of £67. 6s. The subscribed ordinary capital is £7,670; but, as it has been decided to increase the plant and extend the mains at once, further subscriptions for Ordinary shares, to be paid in full on allotment, are invited from existing shareholders. This Company is, we believe, the smallest electrical undertaking with Parliamentary powers. With a first year's load of 15,291 units (sold) it has naturally been difficult to show high-class results, especially as "management" includes such items as "legal expenses, £49. 17s. 2d." (owing to a right-of-way action), and "auditor's fees, £18. 6s. 6d."—two sums which, in themselves, represent 1d. a unit.

IMPERIAL TRAMWAYS COMPANY (LIMITED).—At the general meeting of this Company, on Monday, at Bristol, the Chairman referred to the proposals of the London United Tramways for the extension of their lines and for the introduction of electric traction, and that the Hanwell Council, as well as the Acton, Brentford and Hounslow Councils, had approved the scheme. He anticipated very important results from the development of the United system, inasmuch as they had received memorials from other districts adjacent to their lines begging them to apply at once for authority to construct light railways, to be worked by the overhead trolley system, and to connect up with their other lines. With regard to the small tramway undertaking at Darlington, they would shortly have to substitute electricity. As to the Middlesbrough, Stockton, and Thornaby electric tramways, the work of construction had been carried out under the superintendence of the Managing Director (Mr. J. Clifton Robinson), and the work had been completed in so expeditious a manner as to form what he believed to be a record piece of tramway work in the United Kingdom. He knew of no previous instance of 15 miles of the best form of concreted and paved tramway having been laid in six months. The power-station and depots were rapidly approaching completion, and the electrical equipment was well advanced. He announced that the Directors intended to apply themselves to the matter of substituting a £10 share for the present one of £6, as the value of the Company's assets now undoubtedly approximated more nearly to £10 in value. Dividends of 6 per cent. per annum on both the Preference and Ordinary shares were declared.

ROYAL ELECTRIC COMPANY.—The numbers are published of 78 £100 debentures which have been drawn for payment on April 1 at the Bank of Montreal, 22, Abchurch-lane, London, E.C. at £105.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed Tuesday, March 29, as a special settling day for the further issue of 2,500 £10 Ordinary (fully paid) shares (Nos. 10,001 to 12,250) of W. T. Henley's Telegraph Works Company (Limited), and has ordered these shares, as well as the further issue of 12,000 Ordinary shares (Nos. 40,031 to 52,030) of the St. James's and Pall Mall Electric Light Company Limited, to be quoted in the Official List. Application has been made to the Committee to appoint a special settling day in, and to grant a quotation to £100,000 Four and a-half per Cent. Redeemable Debenture Stock of the Barcelona Tramways Company (Limited) and to allow the further issue of 5,661 ordinary shares (Nos. 10,001 to 15,761) of the House to House Electric Light Supply Company (Limited) and $603,000 additional Five per Cent. 30-year Consolidated Mortgage Gold Coupon Bonds of 1926 (Nos. 7,001 to 7,603) of the Milwaukee Electric Railway and Light Company to be quoted in the official list.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 18 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,933.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half month ended March 15 is £1,890, against £2,516 in the corresponding period of 1897.

WINDSOR ELECTRICAL INSTALLATION COMPANY (LIMITED).—The annual meeting of this Company was held last week at Windsor, under the presidency of Mr. M. Drury Lavin. The Directors' report stated that the number of lamps installed on Dec. 31 last was equivalent to 4,985 8 c.p.; since which date 395 had been added. During the year a new engine, twice the size of the original ones, had been added, and the capacity of the storage battery had also been doubled. Various extensions of the mains were made. The net profit for the year was £1,256. 16s. 7½d., and out of this sum the Directors recommended that a dividend of 4 per cent. be declared on the paid-up capital of the Company, absorbing £652. 7s. 4d., and leaving a balance of £604. 9s. 3½d. to carry forward. Mr. A. W. H. Good had resigned his position as secretary in the early part of the year, but it was not considered necessary to appoint another permanent secretary, as Mr. A. W. Shipley (a Director of the Company) accepted the position of Managing Director. It was proposed to issue the remaining capital (£5,000) during the current year, and the Directors recommend that the shares be issued at a premium of 2s. 6d. each. Current was being supplied at 7d. per unit, but the Directors hope to reduce the price to 6½d. when the equivalent 8,000 c.p. lamps is connected to the mains. On the motion of the Chairman the report was adopted and a dividend at the rate of 4 per cent. was declared.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Mar. 19	3,480	+232	...	...	...
Bristol Trams & Carriage	,, 18	2,503	+450	11	25,899	+ 3,896
City & South London Ry.	,, 20	1,030	+ 18	12	12,826	+ 8
Dover Tramways	,, 19	117	...	28	3,097	...
Dublin United (Southern)	,, 18	403	- 39	11	4,379	- 291
Liverpool Overhead Rly.	,, 20	1,316	- 44	12	16,140	+ 769
Sheffield Tramways	,, 20	931	+ 25	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price March 16.		Price Wednesday, March 23.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 19. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.					£ s. d.			
£19,126	£10	3/0	Central London Ordinary	10¼	10⅜	10¼	11	2 14 1	June and December	10⅜	10⅛
143,106	10	1/0⅜	Do. (6s paid)	6⅛	6⅜	6⅛	6⅜	2 13 4	,, ,,	6⅛	...
£600,000	Stock	1¾%	City and South London Railway Con. Ordy.	66	68	66	68	2 15 2	January and July	67⅜	66⅜
3,419	£10	5%	Do. 5% Perpetual Preference	15	16	15	16	3 2 6	,, ,,	15⅜	...
£135,761	Stock	4%	Do. 4% Perpetual Debenture	138	140	138	140	2 17 2	May and November	...	...
£40,000	Stock	3%	Waterloo and City Ordinary	136	139	135	139	2 3 6	June and December	139	135
37,480	10	3½%	Liverpool Overhead Railway Ordinary	10⅛	10⅜	10⅜	10⅝	3 0 6	February & August	—	
10,000	10	5%	Do. 5% Preference	15⅜	16⅛	15⅜	16⅛	3 1 6	,, ,,	—	—
125,000	Stock	4%	Do. 4% Debenture	108	110	109	111	3 12 7	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price March 16.		Price Wednesday, March 23.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 19.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£2923,960	Stock	19/6	Anglo-American	59	61	59	62	4 16 9	Feb., May, Aug., Nov.	61	59½
£3,088,020	Stock	39/0	Do. Preferred	108	109	109½	110½	5 8 9	" "	109¾	108
£3,088,020	Stock	5/0	Do. Deferred	11	11½	11⅞	12½	..	—	12¼	11¼
£137,400	£100	4%	*African Direct Telegraph (Red)	100	104	100	104	3 16 11	January and July	—	..
£25,000	10	..	Amazon Telegraph	7	8	7	8	..	—	..	—
130,000	10	3/0	Brazilian Submarine	16⅜	17¼	16⅜	17¼	4 1 2	Mar., June, Oct., Dec.	16⅞	16⅛
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	112	116	4 6 2	June and December	—	—
10,000,000	$100	$2½	Commercial Cable Capital Stock	187	192	187	192	4 3 6	Jan., Apr., July, Oct.	—	—
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	106	108	106	108	3 14 1	" "	106¼	105
16,000	10	6/0	Cuba Submarine	6⅝	7⅛	6⅝	7⅛	9 6 8	February and August	7	6⅛
6,000	10	10%	Do. Preference 10 per Cent.	14⅛	15⅛	14⅛	15⅛	6 9 0	" "	15	14⅞
12,981	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	—	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	..
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	—	—
60,710	£20	3/0	Direct United States Cable, 1877	10⅝	11⅛	10⅝	11⅛	5 15 7	Jan., Apr., July, Oct.	11⅞	10⅛
400,000	£10	2/6	Eastern	17⅝	18⅛	17⅝	18⅛	3 11 3	" "	18⅛	17⅜
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18⅝	19⅜	18⅝	19⅜	3 1 6	" "	19	18⅝
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	128	131	128	131	3 2 0	May and November	131½	129
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	—	..
250,000	10	2/6	Eastern Extension	18⅜	19⅛	18⅜	19⅛	3 13 8	Jan., Apr., July, Oct.	19⅛	18⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	128	131	128	131	3 1 8	February & August	128	—
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99	103	99	103	4 17 3	January and July	101	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99	103	99	103	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 16 2	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	108⅞	111⅞	107⅞	110⅞	3 13 9	May and November	..	—
180,227	10	1/9	Globe Telegraph and Trust	11⅞	12⅛	11⅞	12⅛	3 17 7	Jan., Apr., July, Oct.	12⅛	11⅞
180,042	10	6%	Do. 6 per Cent. Preference	17⅛	18	17⅛	18	3 6 8	" "	17⅞	17⅝
150,000	10	5/0	Great Northern of Copenhagen	29	30	29½	30½	3 5 7	January, April, July	—	—
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	100	103	100	103	4 17 1	March & September	—	—
17,000	25	12/6	Indo-European	52	55	52	55	4 10 11	May and November	—	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	106	109	106	109	5 10 1	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105	108	105	108	3 13 5	June and December	—	—
11,839	8	4/0	Reuter's	8	9	8	9	4 8 11	April and October	..	—
3,381	£100 Cert.	6%	Submarine Cables Trust	..		140	145	4 4 3	" "	140	—
15,609	10	6/0	West African Telegraph	4	5	3½	4½	..	..	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 16 2	March & September	102	—
30,000	10	..	West Coast of America	¼	¾	¼	¾	..	..	..	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	107	104	107	3 14 9	June and December	..	—
88,321	10	1/0	West India and Panama	½	¾	½	¾	..	May and November	⅝	—
34,563	10	6/0	Do. 6 per Cent. 1st Preference	8	8½	7½	8	7 10 0	" "	7⅝	—
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	5½	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 2	January and July	—	—
64,256	15	3/0	Western and Brazilian	11½	12	11⅜	12¼	2 9 0	May and November	11¼	11⅛
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	8	7⅛	8	3 15 2	" "	7⅞	—
33,129	7½	1/6	Do. Deferred Ordinary	4	4½	4⅛	4⅝	..	" "	4¼	4
£382,230	..	4%	Do. 4 per Cent. Debenture Stock	106	109	106	109	3 13 9	June and December	107⅛	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	..	—
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3	3½	3	3½	5 14 4	August	—	..
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16	1/16	1/16	1/16	..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	..	—
484,697	5	3/0	National	6½	6¾	6½	6¾	4 8 11	February & August	6¾	6½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	..	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	15	17	15	17	3 10 7	" "	15⅞	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	5½	6¼	5¾	6¼	4 0 0	" "	6 1/16	5⅝
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	102	107	102	107	3 6 0	June and December	104½	103⅜
171,504	1	0/4	Oriental	⅜	⅝	⅜	⅝	6 13 4	April and October	..	—
58,000	5	5/0	United River Plate	4	4½	4	4½	5 11 1	July	..	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	106	109	105	108	4 13 6	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
£200,000	5	4½%	Birmingham Electric Supply (fully paid)	10¾		10½			March	..	—
50,000	£10	20/0	City of London Electric Lighting (fully paid) xd	26	27	26	27	3 14 1	February & August	27½	26½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid) xd	17⅛	18½	17½	18½	3 4 10	January and July	18	17¾
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	..	..
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	13½	14½	13⅛	14⅛	2 8 6	February & August	..	..
20,000	5	2/3	Do. 4½ per Cent. Preference	6¼	6¾	6¼	6¾	3 6 8	" "	6 1/16	..
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	—	—	January and July	—	—
£26,000	5	2/6	Chelsea Electricity Supply Ordinary	11½	11⅞	10⅞	11⅛	3 6 8	March	11⅝	17⅛
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	115	117	115	117	3 17 5	June and December	116½	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	14⅞	15⅛	14⅜	15⅛	..	..	15	14⅞
20,000	£10	6/0	Do. 6% Cumulative Preference	15⅞	16⅛	15⅞	16⅛	3 13 10	March & September	—	—
10,000	£5	..	House-to-House Electric Lighting Supply Ord.	11	12	14	15	..	..	11⅞	11⅝
10,000	£5	7%	Do. 7 per Cent. Preference	11⅜	12⅛	11⅝	12⅛	2 17 2	March & September	—	—
111,000	£5	..	London Electric Supply Ordinary	4	4½	4	4½	—	—	—	—
48,050	£5	..	Do. Preference	6½	7	6½	7	..	..	..	—
49,900	10	5/0	Metropolitan Electric Supply Ordinary	20½	21½	21	22	2 10 0	April and October	21⅞	21
12,500	10	3/8	Do. issued at 2 prem. (fully paid)	20½	21½	20½	21½	..	" "	21½	20⅞
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	119	—
6,452	10	12/0	Notting Hill Electric Ordinary xd	19½	20½	19½	20½	2 18 6	March	20 1/16	..
275,000	1		Rand Electric	1 1/16	1 1/16	1 1/16	1 1/16	—	..	—	—
£125,000	Stock	5%	River Plate Elec. Lt. Trct'n, Ltd., 5% 1st Mor. Deb.	90	95	90	95	5 6 6	..	..	—
150,000	$100	$2	Royal Electric Company of Montreal Shares	145	147	145	147	..	..	..	—
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 4 1	April and October	..	—
31,980	5	11/0	St. James and Pall Mall Electric Ordinary	18½	19½	18	19	3 16 4	February & August	19	18⅞
40,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	—	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	107	110	107	110	3 13 1	June and December	..	—
67,900	5	8/0	Westminster Electric Supply (fully paid)	17½	18½	17	18	3 6 8	March & September	18	17⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	5%	Brush Electrical Engineering	1⅞	2⅛	1⅞	2	—	—	2 1/16	—
90,000	2	1/2⅞	Do. 6 per Cent. Pref. Non-Cumulative xd	2½	2⅝	2½	2⅝	4 16 0	—	2 1/16	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110	114	110	114	3 18 11	February & August	2 1/16	2⅛
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 3 2	June and December	—	—
10,000	£10	..	British Aluminium Ordinary	..		—		—	—	—	—
20,000	10	..	Do. 7% Cumulative Preference	..		..		..	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	9	10	9	10	5 0 0	June and December	9⅛	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	110	113	110	113	4 0 0	" "	..	—
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1	1½	1	1½	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	2⅝	2	2½	—	—	2¼	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	86	90	86	91	5 12 4	January and July	—	—
99,261	5	1/6	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2⅛	3	5 10 0	February & August	—	—
17,139	5	2/6	Do. (£5 paid)	4	5	4	5	5 10 0	" "	—	—
£200,000	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.)	103	105	103	105	3 16 2	June and December	—	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅜	2⅞	2⅜	2⅞	3 13 1	February & August	2⅞	2⅛
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3⅛	3⅝	3⅛	3⅝	4 3 4	August	..	..
91,196	1	10/0	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	—	—	..	—
12,500	10	18/0	Henley's Telegraph Works Ordinary xd	22½	23½	22⅛	23⅛	4 3 4	February & August	23⅛	22⅜
3,000	10	7/0	Do. 7 per Cent. Preference xd	18½	19½	18½	19½	3 11 10	" "	—	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 3	" "	—	—
50,000	£10	15/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "	22 1/16	21⅜
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	104	108	104	108	3 14 6	March & September	—	—
87,350	13	24/0	Telegraph Construction and Maintenance xd	36	39	36	39	4 12 4	March and July	38	36½
£50,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July	—	—
£22,500	£5	3/6	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	—	—
£13,500	£5	3/0	Do. 6% Cumulative Preference	7	7½	7	7½	4 0 0	" "	..	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	106	108	106	108	3 18 6	May and November	108½	—

* In calculating the yield on this security allowance has been made for accrued interest, but not for

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NOTES.

We announced in our issue of March 4th that an important action had been heard in the County Court at Leicester, affecting the legality of trading in the sale of lamps and other electrical apparatus, on the part of local authorities owning electric supply works. Judgment has recently been given by Judge Wightman in this action, and details of his Honour's decision appear in another part of our issue this week. With the portion of this decision relating to the liability of the purchaser, on the ground of his having entered upon a specific contract to purchase, we are less concerned than with the judgment that, "having reviewed the various sections of the Acts of 1882, 1888 and 1890, his Honour could see nothing by reasonable implication to authorise the Corporation to supply any internal fittings except meters." This judgment strikes at the root of the matter, and, except in so far as it may be modified or reversed by a higher Court, it decides that the Electric Lighting Acts do not in themselves sanction the practice of municipal bodies trading in the sale of lamps, motors, and other apparatus for consuming electrical energy. Doubtless, although not specifically alleged to do so, the ground of this decision must also adversely affect the practice of municipal free-wiring and hiring-out of appliances. Only where the right to trade in these ways is reserved to a municipal body through a charter, or by other legal instruments than the Electric Lighting Acts, can these practices be resorted to with impunity. We note that leave has been granted for an appeal against the decision of Judge Wightman. The issue is of prime importance to the business of municipal electric supply, and it is greatly to be hoped that, should an appeal be entered, a decision may be arrived at upon a broad and firm basis, so that municipalities generally may realise the position in which they stand.

A letter in our correspondence columns, written disinterestedly for the information of Prof. Silvanus Thompson, discloses the fact which must be known to all wiring contractors, viz., that flexible cord can be obtained whose vulcanised rubber insulation is good enough for use at 200 volts. Our correspondent might have gone further, and pointed out how seldom wire of this quality is used, and how little its sale appears to be pushed by wire manufacturers, although it is much more suitable even for 100-volt circuits than wire with but one or two lappings of pure rubber within its cotton or silk covering. Another point to which little attention has been drawn is the size of the conductors used in these cords. The wiring rules issued by the Institution of Electrical Engineers recommend a conductor of 62/38 or 97/40 as being equivalent to No. 18 S.W.G.—the smallest size permissible—and they give in their wire table other sizes equivalent to Nos. 17, 16, and 14 S.W.G., respectively. The Institution has, however, not been successful in securing the adoption of these sizes as a standard, for in the price catalogues of five of the leading makers of this class of wire not one of these precise sizes is quoted for. In fact, during a conversation with the manager of one of these firms, we were informed that the size 35/40 (equivalent to a single wire of No. 22 gauge) is the one most ordered by electric-light contractors. We agree with Prof. Silvanus Thompson that the flexible wire used in wiring buildings leaves much to be desired, but we attribute this to the wiring contractors rather than to the manufacturers, for the latter are as a rule only too glad to supply wire to any reasonable specification as soon as there is the smallest demand for it.

Founders' shares in the Metropolitan Electric Supply Company (Limited) have been successively matters of hazard, of enviable profit and of unseemly discord and dissension. The nominal value of the existing 100 of these shares is £10; but so greatly were they appreciated in value that their holders recently refused point-blank to redeem them by £10 Ordinary shares at the rate of 140 of these latter per Founders' share, and it was stated that they would not entertain any offer less favourable than the allotment of 300

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Ordinary shares. Considering that these last-named shares stand at £22, it will be seen that the realisable present value of the demanded redemption amounted to £6,600 per share, or practically 66,000 per cent. of their nominal value; while the redemption offered by the directors would realise but 80,800 per cent. Failing the negotiations for the abolition of Founders' shares it is proposed to issue further Ordinary shares at par. Opposition to this course appears to have been threatened by one at least of the holders of Founders' shares, on the ground that extension of the Ordinary capital by the issue of new shares at par would prejudice these shareholders. Litigation is threatened, and the Directors seem to have decided to let it take its course.

Considering that the Great Western Railway Company not only has running powers—or a species of "usufruct," as it were—over the Inner Circle, and is part owner of the Hammersmith and City line, but may also be required to adapt its locomotives to suit the form of tractive power adopted for these lines, it is reasonable that that Company should have a voice in the proposed scheme for the introduction of electric traction. Yet, in our opinion, this does not furnish sufficient ground for the Company to oppose the scheme in its entirety; and there would appear to be more than one way of arriving at a fair arrangement without sacrifice of the inestimable advantages of electric traction on the "Underground."

To begin with, it has been shown to be practicable to work a section of a railway electrically without in any way interfering with the ordinary steam traffic over the entire railway system, including the electrically-worked section. Thus, on more than one section of the New York, New Haven and Hartford Railroad electric traction has been adopted, yet the main steam traffic over these sections has not been suspended, the electric and steam traffic being carried on without interfering with one another. If no better solution can be arrived at it would still be practicable to work the "Circle" and some of the suburban trains electrically, while still continuing the steam traffic of the Great Western Railway and London and North Western Railway Companies' trains over the same lines.

It might be objected that the American lines cited are surface railways, and that the conditions are essentially different from those obtaining on the underground railways of London. We do not think the differences are essential, or that they vitally affect the case; but we are willing to admit the desirability of working the "Underground" entirely by electricity if an amicable arrangement can be arrived at. What we are anxious should be avoided is an abandonment of the entire project through a mistaken belief that dual working is impossible. It appears that already the Metropolitan Railway Company has the right to dictate to the Great Western Company the class of locomotive the latter should use on these lines; and doubtless it has exerted this right in regard to the special type of steam locomotive now employed. To enforce the use of electric locomotives, therefore, would seem to be but an exercise of this just right; and, in view of the fact that provision has been made for the settlement of disputes by arbitration, it is to be hoped that this will not be held to furnish adequate ground for rejection of the Bill, now being considered by a Committee of the House of Commons, to provide for electric traction on the Metropolitan Railway.

The Corporation of London is still fretful about the recent decision, upheld on appeal, that the Postmaster-General may lay what telegraph or telephone wires he pleases in the streets of London, and may lease them to the National Telephone Company or anyone else. By a liberal expenditure on printing and postage the Corporation has endeavoured, with no inconsiderable success, to raise a kindred feeling of resentment in the breasts of other local authorities who would still fain believe that the streets are the patrimony of the Corporations. The wording of the resolution proposed at the annual meeting of the Association of Municipal Corporations last Saturday, "That it is undesirable that the jurisdiction of the local authorities over telephone companies should be curtailed or interfered with . . ." shows exactly what the grievance is, for no one can impartially argue that to give local authorities the right to veto the use of underground junction lines, as a connection between telephone subscribers and the trunk lines, can tend to improve or cheapen the telephone service. The use made by the various corporations of their right of positive veto as regards the Telephone Company itself is sufficiently retarding the burying of the wires and the consequent improvement of the telephone service. But the City Solicitor and his supporters will not view the matter in this light; they say that they do not wish to have their privileges curtailed by the National Telephone Company riding on the back of the Postmaster-General; that they do not want to be overridden by any of these companies, and that the companies overran the roofs of houses as if they were their own private property. The picture of the National Telephone Company riding pickaback on the Postmaster-General, striding over the roofs of houses and trampling down mayors and corporations may be original but is hardly accurate; yet we would rather have the local authorities suffer this inconvenience than that the perfecting of the telephone system of this country should be further postponed.

At an unusually thin meeting of the Physical Society, last Friday, Mr. Campbell Swinton exhibited a number of interesting vacuum tubes. It appears that he has been extending the researches of Sir W. Crookes along the line suggested by the now well-known experiment devised by him some years ago, in which the cathode stream is made to cause the rotation of a mica vane. By a sliding arm, to which is attached the tiny bracket carrying the vane, Mr. Swinton is able to bring the mica wheel either into or out of the cathode stream as he pleases, and in this way has been able to trace the path of the returning stream from the anode. His observations in the main confirm Sir William Crookes' original hypothesis, but at the same time call up a number of new and important questions bearing upon the nature of the forces producing rotation, and the electrostatic condition of the mica itself.

During the discussion which has been going on in *The Times* between rival naval experts as regards the merits and demerits

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of naval bases for our fleets, their importance as depôts for our submarine cables has not yet received the attention they are entitled to. Those who disparage naval bases because they can be so easily destroyed in time of war might apply the same argument to our cable stations, or even to the cables themselves. It is the case all over the world that the chief British naval stations are also the landing places of her chief submarine telegraph lines; and any successful attack upon the naval stores and warlike material accumulated at these depôts would most certainly involve the dislocation of our imperial telegraphs. This is a reason surely for maintaining our naval bases, and for putting them in a condition of defensive security. By this we mean, not in a position of impregnability, for that would be impossible; but provided with means of defence against sudden assault, and of holding out until help could arrive by sea—help which the cable alone would be most likely to procure with sufficient promptitude. The part which submarine telegraphy, chiefly in British hands, would play at the outbreak of hostilities must have the most vital consequences; and without it our flying squadrons would be rendered almost as "blind," though not as slow, as they were in the time of Nelson. Anyone who takes the trouble to examine a telegraph cable map will see for himself that our naval bases shelter something far more valuable than ships' stores, and are in fact our bases of communication.

Erratum.—In the editorial comments on Mr. Heaviside's serial, on page 712, last week, in the fifth line of the first column, *for* "alternate" *read* "attenuate."

Crystal Palace School of Practical Engineering.—Sir Henry Mance will preside at the meeting for the award of certificates to students at this school on Wednesday next at noon.

Donation to the Göttingen University.—Herr Krupp has given a sum of £1,000 to the Institute for Physical and Electrical Chemistry at Göttingen University. Prof. Nerst is the head of this Institute.

Electric Lighting in China.—A Chinese company has been formed in Hankau for purposes of electric illumination, and the native authorities of Shanghai, after having seen the electric light in the foreign colony for the last 10 years, have finally decided to introduce it within the inner city.

Cable Interruptions and Repairs.—

	Date of Interruption.		Date of Repair.
Latakia—Cyprus	Feb. 10, 1898	...	—
Saïgon—Hong Kong	Feb. 28, 1898	...	—
Lourenço Marques—Durban	Mar. 19, 1898	...	Mar. 25, 1898
Gibraltar—Tangier	Mar. 19, 1898	...	Mar. 28, 1898
Cayenne—Pinheiro	Mar. 24, 1898	...	—
Odessa—Constantinople	Mar. 28, 1898	...	—

Law of Electric Supply Stations.—The Joint Committee of Lords and Commons appointed to inquire into the law relating to electric generating stations held a short private sitting yesterday, at which Lord Cross was appointed Chairman of of the Committee; an adjournment was then made until the 21st inst.

Central London Railway.—Some of our American and other contemporaries have published premature descriptions of the Central London Railway, which is as yet far from completion, the excavation work not having been finished. We note with amusement that our American contemporaries publish a set of diagrams purporting to show the acceleration and other curves on a train-run from Oxford-street station to Tottenham Court-road station!

The Electric Light in Lighthouses.—Replying to Mr. Horace Plunkett in the House of Commons on Tuesday, Mr. Ritchie said that he was informed by the Elder Brethren of Trinity House that they adhered to the opinion expressed by their Committee as to the superiority of electricity to gas for lighthouse purposes. Whether electricity, gas or oil was to be adopted as the illuminant in the future must depend to a great extent on the circumstances of the particular lighthouses.

Royal Institution.—Among the lecture arrangements after Easter are three lectures by Lord Rayleigh on "Natural Philosophy." The Friday evening meetings of the members will be resumed on April 22nd, when Mr. W. H. M. Christie, the Astronomer Royal, will deliver a discourse on "The Recent Eclipse." Succeeding discourses will probably be given by Prof. A. Gray, Mr. E. A. Minchin, Prof. W. A. Tilden, Lord Rayleigh and other gentlemen.

The British Association.—For the meeting of the British Association this year, which is to take place at Bristol under the presidency of Sir William Crookes, the following officers of sections have been appointed:—Section A—President: Prof. W. E. Ayrton; Vice-Presidents: Profs. Rücker and S. P. Thompson; Recorder: Prof. W. H. Heaton. Section B—President: Prof. F. R. Japp; Vice-President: Prof. W. Ramsay; Recorder: Dr. C. A. Kohn. Section G—President: Sir John Wolfe-Barry; Vice-President: Mr. G. F. Deacon; Recorder: Prof. T. H. Beare.

Iron and Steel Institute.—The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George street, London, on May 5 and 6, 1898. At this meeting the Council will present their annual report for the year 1897, and a number of Papers will be read and discussed. A detailed programme will be issued in due course. The annual dinner of the Institute will be held on May 5th in the Grand Hall of the Hotel Cecil. The autumn meeting of the Institute will be held at Stockholm under the auspices of the Swedish Association of Ironmasters (*Jernkontoret*) on August 26 and 27, 1898.

Tramway Traffic in Montreal.—The total number of passengers carried by the Montreal Street Railway Company during the year ended September 30, 1897, was, says the *Railway World*, 32,047,317—a traffic which, however, is constantly increasing. The population of Montreal, including suburbs, is about 225,000. As an indication of the extent to which tramway business has been developed in the Canadian metropolis, it may be interesting to compare its traffic with that of Sheffield for instance, where the population is some 50 per cent. greater, and the total number of tramway passengers carried during the year ended June 30, 1897, was 8,458,074, or, roughly, 25 per cent. of the number carried in Montreal.

Power from the Upper Niagara River.—There are good prospects, says the *Western Electrician*, that another canal will be built to divert a portion of the water of the Upper Niagara River from its natural course, to be used for power and other purposes. This time Lockport, Niagara County, N.Y., hopes to benefit by the project, and recently the contract was signed by the Mayor and City Clerk on behalf of the City, and by the Presidents of the Niagara, Ontario and Lockport Power Company and the Lockport Water and Electric Company for a supply of 15,000,000 gallons of water daily for 10 years at an annual cost of £10,000. The canal must be finished and water ready for delivery by May 1, 1904, or the contract will be without effect.

A Substitute for Platinum in Incandescent Lamps.—According to a German contemporary, experiments with iron-nickel alloys have shown that different co-efficients of expansion are obtained according to the percentages of the two metals. An alloy containing 45 per cent. of nickel has the same coefficient of expansion as platinum, and it is stated that this has been confirmed by experiments made at the Reichsanstalt. It is proposed to use this alloy to replace platinum in the manufacture of incandescent lamps. It will be remembered that in our issue of January 7th last (p. 348) we referred to an interesting paper read before the Société Internationale des Electriciens by M. C. E. Guillaume, in which experiments on the expansion and magnetic properties of steel-nickel alloys were described.

The Northampton Institute.—The formal opening of the Northampton Institute, Clerkenwell, took place on March 25th. This Institute forms the technical and trades branch

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of the City Polytechnic, and is built upon a site given by the late Marquis of Northampton and his son, the present Marquis. Besides the technical and trades department there is also a social and recreative section. After the formal opening and inspection of the building by the Lord Mayor, who attended in state for the purpose, a concert was held. We are informed that the buildings and equipment have, up to the present, cost over £80,000, exclusive of the value of the site—estimated at £25,000. Dr. R. Mullineux Walmsley is the principal.

A 100-Mile Transmission Scheme.—According to the *Frankfurter Zeitung* a scheme has been worked out in Stockholm for the utilisation of part of the 100,000 H.P. running to waste in the waterfall of Elfkarleby, 100 miles from that city. The idea of transmitting a part of this power to Stockholm has exercised the minds of the citizens for some time past, and has within the last few months assumed a more practical form, several engineers and electricians having been commissioned to work out a detailed scheme. This project is now ready. It is proposed to utilise in the first instance "only 20,000 H.P." of that available, and the estimated cost of the installation works out as follows. Power station, including all the necessary works and machinery, £178,000; transmission line, £237,000; buildings and transformers in Stockholm, £29,000; making a total of £444,000. A loss of 5,000 H.P. is estimated so that 15,000 H.P. would be available in Stockholm. This is to be sold at 44s. 5d. per horse-power per year, making an aggregate revenue of £33,300 per year. Without making any allowance for working expenses, our contemporary naïvely remarks that this yearly revenue capitalised at 4 per cent. is equivalent to £833,000 and that there is a consequent gain of nearly £400,000 to the State.

The Paris Tramways.—The Paris Omnibus Company has for some time past been considering the question of adopting mechanical traction on a certain number of its most frequented lines, so as to enable one or two trailers to be used during the busier hours of the day. To follow out "a complete programme," an expenditure of £1,600,000 would be necessary, which would have to be redeemed by the time the concession expires in 1910. The Company has therefore modified its original scheme to include only the transformation of 15 lines at an expenditure of £1,000,000, which it will obtain by means of a loan, redeemable in 12 years, if no arrangement can be made with the municipal authorities for a prolongation of the concession. The Company also offer to spend a further sum of £600,000 on the transformation of ten more lines if the municipality will take over the obligation of redeeming the second loan. In exchange for this the Company offer to adopt mechanical traction on all its tramway lines, to construct 14 new tramways and open 5 new omnibus routes, to pay the town two-thirds of the profits exceeding those necessary, for a dividend of 70 francs per share, and to reduce the fare for inside passengers from 3d. to 2d. on the condition of transfer tickets being abolished. Accumulator traction is to be adopted and it is proposed that the cells be charged by the electric lighting companies during the hours of light load.

The Transparency of Bismuth in a Magnetic Field.—In a communication to the Académie des Sciences on February 7th last, M. Buisson described some experiments he had made to see whether the transparency of bismuth is increased in a magnetic field in the same way as is its electrical resistance. Although, according to the electromagnetic theory of light, the coefficient of absorption is, as a first approximation, proportional to the square root of the conductivity, experiments have shown that some metals are more transparent than they should be theoretically. A thin sheet of nickel, obtained electrolytically, was placed in a magnetic field of 15,000 C.G.S. units, and it was found that its transparency was the same whether in or out of the field. The resistance, on the other hand, increased by at least 60 per cent. Lénard, and subsequently Sadovsky, have shown that the resistance is different for a continuous current than for an oscillatory one, and that each of these resistances varies differently in a magnetic field; in the particular case of a wire perpendicular to the lines of force its resistance to the oscillatory current increases with the field more rapidly than the resistance to continuous current in such a way as to exceed it in fields greater than 6,000 C.G.S. units. It also depends on the frequency. Thus, in the case of luminous phenomena, one must suppose that the resistance varies with the frequency according to an unknown law, such that it is independent of the field when the frequency attains that of light. M. Buisson thinks it would be nearer the truth simply to allow that the conductivity which intervenes in luminous phenomena is of a different order to that measured under usual conditions.

A System of Night-Signalling for Ships.—The United States Navy Department is, we are informed, fitting a number of their warships with a system of incandescent-lamp signalling provided by the Telephotos Company, of Buffalo. A series of four double lanterns, lighted by powerful groups of incandescent lamps are hung vertically on strong wire cables, the upper end of which can be run up to a mast or yard arm, while the lower end is intended to be fastened to the deck of the vessel. The upper half of each lantern is white and has within it a group of three lamps surrounded by powerful lenses. The lower half is red and has four lamps, in order to make the red beams the stronger. The cable supplying the lamps passes to the deck, or the bridge, where a keyboard enables the operator to spell out the code signals very much in the same manner as a typewriter is manipulated. The keyboard is arranged on a standard and enclosed like a binnacle, and while operating it the operator stands. By an automatic arrangement, each key when depressed lights a combination of the four red and the four white lights, making a letter or a number, according to the code of signals. Another feature of the keyboard is that, when one letter is down, all the other keys are locked so that another cannot be accidentally pushed down and confuse the signals. This will be recognised as a very valuable feature of the machine. Any key pressed down can be turned one-quarter way around like a screw, which motion locks it in place and leaves the signal burning in case it is desired to use it as a standing signal for an order in the secret Naval code. Thus the keyboard can be used to telegraph ordinary instructions by the usual letters, or to send a cipher despatch or special code orders.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 1st.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read, "Mechanical Refrigeration," by J. T. H. Burrell.

ROYAL INSTITUTION.

9 p.m. Evening Discourse, "Liquid Air as an Analytic Agent," by Prof. Dewar, F.R.S.

SATURDAY, April 2nd.

INSTITUTION OF JUNIOR ENGINEERS.

11 a.m. Visit to the Thames Ironworks, Blackwall.

CHESTERFIELD AND MIDLAND COUNTIES INSTITUTION OF ENGINEERS.

3 p.m. General Meeting in the Municipal Science College, Derby. Papers to be read: (1) "Electric Blasting," by W. Maurice; (2) "Photographs of Electric Detonators," by L. W. de Grave.

MONDAY, April 4th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7.30 p.m. Ordinary Meeting at the Royal United Service Institution, Whitehall.

TUESDAY, April 5th.

RÖNTGEN SOCIETY.

8 p.m. General Meeting at 11, Chandos-street, Cavendish-square, W. Paper to be read: "The Influence Machine and its Advantages for Lighting X-Ray Tubes," by James Wimshurst.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "The Electricity Supply of London," by A. H. Preece.

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday noon.

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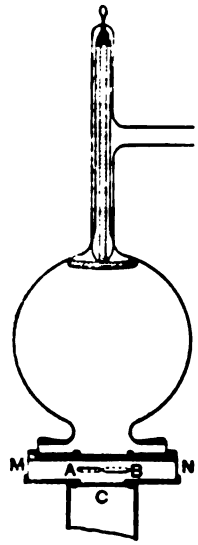
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Crypto-luminescence.—A. Róiti has investigated, somewhat on Sagnac's lines, the invisible luminescence produced in metals by the impact of Röntgen rays. The manner in which this luminescence is exhibited and studied is very elegant. A spherical Röntgen tube, with a slightly convex cathode and a partition of aluminium, MN, opposite (*see* Fig. 1), is provided with a chamber, AB, in which a circle of two semi-circular pieces of different metals is mounted just outside the tube. Another circle of the same two metals, but reversed, is in contact with the first circle. Behind it again is a tube provided with a fluorescent screen, C, as used in the author's "cryptochrosis" experiments. As a rule, the screen will be brightened, and since the total thickness and the kind of metal traversed is the same in both cases, no difference should appear on the screen. But in most cases one-half of the field is brighter, and since that can only be due to some kind of luminescence produced in the metal first encountered, the author describes the phenomenon as "crypto-



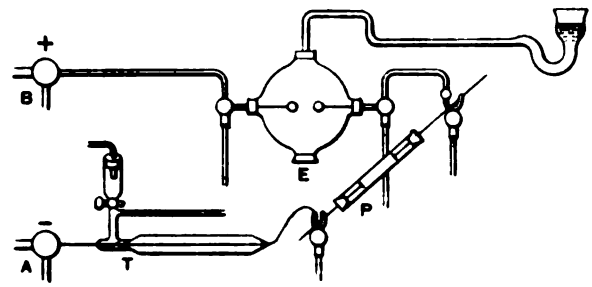
luminescence." He made a large number of experiments with lead, tin, silver, platinum, gold, copper, nickel, palladium and other metals, and found that, as a general rule, the crypto-luminescence increased with the atomic weight. But the most remarkable circumstance is that this luminescence, whatever its nature, is intercepted by a layer of air 5cm. thick, and the field is then of the same brightness on both sides.

[Róiti, *Rendic. dei Lincei* VII., February 20, 1898.]

Another Mercury Interruptor.—The same author describes a mercury-spring interruptor which allows of a wide range of frequencies. A spiral spring is provided with a point which dips into mercury and thereby establishes a circuit. As soon as the circuit is established, the iron core inside the spring becomes magnetised and the spring contracts, thereby breaking the circuit. The stem carrying the core carries also a kind of toothed wheel, which gears into the spiral from the inside. By turning the stem round and raising or lowering it, the number of turns which are free to vibrate may be altered, and the frequency thereby modified. The mercury and spring are contained in a tube, and the former is surmounted by petroleum which prevents oxidation and damps the motion of the spring.

[Róiti, *Elettricista*, November, 1897.]

Thermal Phenomena in Electrolytes.—P. Cardani applies his petroleum thermometer to the study of the thermal phenomena in circuits in which the resistance can be easily altered without affecting the inductance, *i.e.*, in electrolytes. In the annexed diagram, AB are the terminals of a Holtz machine which is driven by a small motor. E is a spark-gap thermometer, and P the electrolytic resistance, while T is the petroleum thermometer already familiar from the author's study of derived circuits. The author finds that the amount of heat developed is proportional to the resistance as determined by Stefan's law, which is strictly obeyed by liquids. To determine the resistance opposed by any electrolyte to the discharge of a condenser it is therefore only necessary to make two measurements with it—one with the electrodes in contact, so as to



obtain the thermometer reading without the liquid resistance, and the other with the electrodes a known distance apart. The readings are N_0 and N respectively, and they are governed by the formula

$$N_0 - N = \frac{N}{\alpha}\left(k\frac{L}{S}\right)$$

where k, L and S have the usual significance, and α is a constant depending upon the apparatus outside the electrolyte.

[Cardani, *Nuovo Cimento*, January, 1898.]

Disturbances in Electrolytes.—Some time ago Sella and Majorana discovered that the action of ultra-violet light on a spark-gap is modified as soon as the gap reaches a certain length which they call the critical distance. The effect of ultra-violet rays and X-rays is to facilitate the discharge when the distance is below the critical distance, and the rays impinge upon the cathode; when the distance is greater the rays impede the discharge when they fall upon the anode. V. Volterra has tried to trace a similar discerning action in the effect of local disturbances upon the discharge through electrolytes. He was led to the investigation by the suggestion thrown out by previous workers that the discharge in air is itself an electrolytic phenomenon. The disturbance he produced in the electrolyte was not due to radiation, but to a change of concentration or degree of dissociation. He found that if an electric current passes through a voltameter and the electrolyte is "disturbed" along a constant length, so as to increase its conductivity, and to render it electropositive with respect to the undisturbed portion, three cases occur. When the distance between the electrodes is below a certain limit the passage of the current is facilitated, especially if the disturbance is near the cathode. At a certain "critical distance" no effect is produced, and when that distance is surpassed the hindrance opposed by a disturbance at the anode outweighs the encouragement offered by the same disturbance at the cathode. The analogy is therefore very clear, and it only remains to account for it. Considering that the laws of solution and of electrolysis are now in a fair way of being completely unravelled, it is very probable that they will be utilised to shed light on the apparently simple but actually more recondite laws of gaseous discharge.

[Volterra, *Nuovo Cimento*, January, 1898.]

Animal Electricity.—The Royal Academy of Sciences of Bologna, says *Nature*, announces that a gold medal, in memory of Aldini, will be awarded in 1899 for the best essay on animal electricity. The essays may be either in Italian, French or Latin. They may either be in manuscript or printed, but they must not have been published longer ago than two years before the award. Papers competing for the prize are to be sent before May 29, 1899, addressed to the Secretary of the Royal Academy of Sciences of the Institute of Bologna.

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THE PERMANENCY OF THE BOARD OF TRADE CLARK CELL.

BY W. R. COOPER, M.A., B.SC., A.I.C.

The final Board of Trade specification, which was adopted in July, 1894, has now been sufficiently long in existence for its merits or its defects to be apparent. Judging from recent correspondence upon the subject, these instructions do not appear to have given entire satisfaction. There are two distinct objects to be attained by such a specification. First, the cells constructed in accordance with the instructions should not differ in E.M.F. from the normal value by more than some definite amount. Secondly, the cells should be permanent. With regard to the first object, the Board of Trade desired an accuracy of one part in 1,000, and it will generally be conceded that accuracy to this extent can be obtained by carefully following the directions. Mr. Dearlove, in a recent communication, states that his results were neither uniform nor constant. The author has always found want of uniformity in new cells of this type, but after the first week or ten days they have generally become fairly constant. The specification does not, however, appear to be so satisfactory as regards secular change, the importance of which cannot be over-estimated. There is a marked tendency for the E.M.F. to fall, until finally the cells are no longer accurate to one part in 1,000.

In the adjoining table some results are given illustrating these points. The cells to which they refer were all set up by the author very carefully in accordance with the Board of Trade specification. They were tested by comparison with standards belonging either to the Central Technical College or to the author, which there is reason to believe are practically normal. Temperature corrections have been applied to all results here given; but it should be stated that the thermometers could only be read approximately to about 0·2deg. Moreover, local differences of temperature amounting to 0·1deg., corresponding to 0·0001 volt, are easily overlooked unless particular attention is given to the circulation of the water in the baths employed. The results, however, are generally the mean of several determinations, and may therefore be considered to be free from a greater error than two or three ten-thousandths of a volt as far as the comparisons are concerned. The materials used were obtained from Messrs. Baird and Tatlock, and were of the same purity throughout. The mercury was re-distilled *in vacuo* by the author. The mercurous sulphate was white, and only gave a slight yellow coloration after prolonged washing. For the cells, from A to O inclusive, the paste was practically the same; but for the last three a fresh lot was prepared. The zinc sulphate solutions were carefully made up according to the specification, and were free from iron.

On referring to the results that are given it will be noticed that cells generally start with being low, but assume the normal value in about a week or ten days after construction, the mean error then amounting to one in 7,000. As time goes on, however, the E.M.F. steadily falls, though some cells appear to recover to some extent. Thus at the end of nearly three years and a-half, cells A to O have a mean error of about one in 700, which is ten times the initial error, and considerably exceeds the error of one part in 1,000, which is supposed to be the limit likely to occur in single cells set up according to the Board of Trade instructions. Cells W, X, Z, after two years and three-quarters, show an even greater error, amounting to one part in 500.

LOCAL AUTHORITIES AND TELEPHONE COMPANIES.

At the annual meeting of the Association of Municipal Corporations held at the Guildhall last Saturday, Sir Albert Rollit presiding, the City Solicitor (Mr. H. Homewood Crawford) moved the following resolution :—

"That it is undesirable that the jurisdiction of Local Authorities over telephone companies should be curtailed or interfered with by the undue exercise by Her Majesty's Postmaster-General of his rights or privileges under the Telegraph Acts ; and that a representation to this effect be made to Her Majesty's Government."

He said that he was not moving it in any spirit of hostility to either the Postmaster-General or the National Telephone Company. The Corporation of London felt very strongly that the time had come when some action ought to be taken to protect the interests of street authorities as regards the powers and privileges of telephone companies which are derived by virtue of concessions from the Postmaster-General. As most of them were aware the local authorities, *vis-à-vis* the telephone companies, had a positive veto ; but as soon as the Postmaster-General had acquired what practically is a monopoly, the local authorities were ousted of that jurisdiction which they formerly had, although it was true that the Government authorities, when the agreement which had recently been entered into with the National Telephone Company came before Parliament, stated that there was no desire to curtail or interfere with the action of the local authorities; but they found in practice, at all events in the City of London, that that had taken place. He thought it might strengthen the hands of those who were seeking to have a proper inquiry into this very important matter that such a resolution as he suggested should be passed by the Association. He (the City Solicitor) said that the local authorities were desirous of doing their duties, but they did not wish to have their privileges curtailed by the National Telephone Company riding on the back of the Postmaster-General. He, therefore, hoped that the Association would pass the resolution with a view to strengthening the hands of those who were doing their utmost to maintain the rights and privileges of local authorities, and especially of street authorities.

The TOWN CLERK OF NOTTINGHAM thought there ought to be more deliberation about such a motion. The evidence ought to be sifted and discussed by the Council. He did not think that a large, broad principle of that kind which affected the National Telephone Company, and which affected the City of London, especially in its late lawsuit with the Company, and which also affected the Postmaster-General, should be decided in a hurried way. He therefore proposed that the matter should be referred to the General Council for consideration.

Mr. ALDERMAN STUBBS (New Bromley) said that the traffic of the Telephone Companies over the roofs of property of London and other towns was one that might fairly be added to the resolution, and assuming that it went to the Council for consideration, he hoped that they would deal with that branch of the subject, inasmuch as the alternative at the present moment was either to submit to the roofs of houses being run over like a public thoroughfare, or to commence an action against the Telephone Companies.

The CITY SOLICITOR said he accepted the proposal to refer the resolution to the Council with pleasure, as he did not wish to rush an important question of this kind.

Mr. ELLIOTT (Newbury) said he should prefer that they should vote upon it that morning. It might be that it would require a lot of consideration as to details, but it did not require much consideration to enable the representatives of local authorities present to know that they did not want to be overridden by any of these companies, or by the sanction of the Postmaster-General. It was quite true that once those companies got that sanction they overran the roofs of houses as if they were their own private property.

The original motion was then withdrawn, and the amendment to refer the subject to the General Council was accepted.

Cell.	Date of setting up.	Differences from standard in volts.										
		Nov. 3, '94	Nov. 6, '94	Nov. 8, '94	Nov. 21, '94	Nov. 24, '94	Dec. 3, '94	May, '95	July, '95	Jan. '96	Feb. '96	Feb. '98
A	Oct. 31, '94	−0·0002	−0·00005	0·0000	..	..	..	...	...	−0·0024	−0·0020	−0·0051
B	,,	−0·0017	−0·0010	−0·0009	−0·0013	−0·0010	−0·0012	−0·0029	...	−0·0026	...	−0·0010
D	,,	−0·0010	−0·0005	−0·0004	−0·0007	−0·0001	−0·0003	−0·0008	...	...	−0·0007	−0·0029
E	,,	−0·0008	−0·0004	−0·0004	−0·0006	0·0000	−0·0002	−0·0006	...	...	−0·0007	−0·0014
F	,,	−0·0001	−0·00005	0·0000	...	...	...	...	..	−0·0010	...	−0·0013
J	,,	−0·0003	−0·0002	−0·0001	...	...	...	...	...	...	...	−0·0027
K	,,	−0·0011	−0·0006	−0·0005	−0·0009	−0·0007	−0·0009	−0·0029	...	−0·0043	−0·0030	−0·0018
L	Nov. 14, '94	...	..	...	−0·0004	+0·0001	−0·0001	−0·0020	..	−0·0025	−0·0016	−0·0018
M	,,	...	...	...	−0·0005	+0·0002	+0·0001	..	...	−0·0044	...	−0·0020
N	,,	...	...		−0·0008	0·0000	−0·0003	−0·0028	...	−0·0034	...	−0·0016
O	,,	...	...	...	−0·0006	−0·0001	−0·0003	−0·0040	...	−0·0016	...	−0·0027
W	June 27, '95	...	...	...	...	...	...	...	+0·0001	−0·0009	−0·0007	−0·0030
X	,,	...	...	...	...	...		..	+0·0002	...	−0·0004	−0·0026
Z	,,	...	..	...	...	...	...	...	0·0000	...	−0·0007	−0·0028

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THE COST OF GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY.*

BY ROBERT HAMMOND.

Section 9 of the Electric Lighting Act, 1882 (45 and 46 Vict., chap. 56), runs :—

ELECTRIC LIGHTING ACT, 1882.

Accounts—9.—The Undertakers shall on or before March 25th in every year fill up an annual statement of accounts of the undertaking, made up to December 31st then next preceding ; and such statement shall be in such form, and shall contain such particulars, and shall be published in such a manner as may from time to time be prescribed in that behalf by the Board of Trade.

The Undertakers shall keep copies of such annual statement at their office, and sell the same to any applicant at a price not exceeding 1s. a copy.

In case the Undertakers make default in complying with the provisions of this section, they shall be liable to a penalty not exceeding 40s. for each day during which such default continues

As regards the manner of publication, the Board of Trade prescribe that copies of the accounts shall, in the case of local authorities, be forwarded to the Board of Trade and to the Local Government Board (in Scotland to the Secretary for Scotland), and in the case of companies to the Board of Trade and to the local authorities. The Undertakers have to state not only the amount of the revenue and the working expenses of the undertakings, but to analyse the expenditure under numerous headings, which may generally be summarised as under :—

1. Coals or other fuel.
2. Oil, waste, water and stores.
3. Wages on generation and distribution.
4. Repairs and maintenance.
5. Rents, rates and taxes.
6. Management—*i.e.*, salaries, stationery and printing, general establishment charges, law expenses, insurance, &c.

There is also a statement from which, if it be faithfully and fully filled in, it is possible with ease to arrive at the cost of, as well as the average revenue arising from, the "units sold," to discover the load-factor, and to determine the percentage of "quantity not accounted for."

Where companies are undertakers, an almost identical form to that for local authorities is prescribed. The points of difference are :—

(1) In the companies' form the item "proportion of salaries of engineers" appears under the headings of "Generation" and "Distribution" (*i.e.*, *Works Costs*) ; whereas in the case of local authorities the item has to be included under *Management*.

(2) Provision is made in the companies' form, under "Management," for remuneration of directors and auditors.

(3) The companies' form provides in the revenue account a heading for "Depreciation."

In the case of companies the returns have to be audited by an auditor appointed by the Board of Trade. With regard to (1) it is, I think, to be regretted that the two forms are not identical, because, without readjustment of the item of salaries, no trustworthy comparison can be made between the "works costs" of undertakings of local authorities and those of companies. Such readjustment has been made by me throughout this Paper in the costs of 1896 and 1897, the *whole* of the salaries of engineers being placed under "Management," as in the returns of the local authorities. Manifestly the proper plan would be to place the salaries, especially those of assistants, under the headings of "Generation" and "Distribution" (*Works Costs*). To secure uniformity it might be prescribed by the Board of Trade that the salaries of all assistants other than those directly concerned with "Management" should be debited to "Generation" and "Distribution," and that one-half of the salary of the managing engineer should be so allocated.

The Undertakers are under an obligation to file their accounts, made up to the previous December 31st, on or before March 25th in every year ; but this obligation is not strictly complied with, especially by local authorities—mainly because, in most cases, their financial year does not end till March 31st, and in some cases not till May 31st. It may indeed be said that after the rush of the law-abiding, at the beginning of each year, the returns from the law-breakers drop in most casually over the remainder of the twelve months, and it is therefore impossible to compile a complete record of the costs for any year till the end of the following year ; and even then one has to mourn the stiff-neckedness of certain individuals who risk the penalty of 40s. per day, not only by not filing accounts within the specfied time, but by withholding some of the items demanded by the Board of Trade form.

On the whole, however, those holding powers under the Electric Lighting Acts have fully complied with their statutory obligations.

The extent to which the data have been growing may be seen by the following table :—

Year.	No. of electricity works in operation under statutory powers, or for which statutory powers were subsequently secured.	Year.	No. of electricity works in operation under statutory powers, or for which statutory powers were subsequently secured.
1882	2	1890	17
1883	3	1891	31
1884	3	1892	39
1885	4	1893	62
1886	4	1894	81
1887	6	1895	93
1888	7	1896	112
1889	14	1897	121

The Board of Trade have made no publication of these returns, and the only course open to the inquirer is to apply to the various undertakers for copies of the same.

As no Paper on the subject has been laid before the Institution since Mr. R. E. Crompton's "Cost of Electrical Energy," read on April 26, 1894, it has struck me that a fairly complete analysis of the returns, as far as "costs" are concerned, might prove useful to the members, and possibly have a convincing effect upon those who have not hitherto examined the data, as to the gradually decreasing cost of the production and distribution of electrical energy from central electricity supply works in the United Kingdom. Before embarking on that analysis I draw attention to the fact that the existence of such data, as far as I am aware, is unique in the history of English industries, if not in that of the industries of the world. The nearest parallel to it in this country that I can recall is the quarterly and duly audited returns of the selling price of finished iron, published by the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England, and accepted by both masters and men as the basis of wages for the ensuing three months. The finished iron makers, however, though heartily co-operating in the publication of these data, would, I imagine, stand aghast at the idea of disclosing the costs of all the items that go to make the finished article—*i.e.*, the pig iron, coals, fettling, repairs, wages, depreciation, and, we may now add, electricity. Similarly, I fancy that Col. Makins, the chairman of the Gas Light and Coke Company, would shrink from such a rigid analysis of his cost sheets as that set out in the form prescribed by the Board of Trade for electricity undertakings.

Some, indeed, have been puzzled to understand why so socialistic a condition was thrust upon our industry. It must be remembered that 20 years ago, when we were agitating for statutory powers for electric lighting, there was a strong anti-monopoly feeling prevalent. The Legislature would accord only a 21 years' tenure, with an option at the end of that period on the part of the local authority to buy up the undertaking at a break-up value. Meanwhile the local authority had to know exactly how the business was progressing. Hence clause 9, as to filing accounts, in the Act of 1882. When we secured in 1888 an extension of the tenure to 42 years, the onerous clause was allowed to remain. The English are notably a patient race. The clause was accepted without a murmur as part of the nature of things, and it has unexpectedly operated most markedly in assisting the reduction of costs of production and in the lowering of prices to consumers. The publication of analyses of the current year's returns, in the electrical papers,* has acted like an irritant upon the engineers of those works whose costs were high, and as a stimulus to still greater economies on the part of those whose costs were low.

My task is to summarise the returns of each undertaking in the United Kingdom, as far as I have been able to obtain them. They go back to 1890, and, in almost every case, end with the 1896 return, but where the 1897 return has been obtainable it is included. It is, unfortunately, out of my power to include the costs of production in works established solely for the supply of electrical energy to tramways, these works being under no statutory obligation to file such returns. The figures tabulated by me refer to those undertakings that are operating under the Electric Lighting Acts, 1882-88, having, of course, electric lighting for their main object, and only being assisted to a very slight extent by a demand for electrical energy for other purposes than lighting ; though in the Provisional Orders under which they are operating it is made clear that they are constituted in their districts the suppliers of electrical energy for all purposes that may be demanded.

It may be objected that in going beyond the analysis of the *Works Costs* I am stepping out of the path of the engineer into that of the statistician ; and I should admit the justice of the criticism had the Board of Trade form, in the case of local authorities, not located engineers' salaries, &c., under the heading of "Management." As, by this arrangement, *Works Costs* become bereft of the important item of superintendence, I feel compelled, in order to make my returns complete, to bring in the whole of the

* Abstract of a Paper read before the Institution of Electrical Engineers March 24, 1898.

* [See "Electricity Works Accounts," as published weekly in *The Electrician*.—ED. *E.*]

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management items, though agreeing that the bulk are not chargeable to the engineering department. On the other hand, general use of electrical energy will depend not entirely on the *Works Costs*, but upon the gross cost of the energy delivered to the consumer; and though the engineer may have no responsibility for the outlays on management—not even the fixing of his own salary—I feel that my analyses of *Costs* would be incomplete if I did not include all the items that contributed. In this connection I may repeat that in only the 1896 and 1897 analyses are the salaries of engineers, in the case of companies, included under the heading of "Management," as in the case of local authorities.

At Leeds our average price this year will be 4d. per unit, compared with 8d. per unit five years ago; and at Brighton the charge is 1½d. per unit for all consumption beyond an average of one hour per day, the first hour's consumption being charged at 7d. per unit. The costs achieved by Mr. Crompton's company at Kensington, the oldest-established works in the metropolis, are set forth below :—

Kensington Works.

Year.	No. of units sold.	Works costs per unit sold.	Total costs per unit sold.
1891	385,050	3·53d.	4·91d.
1892	535,343	2·77d.	3·85d.
1893	724,308	2·48d.	3·45d.
1894	977,797	2·11d.	2·86d.
1895	1,228,734	1·82d.	2·57d.
1896	1,514,729	1·57d.	2·66d.

And the works designed by Prof. Kennedy for the Westminster Company :—

Westminster Works.

Year.	No. of units sold.	Works costs per unit sold.	Total costs per unit sold.
1891	627,500	3·33d.	5·32d.
1892	1,217,871	2·93d.	4·24d.
1893	1,704,615	2·27d.	3·44d.
1894	2,173,298	1·74d.	2·69d.
1895	2,830,396	1·51d.	2·31d.
1896	3,503,054	1·24d.	2·09d.
1897	4,355,781	1·29d.	2·19d.

Or the works designed by Dr. Hopkinson for the Manchester Corporation :—

Manchester Works.

Year.	No. of units sold.	Works costs per unit sold.	Total costs per unit sold.
1894	1,168,382	1·49d.	2·17d.
1895	1,748,244	1·22d.	1·80d.
1896	2,508,588	0·94d.	1·45d.

Or those laid down by me at Leeds :—

Leeds Works.

Year.	No. of units sold.	Works costs per unit sold.	Total costs per unit sold.
1894	291,113	2·17d.	3·11d.
1895	524,629	1·46d.	2·05d.
1896	701,409	0·96d.	1·73d.
1897	833,280	0·78d.	1·50d.

Or those laid down by Prof. Kennedy at Edinburgh :—

Edinburgh Works.

Year.	No. of units sold.	Works costs per unit sold.	Total costs per unit sold.
1895	888,335	0·92d.	1·67d.
1896	1,721,557	0·63d.	1·13d.

With only two exceptions, the costs show a decrease on those of the preceding year. Costs of production and distribution tend to decrease year by year as the output increases. The obvious inference is that on still increased outputs the costs per unit will continue to decrease.

Nelson's 0·15d. for fuel is excluded, as the bulk of the steam at those works was raised from the heat generated in the gas retorts. Apparently, then, if the most favourable features of each works were reproduced in one single works, electrical energy for lighting would be produced and distributed for 0·84d. per unit; but this happy combination necessitates the command of fuel as cheap, and I suppose I ought to add as efficiently used, as at Aberdeen and Leeds; it necessitates the careful control and use of oil which characterises Oldham and Leeds; it requires the minimising of the wages list to the standard of Edinburgh, and the absence from breakdowns to machinery which signalises the working at Newport;

Aggregation of the Lowest Costs in the United Kingdom.—Second Year of Operation and onwards.

Name of place.	Year of operation.	Units sold.	Cost per unit sold.	
Aberdeen	2nd	210,185	Fuel	0·25d.
Leeds	4th	833,280		
Oldham	3rd	227,982	Oil, waste, water, &c. ...	0·05d.
Leeds	4th	833,280		
Edinburgh.....	2nd	1,721,557	Wages	0·20d.
Newport, Mon..	2nd	195,932	Repairs	0·06d.
			Works costs	0·56d.
Cardiff	2nd	308,430	Rents, rates and taxes ...	0·06d.
Worcester	2nd	333,644		
Whitehaven ...	3rd	178,378	Management	0·22d.
			Total costs	0·84d

it demands the happy position of freedom of rent and the friendly consideration of the rating authority, which obtains at Cardiff and Worcester, combined with the economical apportionment of management charges that prevails at Whitehaven.

The assemblage of all the virtues in one works may come in time, but meanwhile we have to be content with an approximation thereto, and it is satisfactory to find that two of the above-named works—Edinburgh and Leeds—show satisfactory signs of nearing the goal with increased outputs, both having respectively succeeded in lowering the record of *costs per output*. In view, therefore, of the exceptional conditions under which the above "ideal" costs are obtained, I do not think that we should be right in taking 0·84d. as the goal to which the bulk of the works in this country can expect to arrive, and I prefer to direct your attention to the carefully reasoned out "ideal standard costs" which Mr. R. E. Crompton laid before us in his 1894 Paper. It will be remembered by those who had the pleasure of hearing Mr. Crompton that he prophesied, to a somewhat incredulous audience, that the day would come when, with an output of 5,000,000 units, costs of production and distribution, in places where best coal cost 20s. per ton, would work out as follows :—

	Per unit sold. d.	d.
Works Costs :		
Fuel—2·5lb. Welsh coal, at 20s.	0·27	
Water	0·01	
Petty stores	0·02	
Wages	0·10	
Superintendence	0·10	
		0·50
Maintenance :		
Material on repairs	0·20	
Wages on repairs	0·15	
Superintendence	0·05	
		0·40
		0·90
Management		0·42
		1·32

or, to arrange the figures in the abbreviated Board of Trade form, now become common :—

	d.
Fuel	0·27
Oil, waste, water and stores	0·03
Wages	0·10
Repairs and maintenance	0·35
Works costs	0·75
Rent, rates and taxes ..... / Management (including engineers' superintendence) }	0·57
	1·32.

After the lapse of four years we are able to chronicle the fact that these "ideal standard costs" have in one case been improved upon, and in two others closely approached, with much lower outputs than the 5,000,000 units fixed by Mr. Crompton :—

Place.	Year.	Works cost. Output.	Works cost per unit sold.	Total cost.	
Edinburgh.....	1896–7	1,721,557	0·63d.	1,721,557	1·13d.
Leeds	1897	833,280	0·78d.	833,280	1·50d.
Manchester	1896–7	2,508,588	0·94d.	2,508,588	1·45d.

In all these cases, however, the coal was obtainable much below the 20s. per ton which Mr. Crompton took as a basis. It may be objected that Mr. Crompton had specially in view London works, and it is interesting to compare, with his "ideal" figures, the lowest results yet attained in the metropolis.

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Metropolitan Works.

—	Costs per unit sold.		
	Mr. Crompton, 1894. "Ideal costs." Units. 5,000,000.	1897 costs. St. James's. Units. 3,028,242.	Westminster. Units. 4,355,781.
Fuel	0·27d.	0·51d.	0·63d.
Oil, waste, water and stores	0·03d.	0·07d.	0·09d.
Wages	0·10d.	0·29d.	0·34d.
Repairs and maintenance	0·35d.	0·40d.	0·23d.
Total works costs	0·75d.	1·27d.	1·29d.
Rent, rates and taxes	0·57d.	0·21d.	0·22d.
Management expenses (including engineers' superintendence)		0·71d.	0·68d.
Total costs	1·32d.	2·19d.	2·19d.

It is a singular coincidence that both these works, though with widely different outputs, should achieve exactly the same total costs per unit, i.e., 2·19d. Bradford, Brighton, Edinburgh, Glasgow, Leeds, Liverpool, Manchester, Portsmouth and Whitehaven have improved upon these results, even after allowance be made for their cheaper coal.

Provincial Works.—Some Comparative Low Costs per Unit Sold.

—	Bradford, '96. Units sold, 813,623.	Brighton, '96. Units sold, 1,388,821.	Edinburgh, '96-7. Units sold, 1,721,557.	Glasgow, '96-7. Units sold, 1,407,842.	Leeds, '97. Units sold, 951,260.	Liverpool, '96. Units sold, 744,617.	Manchester, '96-7. Units sold, 2,515,788.	Portsmouth, '96-7. Units sold, 339,312.	Whitehaven, '96. Units sold, 176,378.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
Fuel	0·40	0·69	0·31	0·45	0·25	0·50	0·40	0·56	0·49
Oil, waste, water and stores	0·11	0·10	0·06	0·07	0·05	0·07	0·11	0·15	0·12
Wages	0·42	0·35	0·20	0·32	0·35	0·32	0·26	0·22	0·54
Repairs and maintenance	0·10	0·30	0·06	0·48	0·13	0·25	0·17	0·39	0·29
Works costs	1·03	1·44	0·63	1·32	0·78	1·14	0·94	1·32	1·44
Rent, rates, and taxes	0·31	0·21	0·17	0·25	0·08	0·07	0·20	0·09	0·09
Management	0·47	0·39	0·33	0·35	0·64	0·56	0·31	0·30	0·22
Total costs	1·81	2·04	1·13	1·92	1·50	1·77	1·45	1·71	1·75

The question arises, What are the conditions tending towards such low costs as those recorded above? Manufacturers of electrical apparatus, of engines, and of boilers, or advocates of certain systems, are only human, and we may pardon them the weakness of claiming the low costs as due entirely to the use of their plant, or the adoption of their pet system; but an examination of the records achieved dispel the illusion that lowest costs can only be obtained by the use of particular engines, boilers, dynamos, &c., or special systems of distribution. A closer examination of the data reveals the fact that low costs are the result of the combination of favourable conditions.

A.—*Output.*

In the first place, the data under review show conclusively what perhaps would be otherwise sufficiently obvious—that *output* is the greatest factor in the reduction of costs per unit. For the purpose of illustrating this graphically I set out curves showing the relation of works costs per unit to units sold in the following places:—

Diagram I. (a)—Works Costs: Edinburgh, Kensington, Leeds, Manchester, St. James's, Westminster; *Diagram I. (b)—Works Costs:* Bradford, Brighton, Bristol, Glasgow, Portsmouth. In these diagrams the abscissæ represent the units sold, and the ordinates the cost per unit. In each place the works costs per unit sold fall rapidly as the output increases from year to year.

Comparing the curves of the three London companies, Kensington, St. James', and Westminster, it will be seen that the works costs of Kensington and Westminster fell in parallel lines from 2·77d. per unit to 1·74d. per unit, with an increased output in each case of 800,000 units, while St. James' exhibits a parallel fall from 2·42d. per unit. Edinburgh, Manchester, and Westminster also run on parallel lines of falling prices, but with widely different outputs. Leeds exhibits the steepest line, and secures the record for lowest price on output. In Diagram I. (*b*) the best curve is that of Bradford, which achieved works costs of 1·03d. on an output of 813,623 units. In spite of the higher price of coal at Brighton, it kept well ahead of Glasgow till the output reached a million units, when Glasgow scored a slight advantage. Portsmouth ran almost exactly parallel with Brighton, but achieved the same works costs on an output lower by 800,000 units, and finally recorded 1·32d. per unit on an output of 839,392 units, against Brighton's 1·44d. on 1,388,821 units.

Turning to the "Total Costs" diagrams, it will be noted that, on the whole, the curves follow similar lines. The curious rise in the St. James' 1893 costs is explained by the exceptionally heavy outlay in repairs and maintenance, viz., £3,228, being £1,113 beyond the amount spent in 1892, and including £1,290 for renewals. Then the general charges were burdened with the heavy law charges —£1,528. Altogether, this rise may be attributed to abnormal circumstances. It will be seen that Portsmouth displaces Bradford from its position of eminence, having scored total costs of 1·71d., against Bradford's 1·81d. on an almost identical output. The downward tendency of works costs of both St. James' and Westminster is checked at 1·25d. and 1·24d. respectively, leading to the supposition that the maximum of works costs for a lighting load in the metropolis should be placed at this figure. On total costs, however, St. James' still shows a falling curve.

Later in my Paper I will discuss the question as to the probable limit of fall in costs, but, after drawing attention to the main features of the curves, I will pass to my next heading, limiting myself for the moment to the very evident deduction that increasing output has a paramount influence on costs per unit. Obviously,

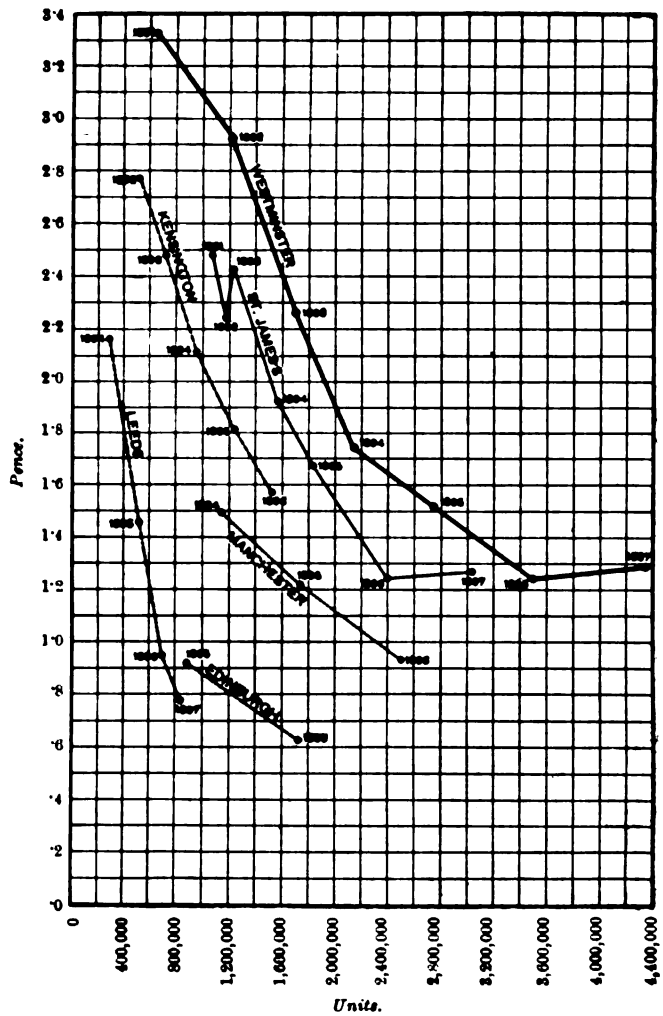

DIAGRAM I (*a*).—Curves showing relation between Works Costs per Unit and Units Sold.

however, *output* is not the only influence on costs, for if it were we should find that throughout the kingdom costs were in inverse ratio to output; whereas, if the record costs are arranged under outputs, it will be seen that the highest costs are by no means characteristic of the lowest outputs, though the converse does apply—*i.e.*, that the lowest costs accompany the higher outputs.

B.—*Load-Factor.*

Former writers have not failed to dwell upon the marked effect which the *load-factor* has upon the costs of production, and in my estimation of the influences which bear upon that problem I place load-factor directly after *output*. Without the latter the most favourable load-factor is useless, but, combined with a healthy output, a favourable load-factor greatly reduces costs. So convinced is Mr. Arthur Wright of the importance of load-factor that he offers to supply all his customers at 1½d. per unit for any consumption beyond an average of one hour per day of their maximum

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demand throughout the year. The advantages arising from a high load-factor are, however, universally acknowledged, and I, therefore, pass on to lay before you the data in connection with it, that I have been able to collect. These data are not demanded by the Board of Trade, and I am much indebted to those works engineers who have responded to my request for information on this head.

I use "load-factor" in the sense of the ratio of the actual units generated to the product of the maximum of the year and the total hours of the year; the "load-factor," therefore, of 1896 being obtained by multiplying the maximum load of 1896 by 8,784 (*i.e.*, 366 days by 24 hours), and of 1897 by 8,760. Though it appears to be the custom at every works to record the maximum load, the "units generated" are in the majority not arrived at by meter, but by calculation, and in some by a process which one of my correspondents describes as "cooking." Under these circumstances I have hesitated about dealing with the data; but finally, being convinced of the absolute accuracy of a portion, and of the approximate accuracy of the bulk, I have decided to set it out, leaving the members of the Institution to convince themselves in particular cases as to whether the "Units generated" have been arrived at in an accurate manner. I plot a curve (Diagram II.) showing the relation between load-factor and works costs per unit sold.

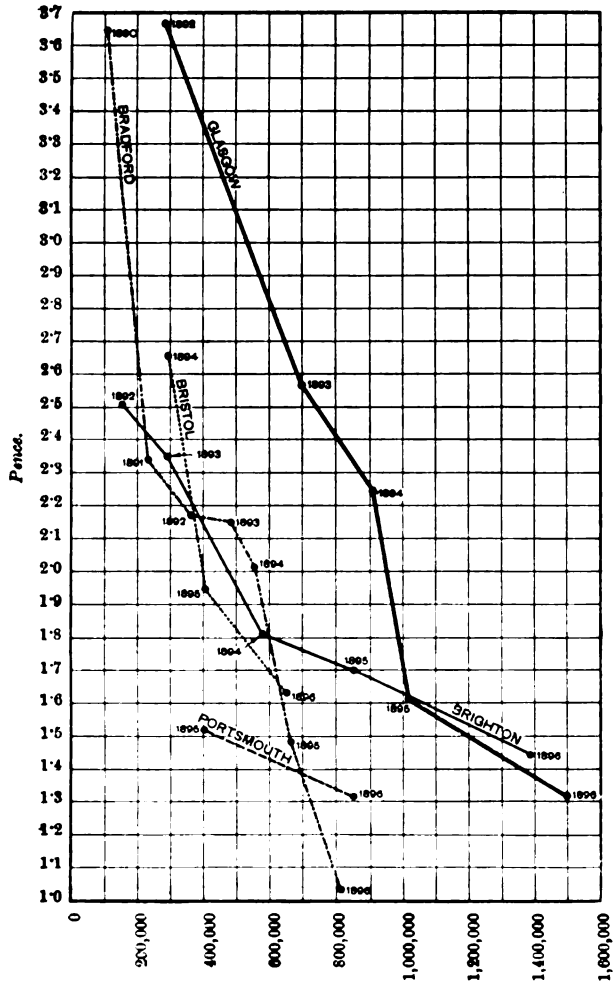

DIAGRAM I (*b*).—Curves showing relation between Works Costs per Unit and Units Sold.

After what I have said under the heading of "Output," it will not be expected that works with high load-factors and low outputs will show better results than those with high outputs and low load-factors, but the curve supports the contention that the load-factor has a marked influence on cost.

Note the position on the diagram of some of the works that have achieved the lowest works costs per output, and it will be seen that the load-factors almost all rule high.

Name of Place.	1896 Load-factor (%).	Name of Place.	1896 Load-factor (%).
Aberdeen	7·85	Manchester	12·62
Brighton	14·53	Newcastle District	18·33
Charing Cross	24·62	Preston	11·28
Dundee	10·50	St. James'	14·91
Edinburgh	13·48	Westminster	15·44
Leeds	*13·44	Whitehaven	17·98

*Calculated by the author.

Observe also that the load-factors vary from 6·16 per cent. to 24·62 per cent.; that the highest load-factor in the kingdom is found, as might naturally be expected, in the Charing Cross and Strand area. Observe also that curves drawn through many of the points show the tendency of works costs per unit to fall in ratio to the increase of the load-factor.

In the discussion of Mr. Crompton's 1894 Paper I drew attention to the fact that, whereas the cheapness of gas was due to the advantages arising from "by-products," so the cost of production of electrical energy would be greatly reduced if "by-uses" of the plant were general in those hours when the bulk of the lighting was not required. Let us take some town as an illustration. Bristol may perhaps be chosen as a place where a day load is likely to develop. Consider what would be the effect on the costs per unit if the load-factor of 12·99 per cent.—equivalent to about 3 hours per day—were increased to 50 per cent., or 12 hours per day, with an increase in output from 650,758 units to, say, 2,500,000 units. Taking output into consideration, the 1896 costs at Bristol are high. The coal works out 0·76d. per unit, as against 0·30d. achieved on an even smaller output in other alternating works. The three-fold addition to the load, and its prolongation over 12 hours in place of the present three hours, would certainly reduce the coal bill to 0·30d. Oil, waste, water, would probably go down from 0 08d. to 0·04d. The amount paid in wages of workmen would only slightly be increased by the more favourable load-factor, as three shifts of men are doubtless engaged all the year round. In 1896 the wages item amounted to £1,443. It would be fair to assume that the increase of the load-factor by 300 per cent. would not affect the wages bill by more than 25 per cent., in which case the 0·53d. per unit for wages would be reduced to 0·17d. The repairs and maintenance expenditure item, standing at £713, would possibly be increased in proportion to the amount of work done by the plant. In any case it would not be greatly diminished from the 0·26d. at which it stood in the 1896 accounts. It might be fair to take it for the larger output at 0·20d. Rents, rates and taxes would suffer no addition, and would therefore drop down to 0·10d.; and management would hardly be increased by more than 50 per cent., thereby reducing this item to 0·19d. To summarise:—

Bristol Works.—(With greatly improved load-factor).

—	1896 cost of production and distribution of 650,758 units.	Estimated cost of production and distribution of 2,500,000 units, increase being obtained by increase of load-factor. Cost per unit sold.	Cost per unit sold of the 2,500,000 units.
	£	d.	d.
Coals	2,068	0·76	0·30
Oil	214	0·08	0·04
Wages	1,443	0·53	0·17
Repairs	713	0·26	0·20
Works costs	4,438	1·63	0·71
Rent, &c	1,019	0·37	0·10
Management	1,341	0·50	1·19
Total costs	£6,798	2·50	1·00

Here, then, we have in a hypothetical case a reduction of costs per unit from 2½d. per unit to 1d. per per unit, by means of a considerable increase in the load-factor. Possibly I have not stated the case as strongly as I might, as the hypothetical works costs of 0·71d. are only on a par with those that have actually been attained by alternating works at Leeds. The illustration will, however, serve to show how important an element in cost is load-factor, and how earnest the zealous works manager should be in his endeavour to secure a day load—one of the prime essentials towards a substantial reduction of cost per unit.

Before leaving this branch of the subject I desire to say a few words with regard to the current method of arriving at the load-factor. It will be seen that I have followed the lines laid down by former writers; but I beg to point out that, though the method applied to each works in succession produces results which are reliable for the purpose of comparison, the load-factor arrived at by no means represents the percentage of use of the plant, and for the following reasons:—In the present stage of every works in the country, almost without exception, there is a gradual increase throughout the whole of the year in the number of lights attached to the circuit, culminating usually in a maximum demand at the end of the year appreciably higher than that which obtained at the beginning. The result is that the ratio of the units actually generated to the product of the maximum demand (which only occurred at the end of the year) and the total hours of the year, is much greater than it would be if an average of the maximum demand at the beginning and at the end of the year were used as the basis of calculation; though it is obvious that such average maximum demand is the more correct basis to take in order to arrive at the

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ratio of actual demand for current to a demand extending over the whole 24 hours daily.

In order to illustrate my meaning, I have in the following cases taken the maximum demand of the close of 1895, averaged it with the maximum which occurred at the end of 1896, and set out the resultant load-factors.

Load-Factors.—Worked out on the Basis of Averaging the Maxima of the Beginning and End of the Year.

Name of place.	Units generated during 1896.	Mean of 1895 and 1896 maximum demand. Kilowatts.	Load-factor on basis of average maximum demand.	Load-factor on basis of 1896 maximum demand.
Bradford	874,525	1,120	10·82	9·59
Brighton	1,653,576	1,107	17·00	14·53
Bristol	861,156	666	14·74	12·90
Edinburgh	1,917,503	1,318	16·56	11·48
Glasgow	1,729,483	1,593	12·36	9·53
Leeds	1,190,000	829	16·31	13·44
Manchester	3,078,357	2,410	14·30	12·62
Portsmouth	900,490	577	17·76	15·57
St. James'	2,687,968	1,806	16·39	14·91
Westminster	3,591,788	2,565	15·94	13·63

The new load-factor, of course, in each case, is higher than the one in current use, and it forms a much more reliable guide to the percentage of hours of demand upon the plant than the older method; though, in order to follow in the footsteps of my predecessors, I have adopted the older method in my tables and diagrams.

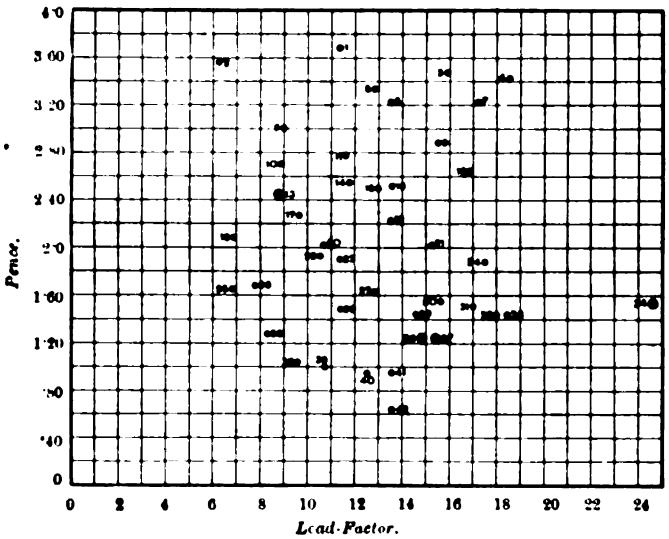

DIAGRAM II.—Diagram showing relation between Works Costs and Load-Factor.

1. Bournemouth.
2. Reading.
3. Dublin.
4. Eastbourne.
5. Cheltenham.
6. Kingston-on-Thames.
7. Hastings.
8. Coventry.
9. Dover.
10. Richmond.
11. Blackpool.
12. Ayr.
13. Hampstead.
14. Bedford.
15. Taunton.
16. Yarmouth.
17. Southampton.
18. Walsall.
19. Pontypool.
20. Hove.
21. Oxford.
22. Lancaster.
23. Hanley.
24. Newport.
25. Southport.
26. Aberdeen.
27. Bristol.
28. Sheffield.
29. Brighton.
30. Worcester.
31. Newcastle-on-Tyne
32. Whitehaven.
33. Newcastle District.
34. Charing Cross.
35. Nottingham.
36. St. James'.
37. Westminster.
38. Bradford.
39. Preston.
40. Manchester.
41. Leeds.
42. Edinburgh.

There is a third method which is sometimes suggested as more reliable than either of the two named, *i.e.*, the comparison of the ratio of the number of units sold to the product of the total of the maximum demands of the consumers into the hours of the year; but this data is impossible to obtain, as in only a limited number of cases is a record made of the maximum demands of consumers. The nearest approach to this is a comparison of the units used per annum per light fixed; but too much reliance cannot be placed upon these data, as the works engineer can never be certain as to the number of the lights fixed. Doubtless the returns made to him by the consumer or by the wiring firm when the lights are first connected are correct, but he cannot rely upon alterations in the number of lights being reported to him. Indeed, it is obvious that the number of lights fixed on a consumer's premises is only of comparative interest to him, the real thing of moment being the resultant maximum demand. As, however, some may deem it interesting to know what is the relation throughout the kingdom between the units sold per annum per lamp fixed, averaged over the year, and the price per unit, I have plotted the data on Diagram III. By a comparison of Diagrams II. and III. it is possible to arrive at the ratio of lamps fixed to the average number in use

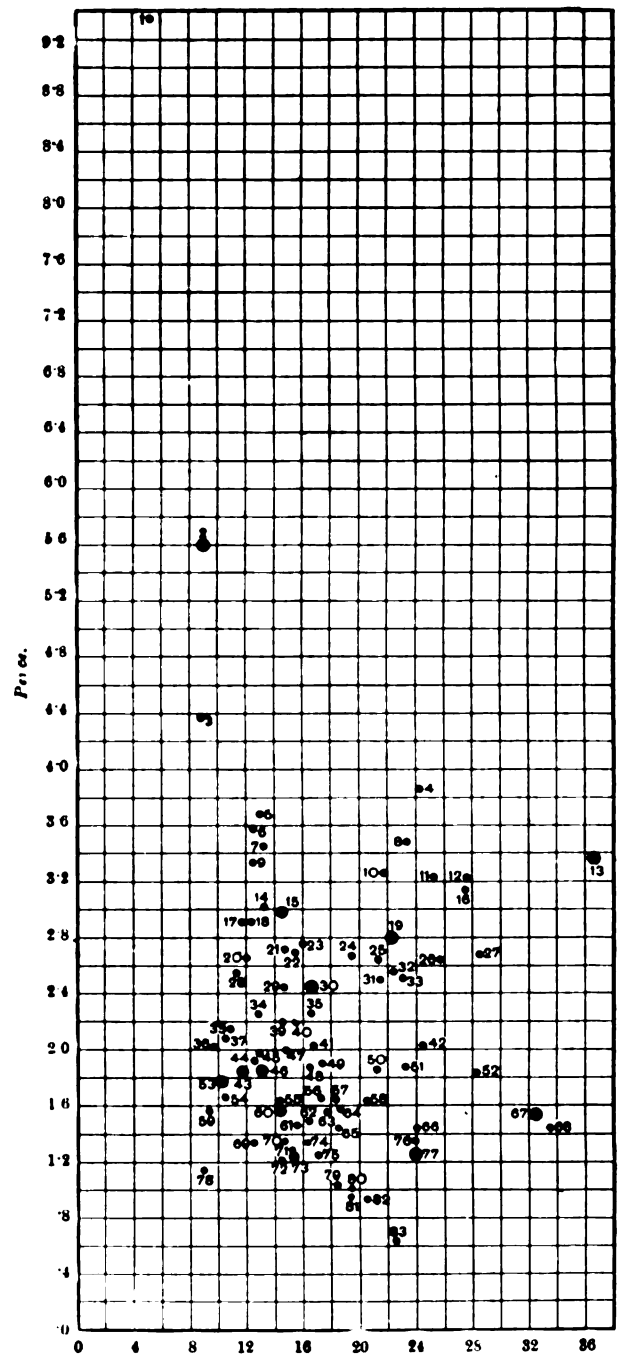

DIAGRAM III.—Diagram showing the relation between Works Costs and Consumption of Electrical Energy per annum per 8 c.p. connected.

1. Salford.
2. Crystal Palace.
3. Burton.
4. Aberystwith.
5. Bournemouth.
6. Reading.
7. Eastbourne.
8. Dublin.
9. Cheltenham.
10. Woolwich.
11. Kingston.
12. Hastings.
13. Islington.
14. Coventry.
15. Metropolitan.
16. Ealing.
17. Belfast.
18. Leicester.
19. St. Pancras.
20. Cambridge.
21. Shrewsbury.
22. Richmond.
23. Blackpool.
24. Oswestry.
25. Ayr.
26. Cardiff.
27. Dover.
28. Scarborough.
29. Halifax.
30. Hampstead.
31. Taunton.
32. Bedford.
33. Yarmouth.
34. Northampton.
35. Southampton.
36. Hove.
37. Pontypool.
38. Stafford.
39. Walsall.
40. Tunbridge Wells
41. Oxford.
42. City of London.
43. Chelsea.
44. Lancaster.
45. Bolton.
46. House-to-House.
47. Sunderland.
48. Oldham.
49. Hanley.
50. Newport.
51. Wolverhampton
52. Dewsbury.
53. Notting Hill.
54. Aberdeen.
55. Hull.
56. Birmingham.
57. Southport.
58. Bristol.
59. Kelvinside.
60. Kensington.
61. Sheffield.
62. Newcastle-on-Tyne.
63. Worcester.
64. Norwich.
65. Newcastle District.
66. Brighton. [trict.
67. Charing Cross.
68. Whitehaven.
69. Huddersfield.
70. Burnley.
71. Nottingham.
72. Nelson.
73. Westminster.
74. Glasgow.
75. Blackburn.
76. Portsmouth.
77. St. James'.
78. Liverpool.
79. Bradford.
80. Preston.
81. Leeds.
82. Manchester.
83. Edinburgh.

throughout the year; but, as the information obtained, though striking, is of little practical value, I do not purpose setting it out on this occasion.

(*To be continued.*)

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ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Bedford (Municipal)	March 4	Kingston-upon-Thames (M'cip'l)	March 25
Clerkenwell (Company)	March 18	Notting Hill (Company)	March 11
Dover (Company)	March 11	Richmond (Company)	March 4
Huddersfield (Municipal)	March 25	Wandsworth (Company)	March 18

Our Table of Accounts deals this week with the electricity supply works at Oxford and Scarborough. We also give some particulars of the accounts of the Bristol Tramways and Carriage Company (Limited).

Oxford Electric Company (Limited).

Owing to its being one of the principal exponents of the "Oxford" system of electric supply, the electricity works undertaking of the Oxford Electric Company (Limited) possesses especial interest for electrical engineers, and for this reason careful attention to its commercial progress, as exhibited in the annual accounts, is of considerable importance. During the past year one or two changes have taken place in the Capital Account. The £25,000 of Five per Cent. Debentures outstanding at the end of 1896 has been redeemed at a bonus of 5 per cent. by the issue of £35,000 in Four per Cent. Debenture Stock, a temporary bank loan of £10,000 being also redeemed. In March 2,000 shares were issued at a premium, the premium sufficing to cover the bonus to the debenture holders and to leave a small balance in hand. The total capital received by the end of 1897 was £85,000.

Considerable extensions in plant and mains have been effected, the capacity of the power station having been raised from 600 to 900 kilowatts. Substantial additions have been made to the lamp connections, the equivalent in 8 c.p. lamps having risen from 19,058 to 21,364. Some 47 new consumers were added, bringing the total number of consumers up to 316. During the year £2,534 has been spent on new mains, £2,990 on dynamos and on transformers for a new substation, and £708 on steam plant.

Referring to our table of costs, it will be seen that the increase in the size and importance of the undertaking is not unaccompanied by several indications of progress in the direction of economy and profit-making. To begin with, a 5 per cent. dividend has been paid on the Ordinary shares, as against 4½ per cent. in the previous year; and this notwithstanding that £500 was set aside for depreciation, as against absolutely nothing on the previous occasion. In regard to the amount of business done, there has been an increase from 250,515 to 300,734 in the units sold to consumers, and from 41,125 to 42,833 in the units sold for public lighting, making a total increase of 51,927 units in all. In view of these facts, the decline from 6·30d. to 5·99d. in the total revenue per unit sold, and the corresponding decline in the revenue per unit sold to consumers, are difficult to comprehend, there having been no reduction in the tariff.

On the other hand, several economies have been effected in the works costs, bringing the total costs down from 3·46d. to 3·20d. Owing to an unfortunate interruption in the use of the batteries, the generating plant was for some time compelled to work under disadvantageous conditions during the hours of low load, the direct effect of this being shown by a rise from 0·638d. to 0·650d. in the cost of fuel. But for this the works costs would probably have shown a more substantial reduction. The fall in the management and property charges from 1·24d. to 1·12d. per unit has been brought about purely by the augmented output, and in face of a considerable increase in the totals for some of the items, notably salaries.

Scarborough Electric Supply Company (Limited).

The salient features in the past year's working of the Scarborough Electric Supply Company (Limited), as compared with the previous year, include : a dividend of 5 per cent. on the Ordinary, as against 4½ per cent.; an increase of £418 in the working profit for the year, bringing this item up to £2,021, or 5·83 per cent. of the mean capital expended; reduction of the percentage ratio of total costs to gross revenue from 63 per cent. to 60 per cent.; a substantial increase in the *earning power* of the generating plant, per kilowatt capacity, this item having reached £9. 17s. 7d., as against £8. 7s.; and the creation of a "Depreciation Fund" by the setting aside of £250 for the purpose. We should also note an increase of 32 in the number of consumers, raising the total to 330; and of 2,340 in the equivalent of 8-c.p. lamps connected, raising this total to 20,067. There has been a slight increase in the actual consumption per 8-c.p. lamp connected, improving the revenue per lamp connected; and the total number of units sold has been augmented by 36,898, bringing the total for the year up to 211,407.

Turning now to the items of expenditure out of revenue, we notice a satisfactory reduction of 0·27d. per unit sold in the total costs, a result brought about by a fall of 0·14d. in the works costs, and 0·13d. in the management and property charges. Generation costs have fallen as much as 0·18d., notwithstanding an appreciable rise in the cost of fuel; but there has been an unfortunate rise in the cost of distribution.

On the whole, whether regarded from a purely financial or an engineering point of view, the undertaking of this Company shows evidence of being in a very satisfactory state of efficiency; and steady improvement in the dividend and other financial results may be looked for in the immediate future.

Bristol Tramways and Carriage Company (Limited).

The business of the Bristol Tramways and Carriage Company consists in two distinct branches—the town tramways, which are worked partly by electric traction, but chiefly by horses, and a considerable business in hackney carriages. There were 8·5 miles of mixed track worked by trolley at the end of last year, and some 31 motor cars. Considerable opposition to the scheme for the electrical equipment of the entire system has been raised by the local authorities, but under the energetic management of Mr. George White, the managing director, the Company may reasonably hope to effect an arrangement by which this scheme may be carried out.

Owing to the mixed nature of the business, and the natural reluctance of the Company to publish further particulars of the proportion represented by the electrical department until things are more settled down, we are unable to present our readers with the full analysis of the half-year's working that the importance of this concern makes desirable. However, much useful information may be gleaned from the annexed table, in which the accounts for the two halves of the last year, so far as they relate in any way to the electric lines, are compared. The receipts of the entire tramway department show an increase of £9,494 during the latter half-year, and there is a substantial increase both in the working profit and in the balance available for distribution to the shareholders. A dividend of 6 per cent. per annum has been paid, and it is an indication of the confidence in this undertaking that its shares have stood for some time at more than 100 per cent. premium, the £10 shares fully paid being quoted at £21.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY (LIMITED).

Date of commencement of Working Electrical Lines.	1895.
System of Electrical Lines	Overhead side-trolley.
Managing Director	George White.
Chief Engineer	W. Wood.

Half-year ended	June 30, 1897.	Dec. 31, 1897.
Passengers carried*	9,497,693†	11,060,817
Miles of electric track constructed	5·5	8·5
Number of motor- and trailer-cars	42	46
Capital authorised, Share	£500,000	£500,000
Capital received, Total	380,250	442,250
" " **Share**	275,000	325,000
" " **Loan** (*including Debentures*)	105,250	117,250
Capital expended	436,021	490,915
Electrical Depreciation Fund	2,139	3,308
Amount carried to Electrical Depreciation Fund	1,169	1,692
Repairs of plant, machinery and rolling stock ‡	*3,538*	*4,376*
Electrical renewals and repairs	*1,497*	*1,146*
Working profit for half-year	13,866	16,860
Balance available for dividend ‡	7,750	8,750
Ordinary dividend paid (per cent. per annum)	6%	6%

* Proportion on electric lines not stated. † Excluding postal riders.
‡ Total for entire business.

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	OXFORD.		SCARBOROUGH.	
Undertaking Worked by	The Oxford Electric Company (Limited).		The Scarborough Electric Supply Co. (Ltd.)	
Date of Commencement of Supply	1892.		1893.	
System of Supply	High-pressure continuous-current transformers		Alternate-current transformer sub-stations and	
Chief Engineer	P. J. Rea.		G. S. Peck.	[partly house transformers.
YEAR ENDED DECEMBER 31st.	**1896.**	**1897.**	**1896.**	**1897.**
QUANTITIES—				
Units generated	425,066	513,999	179,360	214,044
„ **SOLD (TOTAL)**	**291,640**	**343,567**	**174,514**	**211,407**
„ sold to consumers	250,515	300,734	174,514	211,407
„ sold for public lighting, &c.	41,125	42,833	nil	nil
„ used on works	not stated.	not stated.	4,846	2,637
UNITS SOLD PER 8 C.P. LAMP CAPACITY	**14·6**	**11·5**	**8·31**	**10·1**
Maximum supply demanded	271 kilowatts	311 kilowatts	246 kilowatts	286 kilowatts
Number of public lamps	32	32	none	none
Connections to mains in 8-c.p. lamps	19,058	21,364	17,727	20,067
CAPACITY OF PLANT IN 8-C.P. LAMPS	**20,000**	**30,000**	**21,000**	**21,000**
CAPACITY OF PLANT IN KILOWATTS	**600**	**900**	**525**	**525**
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	**£133,300 / £222**	**£150,000 / £167**	**£50,000 / £95·2**	**£50,000 / £95·2**
Share	100,000 / 167	100,000 / 111	50,000 / 95·2	50,000 / 95·2
Loan (including Debenture charges)	33,300 / 55·5	50,000 / 55·6	nil / —	nil / —
RECEIVED (TOTAL)	**73,300 / 122**	**85,000 / 94·5**	**33,196 / 63·1**	**35,967 / 68·5**
Share	40,000 / 66·7	50,000 / 55·6	33,196 / 63·1	35,967 / 68·5
Loan (including Debenture charges)	33,300 / 55·5	35,000 / 38·9	nil / —	nil / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**60,000 / 100**	**65,000 / 72·2**	**16,804 / 32**	**14,033 / 26·7**
Share (unissued)	60,000 / 100	50,000 / 55·6	10,000 / 19·0	10,000 / 19·0
Share (uncalled)	nil / —	nil / —	6,804 / 13·0	4,033 / 7·68
Loan (including Debentures)	nil / —	15,000 / 16·7	nil / —	nil / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	nil / —	nil / —	— / —	— / —
DEPRECIATION FUND	nil / —	500 / 0·556	— / —	**£250 / £0·476**
EXPENDED (TOTAL)	**75,903 / 128**	**84,545 / 94·0**	**33,760 / 64·3**	**35,563 / 67·8**
Lands and buildings	7,508 / 12·5	7,554 / 8·39	6,345 / 12·1	6,602 / 12·6
Plant	31,027 / 51·7	37,093 / 41·2	14,815 / 28·2	15,273 / 29·1
Mains	28,096 / 46·8	30,333 / 33·7	10,208 / 19·5	11,171 / 21·5
Miscellaneous	9,272 / 15·5	9,565 / 10·6	2,391 / 4·55	2,516 / 4·79
BALANCE OF CAPITAL ACCOUNT	**−2,603**[a] / **−4·34**	**+455** / **0·506**	**−564**[a] / **−1·07**	**+404** / **0·770**
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	**£7,574 / 6·30d.**	**£8,576 / 5·99d.**	**£4,384 / 6·03d.**	**£5,182 / 5·88d.**
Revenue from supply	6,863 / 5·65d.	7,699 / 5·38d.	4,255 / 5·85d.	5,025 / 5·70d.
„ meters, &c.	109 / 0·090d.	130 / 0·091d.	128 / 0·176d.	155 / 0·176d.
„ public lighting	459 / 0·378d.	459 / 0·321d.	nil / —	nil / —
„ sale of lamps, &c.	49 / 0·040d.	40 / 0·028d.	— / —	2 / 0·002d.
„ miscellaneous sources	94 / 0·077d.	248 / 0·173d.	1 / 0·001d.	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£4,206 / 3·46d.**	**£4,579 / 3·20d.**	**£2,761 / 3·80d.**	**£3,108 / 3·53d.**
WORKS COSTS	**2,706 / 2·231d.**	**2,977 / 2·08d.**	**2,095 / 2·88d.**	**2,416 / 2·74d.**
Generation of electricity	*2,526 / 2·08d.*	*2,726 / 1·90d.*	*1,941 / 2·67d.*	*2,190 / 2·49d.*
Fuel (including cartage, &c.)	775 / 0·638d.	938 / 0·650d.	904 / 1·24d.	1,139 / 1·29d.
Oil, waste, water, stores	79 / 0·065d.	101 / 0·071d.	70 / 0·096d.	67 / 0·076d.
Wages at station	761 / 0·626d.	861 / 0·602d.	665 / 0·915d.	772 / 0·876d.
Repairs and maintenance at station	911 / 0·750d.	817 / 0·571d.	302 / 0·416d.	212 / 0·251d.
Distribution of electricity	*180 / 0·148d.*	*251 / 0·175d.*	*154 / 0·212d.*	*226 / 0·256d.*
Wages, &c.	145 / 0·119d.	197 / 0·138d.	107 / 0·147d.	120 / 0·136d.
Repairs, renewals of mains, &c.	35 / 0·029d.	55 / 0·039d.	47 / 0·065d.	106 / 0·120d.
Public lighting	—[b] / —	—[b] / —	*nil* / —	*nil* / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	**1,500 / 1·24d.**	**1,602 / 1·12d.**	**666 / 0·916d.**	**692 / 0·786d.**
Royalties	*nil* / —	*nil* / —	— / —	— / —
Rent, rates, taxes	*335 / 0·276d.*	*350 / 0·245d.*	*89*[a] */ 0·122d.*	*124*[a] */ 0·141d.*
Management	*1,165 / 0·96d.*	*1,252 / 0·875d.*	*577 / 0·794d.*	*568 / 0·646d.*
Salaries	737[e] / 0·607d.	841[e] / 0·588d.	284 / 0·391d.	281 / 0·319d.
Stationery, &c.	89 / 0·073d.	91 / 0·064d.	46 / 0·063d.	54 / 0·061d.
Establishment charges	173 / 0·142d.	129 / 0·090d.	187[b] / 0·257d.	169[g] / 0·192d.
Law charges, &c.	166[d] / 0·137d.	191[f] / 0·134d.	60[c] / 0·083d.	64[c] / 0·073d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	**£3,368 / 4·69%**	**£3,997 / 4·98%**	**£1,603**[d] **/ 4·93%**	**£2,021**[d] **/ 5·83%**
Sum carried to Depreciation Fund	nil / —	500 / 0·623%	nil / —	250 / 0·722%
Sum carried to Reserve or Sinking Fund	nil / —	nil / —	nil / —	— / —
Net interest on loans (incl. Debenture charges)	1,550 / 2·516%	1,499 / 1·869%	32[e] / 0·098%	18[e] / 0·052%
BALANCE FROM LAST ACCOUNT	**+360 / 0·501%**	**+537 / 0·67%**	**304 / 0·935%**	**192 / 0·554%**
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	**2,178 / 3·03%**	**2,346 / 2·83%**	**1,600**[f] **/ 4·92%**	**1,845**[f] **/ 5·32%**
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	4½% / —	5% / —	4½% / —	5% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	55·6%	53·4%	63%	60%
Expenditure per kilowatt capacity	£7. 0s. 2d.	£5. 1s. 10d.	£5. 5s. 2d.	£5. 18s. 5d.
REVENUE PER KILOWATT CAPACITY	**£12. 12s. 5d.**	**£9. 10s. 7d.**	**£8. 7s. 0d.**	**£9. 17s. 7d.**
Expenditure per 8-c. lamp capacity	4s. 2d.	3s. 0½d.	2s. 7½d.	2s. 11½d.
REVENUE PER 8-C.P. LAMP CAPACITY	**7s. 7d.**	**5s. 8½d.**	4s. 2d.	**4s. 11½d.**
Price charged for lighting, per unit	7d.[e]	7d.[e]	6½d.[h] to 5¼d.[h]	6½d.[h] to 5¼d.[h]
Price charged for power, per unit				
Price charged for public lighting, per lamp	£14. 6s. 10d.	£14. 6s. 10d.	—	—

OXFORD.—REMARKS—*a* Over-expended. *b* Not separately rendered. *c* Includes £415 Directors' fees. *d* Includes £42 insurance, £19 legal expenses, £26 audit fees, and £79 advertisement. *e* Discount of 2½ per cent. on monthly payments. *f* Includes £48 insurance, £70 legal expenses, £32 audit fees, and £41 advertisement.

SCARBOROUGH.—REMARKS—* Over-expended. *a* Includes rent of telephone. *b* Includes £119 for lighting of works. *c* Includes auditing, and £27 in 1896 and £28 in 1897 for insurance, superannuation, &c. *d* Provision for bad debts, being £20 in 1896 and £53 in 1897. *e* Interest on Bank overdraft. *f* £275 having been written off preliminary expenses in 1896 and £100 in 1897. *g* Includes £65 for lighting of works. *h* With 5 per cent. discount for cash.

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ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS.—By J. Elton Young. This work will be issued early this year. Some extracts from the book have already appeared in *The Electrician*, from which it will be seen that the latest practice in Electrical Testing for Telegraph work has been treated by the Author.

PRACTICAL TELEPHONY.—By Dane Sinclair and F. C. Raphael.

PRIMARY BATTERIES.—A work on this subject will shortly be published, bringing the theory and practice of the Primary Battery up to date. The book will be fully illustrated.

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GOOD-FRIDAY WEEK.

"THE ELECTRICIAN" will be published on THURSDAY in Good-Friday week instead of on Friday. Communications intended for this issue must reach us not later than Wednesday morning's post.

Alterations to existing Advertisements and copy for new Advertisements should reach the Publisher on Tuesday, but in any case not later than Wednesday morning.

OUTPUT AND THE LOAD-FACTOR.

While reserving our detailed criticism of Mr. Robert Hammond's Paper on "The Cost of Generation and Distribution of Electrical Energy," taken as a whole, until after the adjourned discussion upon it at the Institution of Electrical Engineers has been concluded, we desire to call attention to certain matters, intimately connected with electric supply station practice, suggested by the portion of an abstract of the Paper which we reprint this week. The early parts of this abstract deal with a general analysis of the various items of expenditure out of revenue, in the case of all but the very smallest electricity supply works of the United Kingdom. These parts may be regarded as furnishing the ground-work for the subsequent criticisms and deductions, and they are accompanied by a profusion of tabulated data, for which it is quite impossible for us to find space in our abstract. Readers of *The Electrician*, however, need suffer practically no disadvantage from the omission, since they will find in the numerous tables of electric supply works and other Supplements published from time to time in *The Electrician* similar information, though in a somewhat different form; and a comparison of the data we have published, with the deductions drawn by Mr. Hammond in his Paper, will enable our readers to arrive at their own conclusions. Incidentally, we may remark that Mr. Hammond claims to have been the originator of "the idea of publishing analyses weekly." On the recent occasion of our commencing to publish our "Electricity Works Accounts," in the form in which our readers are now acquainted with them, we observed that "it is of interest to notice that the

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tables published in our issue of July 8, 1892, *were the first* in which the capital and revenue accounts of electric supply concerns were conjointly set forth and comparatively analysed." We repeat this claim now, in order that our readers may be under no misapprehension; for although at the early date at which we initiated this useful feature of *The Electrician* there was just as great a need as now that the analyses should be full and comprehensive, taking stock of all the items in the capital and revenue accounts, the scantiness of electric supply undertakings at that time and until quite recently rendered it quite unnecessary and superfluous to publish these analyses weekly. Whether, however, we take the figures obtained from Mr. Hammond's own personal weekly compilations, or turn to the data contained in *The Electrician* Supplements already alluded to, it is abundantly evident that the general trend of electric supply business in the United Kingdom has been maintained almost steadily in the direction of cheapness and improved economy. For convenient reference and in support of this conclusion our readers may turn to a series of small tables contained in the abstract, in which are set forth the progress in total and works costs of the undertakings at Kensington, Westminster, Manchester, Leeds and Edinburgh. These are justly illustrative of the general trend. At Kensington the total costs steadily declined from 4·91d. to 2·57d. between 1891 and 1895, slightly rising, however, in 1896; at Westminster there was an uninterrupted decline from 5·32d. in 1891 to 2·09d. in 1896; and in the other places cited equally satisfactory results accrued. Whatever may have been the causes, or in whatever proportion relatively these may have operated, so happy a consummation gives good reason for rejoicing and congratulation.

These causes, however, cannot be ignored, and the most useful parts of Mr. Hammond's Paper constitute an inquiry into their nature and relative importance. Turning again to the series of short tables just mentioned, it will be seen that in every instance cited there has been a steady increase in the number of units sold, corresponding with the decrease in the total and works costs. Probably it would have been more correct to have compared these costs with the units *generated*, as being a better index than the units sold of the actual work done by the machinery and other plant; but had this been done the same general conclusion must have been arrived at, viz., that, *cæteris paribus*, an increased output results in reduced works costs and total costs per unit. This important conclusion Mr. Hammond has abundantly and convincingly established, subject only to the restriction that other conditions are not to be seriously changed by the increase in output. The influence of such changes he has in some cases, we think, underrated, more especially the influence of the load-factor. "Output," says Mr. Hammond, "is the greatest factor in the reduction of costs per unit," and he places the load-factor "directly after output," though of the opinion that "without the latter the most favourable load factor is useless, but, combined with a healthy output, a favourable load-factor greatly reduces costs." We presume that by a "favourable" load-factor Mr. Hammond means a high load factor, otherwise he uses a question-begging term. Assuming this to be the implication, we see that Mr. Hammond attaches comparatively small importance to the load factor, and would expect lower costs at a gigantic station working with an actually large but, relatively to the capacity, a small output than at a snug little station running on a steady full-load for 24 hours every day in the year, *i.e.*, with a 100 per cent. load-factor. The illustration we have given is, we contend, no exaggeration of the obvious meaning of Mr. Hammond's words; and put in this way it will be evident to the majority of supply-station engineers that Mr. Hammond's contention is not quite sound. Indeed, none of the instances cited by him, in proof of his argument as to the all-importance of output, are free from the influence of a varying load-factor, which should have—but apparently has not—modified the conclusion he draws; and in some cases where an actual increase in output has been accompanied by no decrease, but an appreciable increase, in the costs per unit, there is evidence that the result has been brought about by a temporary fall in the load-factor, due to extensions of plant more than compensating for the increased demand for current. Many examples, in fact, might be cited, of an increase in annual costs being brought about in the face of an increased output, purely on account of temporary over-extension of plant, and this effect is often noticeable even in the works costs, though it is of course more marked when the influence of increased capital outlay is taken into account. But, throughout his entire Paper, Mr. Hammond takes no notice whatever of *Capital*, and utterly ignores its influence on the annual costs and on the relative merits of different systems and existing undertakings—one of the most serious defects in the Paper. From the standpoint of his arbitrary "Order of Merit" it is immaterial whether an undertaking costs £10 or £10,000 per kilowatt in capital outlay.

It is impossible to arrive at an appraisement of the relative values of output and the load-factor on grounds so general as to be universally true. Where the capital outlay and the standing charges per kilowatt are comparatively low, it may be found that a large concern working with a low load-factor is paying better than a much smaller concern turning out a lower ontput at a considerably higher load-factor. But where the capital outlay and standing charges are high in proportion to the total capacity of the plant, satisfactory results can only be obtained—no matter how large or small the works—by running on a high load-factor. To ignore the influence of Capital, therefore, is to leave out of consideration the prime factor in the determination of the relative importance of the load factor and the total output, and to risk arriving at a conclusion diametrically opposite to the truth.

STORAGE BATTERIES.*

BY E. J. WADE.

(*Continued from page 593.*)

Thin Sheet Electrodes.

Planté's own electrodes were the first of this type. His original form, described in 1872, consisted of two long sheets of thin lead rolled up into a close spiral, with a layer of flannel between. He also tried parallel plates arranged as in a modern cell, with ebonite separators; but he finally returned to a spiral form, with strip separation. His plate electrodes consisted simply of a single sheet of flat unperforated lead. Brush mentioned the use of corrugated sheet in one of his earliest patents, filed in 1881, and he illustrated a sheet corrugated in two directions at right angles to each other, as shown in Fig. 71. De Kabath in the same year proposed to wind several thin sheets one upon the other round a thicker central plate, and also to corrugate the sheets; but he does not appear to have then made any provision for overcoming the screening effect that must necessarily be exerted by the outside sheet. In 1883, however, he modified this construction by making U or V-shaped cuts at intervals all over the sheets, and then rolled back the tongues thus formed to serve as spacing-pieces between the different layers, and to leave openings for the penetration of the electrolytic action to

* From a forthcoming book to be published by *The Electrician* Printing and Publishing Company (Limited).

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those innermost. Fig. 72 shows a portion of one of these sheets in elevation, and two cross-sections at right angles to each other.

Another patent of 1881 for sheet electrodes was that of Fitz-Gerald, Biggs and Beaumont. They minutely punctured thin sheets of lead by means of bundles of needles held in a reciprocating tool, and then united a number of them together by pressure, after first superficially sulphating their surfaces to prevent too complete adhesion.

In 1887, Main proposed an electrode constructed on somewhat the same lines. A number of thin sheets were riveted

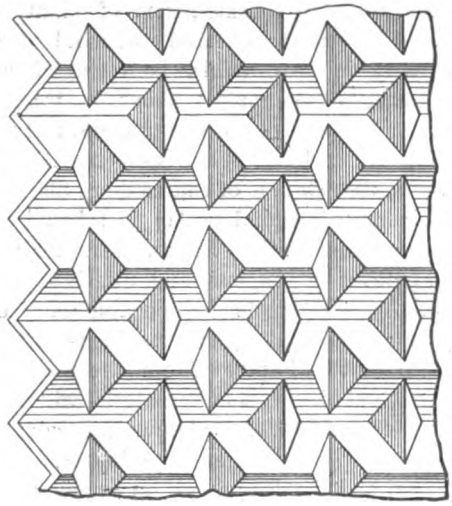

Fig. 71.

together to form a compound plate, and the whole mass then perforated transversely. The individual sheets could also be perforated before building up, and by having their surfaces roughened he considered sufficient space would be allowed between the sheets for the active material and penetration of the electrolyte.

In 1891, Elieson patented electrodes consisting of sheets of perforated corrugated lead wrapped one over the other; the corrugations running at right angles in adjacent sheets so as to keep their surfaces properly spaced apart. A feature of his earlier electrodes of this kind was their construction in the

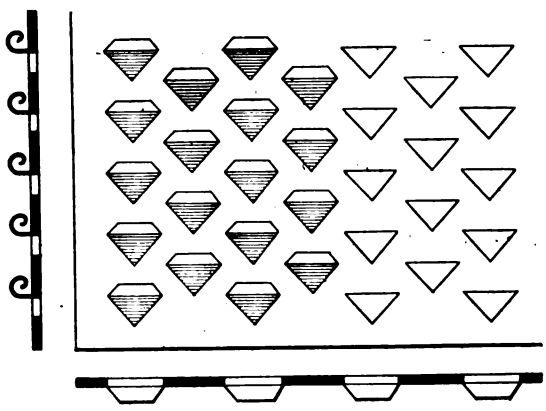

Fig. 72.

form of hollow cylinders or rectangles, but he afterwards conformed to the more usual practice and adapted the flat-plate type.

Crimped or Pleated Sheet Electrodes.

By pleating sheets into a series of narrow folds, concertina-fashion, instead of superimposing a number of layers, electrodes may be obtained which offer an equally large exposed surface for the same thickness, but without any screening effect being exerted between their various parts; and other advantages also result from this modification.

Both De Meritans and Brush constructed electrodes of this kind in 1881, but they are more closely identified with Reynier, who designed various forms on the same principle in 1883 and the following years, and studied their behaviour very thoroughly. In one form, a sheet of lead was folded twice upon itself to form three layers, and then pleated. The longitudinal edges of the outer sheets were split open nearly from top to bottom, in order to give access to both their sides and to the inner sheet, and finally the pleated block was attached to a main bar at one end. The formation of active material pushed the folds of the pleats somewhat apart at their free ends, causing the electrode to assume the appearance of a fan, and to overcome this trouble the pleated sheet was enclosed by a metal frame on all sides. Even this arrangement could not control the expansion, which exerted sufficient force to bulge out the sides of the frame; so, finally, a lozenge-shaped piece had to be cut out of the centre of the electrode (or rather out of the centre of the sheet before pleating), so that the expansion could be taken up internally and the strain on the frame relieved.

A form of pleated sheet electrode was patented by Timmis in 1894, but in this instance the sheet is first obliquely corrugated in order to keep the surfaces of adjacent folds of the pleats apart. In this way strips of sheet a few inches wide are made up into blocks the thickness of the required electrode, and then attached by one edge to a main connecting bar. This bar is situated vertically in the centre of the electrode, and has a block or series of blocks on either side of it, whose other ends are left free to allow for growth and expansion.

Strip Electrodes.

Strip or ribbon supports are used almost exclusively for Planté electrodes, of which type they furnish the largest number of modifications. The strips are mostly arranged either vertically, horizontally, or in flat spirals or spools.

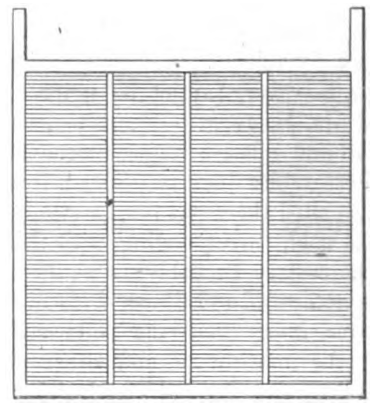

Fig. 73.

Tomassi, in 1881, described an electrode of the first kind, which is typical of numerous later varieties. A number of strips of lead foil were piled one upon the other, and then burned into a surrounding frame, their ends being turned in on themselves to provide spacing pieces between adjacent strips. Fig. 73 is a front view of this electrode with strengthening bars, to which the strips are also burned, crossing the plate vertically at intervals. In 1882, Barrier and Tournielle proposed to keep the strips apart with layers of platinised carbon, and in the same year Lane Fox suggested the use of layers of sand, asbestos paper, or other porous non-conducting material, while in 1887 Akester employed horse-hair for the same purpose. In all these electrodes the enclosing frame rigidly held both ends of the strips, and prevented their elongation when peroxidised, so that their inevitable and natural growth has to be taken up in the body of the plate, and tended to cause distortion and buckling. For this reason the complete frame is dispensed with in many electrodes, and the strips merely united together at one or both ends. In 1884 Jones constructed plates of piles of strips of a somewhat oval section, similar to that of a double convex lens, joining one end of a number of these piles into a vertical connecting plate, but leaving their other ends quite free. The strips rested in direct contact along the central

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plane of the plate, but, owing to their section, gradually opened further apart towards either surface.

In the same year Beeman proposed to divide solid plates up into horizontal strips by a series of parallel cross-cuts with a saw, leaving sufficient uncut metal at one edge to hold them together and form a main conducting bar. To prevent the strips dropping together by their own weight their free ends were burred over and thickened by pressure into projecting studs, which rested upon each other and maintained the spacing without interfering with the lengthways growth of the strips (*see* Fig. 74). The application of this method to perforated plates is shown in Fig. 75, a saw cut passing

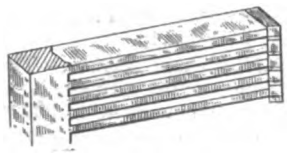

Fig. 74.

through the centre of each row of holes. Another alternative construction was to saw into the solid plate from both sides and leave the connecting bar in the middle instead of at one end.

According to an arrangement patented by Dorman in 1886, lead strips about $\frac{1}{32}$ in. thick were placed one upon the other with two or three small cross slips of some rigid insulating material between each to keep them apart, and the space between these slips then further filled in with glass wool, horsehair, or other suitable substance, so as to completely insulate and separate

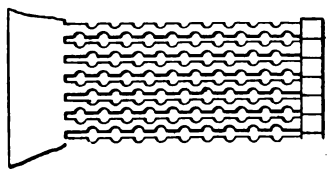

Fig. 75.

the strips from one another. The strips were connected alternately to one of two main bars at either end, so that in reality an interlocked positive and negative electrode was obtained in the form of a flat plate.

Vertical Strip Electrodes.

The first of these was patented by De Kabath in 1881. Strips of lead, alternatingly flat and corrugated, were packed side by side and surrounded by a strip of stouter metal bent into a rectangular frame, the whole being held together by

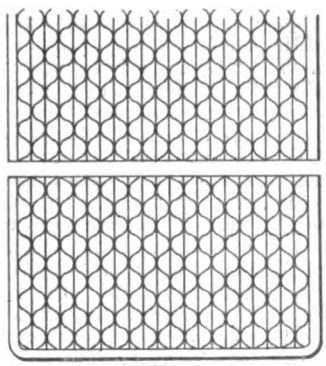

Fig. 76.

transverse rubber bands. This electrode, a portion of which is shown in Fig. 76, appears to have been a very impractical one both mechanically and electrically, for only the pressure between the strips and the frame was relied on to maintain the contact. It seems strange that a direct metallic connection was not established by burning or casting, as this would at once have put the electrode on a more satisfactory basis and anticipated some of the later constructions on the same lines.

De Kabath's other and better-known modification, in which the strips are enclosed in a perforated lead case, has already been referred to. Also in 1881, Carpentier and Pezzier proposed an electrode which promised much better results than De Kabath's plate, but as it was claimed to be an infringement of his patent it was never manufactured on a commercial scale. Narrow strips of lead were obliquely corrugated and folded double on themselves in long loops, so that the corrugations in adjacent layers crossed each other at an angle. A number of the loops were then packed side by side, and their free ends attached to a horizontal main bar leaving the loops hanging downwards.

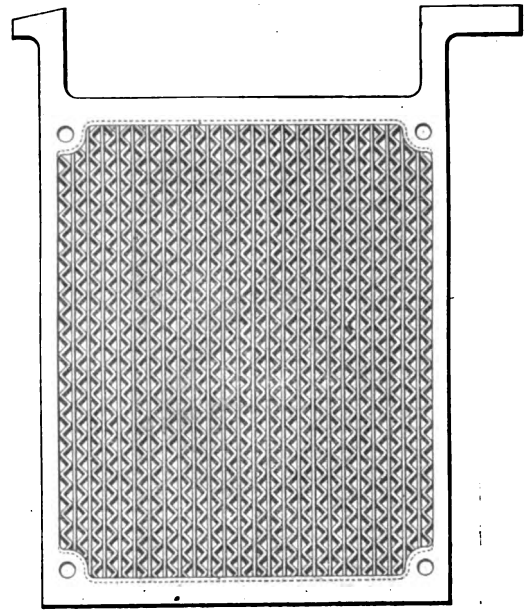

Fig. 77.

These two devices for spacing strips, by using them either alternately flat and corrugated or obliquely corrugated in opposite directions, have been introduced over and over again in electrodes which differ very little from the earlier forms. Of the former type, De Benardos' plate patented in 1887 is an example, but, unlike De Kabath's electrode, the strips have a solid lead frame cast all round them (*see* Fig. 77). Dugardin

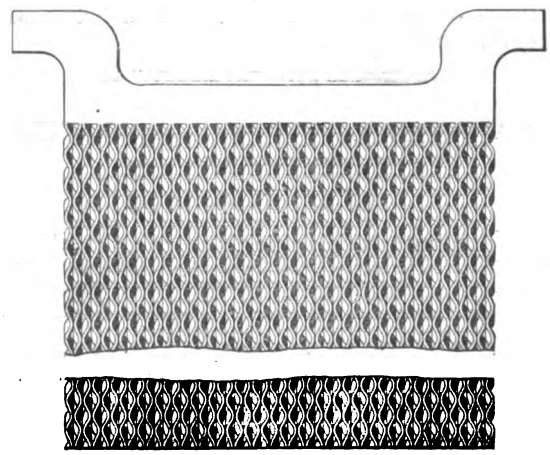

Fig. 78.

described a plate of the latter type in 1886. As an alternative to obliquely corrugating the strips they could be provided with projecting points at intervals to keep them apart, and in either case the whole of their surface was embossed with minute cells or indentations to afford a better hold for the active material. The strips were united to horizontal bars both top and bottom, but these were not rigidly connected in any way so that the plate could lengthen unimpeded. Fig. 78 shows an electrode proposed by Paget in 1888 which is almost identical in construction with Dugardin's.

(*To be continued.*)

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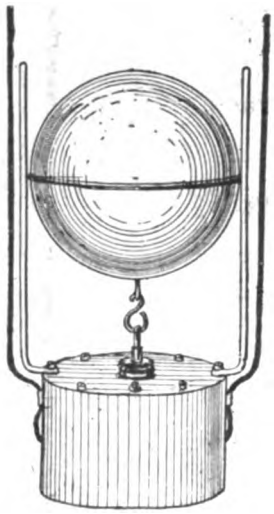
DELMARD'S WATER-LEVEL INDICATOR.

A simple form of electrical water-level indicator for domestic use has been sent us for inspection by the Delmard Water-Level Indicator Syndicate. The apparatus (shown in the accompanying figure) consists of a copper ball hooked to a brass plunger, the latter forming one element of a contact-maker in a cast-iron box. The joint between the plunger and the box is kept water-tight by means of a rubber sleeve, and there is rubber packing between the cover and the box. The contact-maker forms part of a bell circuit. The apparatus is intended to be placed at the bottom of the cistern, and when the water sinks below the level of the ball, the latter sinks down and causes the plunger to close the bell circuit. By having a number of these apparatus at different levels in the cistern, and connecting them through a battery to an ordinary bell-indicator, an indication of the height of the water can always be obtained. The efficient working of the apparatus must depend on the cast-iron box remaining water-tight, for if water percolates through one of the joints, corrosion will cause the contact-maker to be uncertain in its action. We think that more precautions should have been taken in the construction to ensure immunity from this danger, especially at the points where the rubber-



Delmard's Water-Level Indicator.

covered wires are led into the box. If this defect were remedied this type of water-level indicator would have a considerable advantage over one worked by a float or by the ball-valve on the surface of the cistern, as it would naturally be uninfluenced by the surface of the water freezing.

HIGH-SPEED SELF-LUBRICATING STEAM ENGINES.*

BY ALFRED MORCOM.

The subject of high-speed engines is one of such real importance and interest that it may be useful and appropriate on the occasion of the present meeting to give some account of the part taken in their development by the writer's firm, Messrs. G. E. Belliss and Co., of Birmingham.

After their 30 years' experience with high-speed engines, it was natural for the writer's firm to come into the field with this kind of engine for supplying electric light and power. Some preliminary work showed clearly that open engines were not in a position, without further development, to compete with the Willans engines so largely used in central electric stations. These engines are excellent in design and manufacture, and the single-acting cylinders and inclosed plan of lubrication render them quiet running and easy to look after in the station. Their special claims in regard to economical performance had also to be taken into consideration. It was finally decided to combine a double-acting engine of ordinary construction, with a system of forced lubrication, supplying oil under pressure to every bearing; and to inclose all the working parts, in order to prevent splash from the abundant oil supply, and in order to keep out dirt. In the first instance a small single-cylinder engine was put in hand, and the expectations formed were more than realised by its performance. It was found, as had been anticipated, that the oil under pressure enabled the working parts, even when slack, to work without noise, and that after some months' constant working at a load considerably higher than the ordinary full load for this size of engine the bearings had not worn perceptibly. A two-cylinder compound engine indicating 300 H.P. was then completed for driving a dynamo at Messrs. Siemens' Charlton Works. After this engine had been at work continuously for four years, doing the full load required for the supply of electric power, it was opened out, and the working parts, which had not been adjusted during this period, were found practically unworn. These and other experiences gained during the same period proved that the plan of forced lubrication served most satisfactorily all the purposes of quiet and efficient running at high speed, and during the last year or two many hundreds of these engines have been turned out, from smallest size up to 500 H.P. The increasing demand for still larger engines has led to the recent erection by the author's firm of new works for building engines of this kind up to any power that may be required.

Standard Make of High-Speed Engines.—The small sizes up to about 15 H.P. are all single-crank, with single or tandem compound cylinders. The smaller compounds up to 300 H.P. are of the two-cylinder "Crescent" type, as shown in Fig. 1. The cranks are opposite, and a single eccentric actuates the slide valves. The oil pump is an oscillating one, worked off the eccentric, and its oscillation performs the necessary valve action on a surface at the bottom of the pump. The pumps are therefore most simple, without either valves or packing to get out of order. The engine is indeed throughout as simple in every detail as it is possible to make it. The oil is usually drawn from the bottom of the engine casing, through strainers which can be easily removed, into pipes leading to all the bearings; but occasionally, as at Bedford, at the Charing Cross and Strand Electricity Supply Station, at Leeds, and at other places a complete series of reservoir tanks has been fitted, supplied by separate and independent pumps. Pure mineral oil is used at a pressure of about 15lb. per square inch. These two-crank engines are made triple-expansion when necessary by adding two single-acting high-pressure cylinders, tandem with the other two; and this forms one of the simplest and most effective designs that can be devised for high-speed triple-expansion engines. Formerly the engines were fitted with outside glands only where they were used with condensers on board ship; but recently this design has been adopted throughout, in order to keep the patterns constant, and also to prevent the trouble which water from the glands causes with some kinds of oil. The oil question becomes of serious importance in central electric stations fitted with condensers, especially where water-tube boilers are used.

Vibration.—For large central stations situated in densely populated neighbourhoods the design of the steam engine employed has been determined largely by the single question of vibration. The amount of vibration which will cause a nuisance is small; and several London electric stations have incurred serious losses on account of vibrations, which at the engines themselves seem inconsiderable. Having had to approach the subject of vibration in high-speed engines for land and marine purposes simultaneously, the writer was at first led astray by assuming an equality in the conditions, which really did not exist. The vibrations in the engines themselves may be classed as follows:—first, those due to vertical changes in the position of the centre of gravity of the moving parts; second, those due to couples produced by the changing momentum in the several lines of moving parts; and third, those due to the obliquity of the connecting-rod producing retardation and acceleration of the moving parts in each line, which occur twice in each revolution. The "Crescent" engine, with cranks opposite, Fig. 1, is practically balanced against the first class of vibrations; but it has a big couple, and also vibrations of the third class. Engines with three cranks at equal angles, Fig. 4, are practically balanced as regards the first and third classes, but have large couples. The conclusion therefore was hastily drawn that engines for land purposes could be similarly dealt with; and an engine was built which was absolutely balanced as far as the first and second classes of vibrations were concerned, but experience showed that buildings took up the higher speed vibrations forming the third class; and it was finally found necessary to fit a return connecting-rod to one line of cylinders, in order to obliterate these vibrations. This expedient gave both in theory and on trial a perfect non-vibrating engine in the station. Three-cylinder engines, however, with equal-angle cranks in which the third class of vibrations were practically obliterated, were working in central stations without difficulty from vibration; and further investigation led to the conclusion that buildings respond to the quicker vibrations, but are practically indifferent to the heavy but slower vibrating couples which give such trouble in ships. The three-cylinder engine with equal-angle cranks has consequently been adopted as the standard above 200 H.P. for central stations in densely populated districts. Similar engines are also used where a uniform turning effort is especially required; though this object can of course be attained to any desired extent in other kinds of engines also, by providing a sufficiently heavy flywheel.

* Abstract of a Paper read before the Institution of Mechanical Engineers.

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Advantages of Forced Lubrication.—For all kinds of engines the plan of forced lubrication gives the same advantages: namely, automatic lubrication, noiselessness, economy and freedom from wear. This is due to the working surfaces being kept apart by the film of oil forced between them. Although generally the pressure per square inch on the bearing itself is far in excess of the oil pressure used, yet the relaxation of pressure on the return stroke in a double-acting engine permits the oil at these times to be driven between the metal surfaces, and during the fraction of a second occupied by the acting stroke the film of oil cannot be squeezed out. This might indeed be readily taken for granted, and is clearly proved by the absence of wear in the large number of engines lready built. It is at least obvious that the oil is in the best position to take advantage of the momentary relaxation of pressure between the surfaces if it is itself under a pressure sufficient to push it in between the brass and the journal, so as to flood the bearing completely. If the oil is supplied by gravity alone, under the head usually given in double-acting engines, there is not sufficient time for permitting it to penetrate to any distance. In a single-acting engine under constant thrust no such film is possible. In both the latter cases the journal will, of course, be greased; but if friction and consequent wear of the journal are to be absolutely prevented such a film of oil as the forced lubrication provides between the journal and brass is essential. The better the body of the oil the less chance will there be of effective lubrication without adequate oil pressure. To show how the oil film should affect the economy, reference may be made to a Paper by Prof. Robert H. Thurston, published in *Engineering* (January 18, 1889, p. 69), in which the friction in an engine with balanced slide valve is subdivided as follows: main bearings 47·0 per cent., piston and rod 32·9, crank pin 6·8, cross head and wrist pin 5·4, valve and rod 2·5, and eccentric strap 5·3 per cent. The friction of piston and rod here probably includes that of the guides, which are lubricated under pressure in the engines now described; and in addition to this it will be seen that the journal friction, which can be reduced by oil under pressure, amounts to nearly 65 per cent. of the whole. When it is borne in mind that in an ordinary engine, working at one-quarter of its full power, about 50 per cent. of the power developed is wasted in

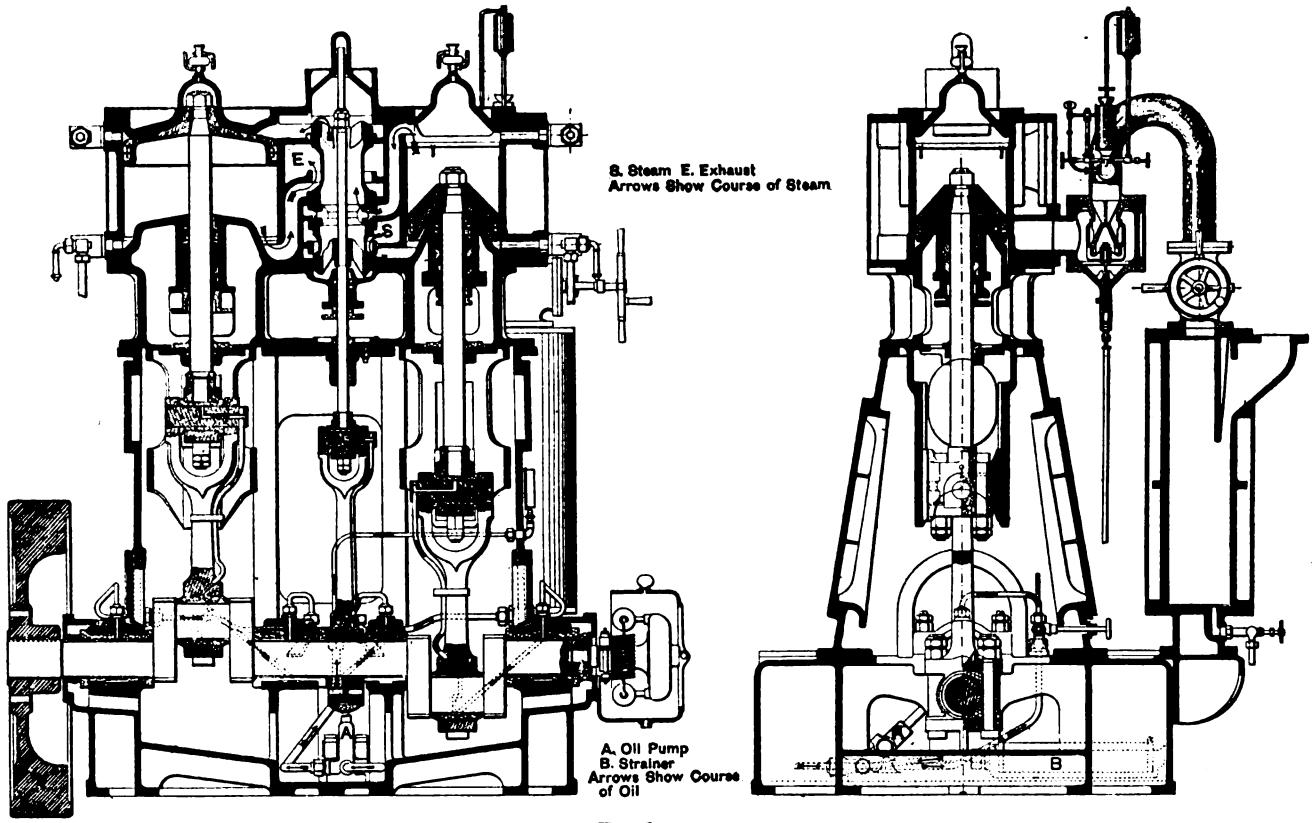

FIG. 1.

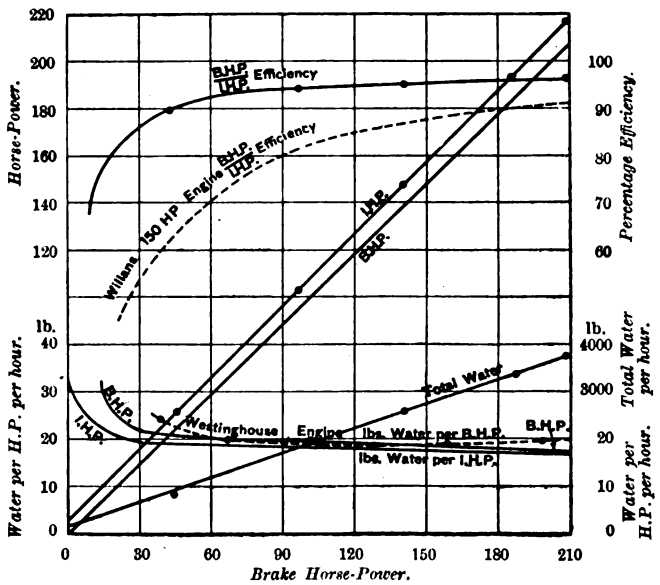

FIG. 2.—Belliss 200 H.P. High-Speed Self-Lubricating Engine (Condensing) Sunderland Electric Supply Engine.

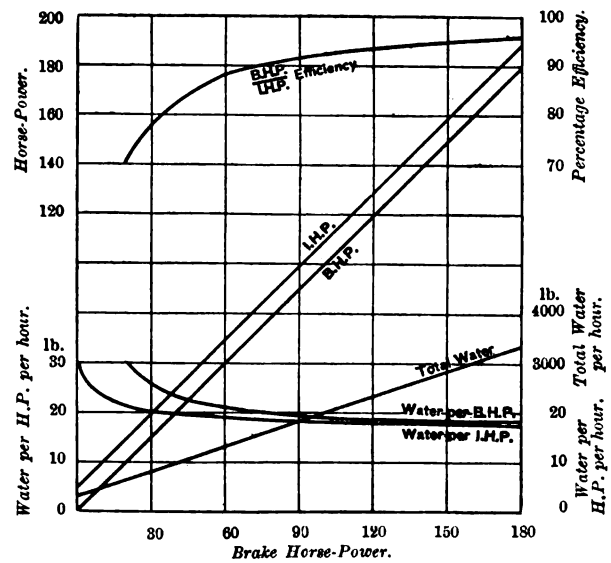

FIG. 3.—Belliss 200 H.P. High-Speed Self-Lubricating Engine (Condensing). Cheltenham Electric Light Engine.

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Table I.—*Trials of Belliss 200-H.P. High-Speed Self-Lubricating Engines, Condensing.*
Cylinders 12¼in. and 20in. diameter, with 9in. stroke.

Station	Sunderland Electric Supply Engine, tested by Prof. Kennedy.					Cheltenham Electric Light Engine, tested subsequently.				
Load	Maximum.	Normal full.	Three-quarters.	Half.	One-quarter.	Maximum.	Normal full.	Three-quarters.	Half	One-quarter
Mean effective pressure per square inch reduced to low-pressure cylinder ..... lb.	42·3	37·6	28·6	20·0	9·7	...	36·1	...	20·6	10·4
Mean revolutions per minute ..... revs.	364·6	365·0	364·5	363·9	363·8	...	365·5	...	361·0	361·5
Mean indicated horse-power ..... I.H.P.	217·5	193·6	147·1	102·7	49·8	..	185·7	...	104·8	53·1
Mean brake horse-power ..... B.H.P.	209·5	186·0	140·6	97·0	44·5	...	176·8	...	97·4	44·2
Mechanical efficiency $\frac{B.H.P.}{I.H.P.}$ ..... per cent.	96·3	96·1	95·2	94·4	89·3	...	95·2	...	93·0	83·2
Water per hour, total ..... lb.	3772	3383	2628	1920	888·5	...	3301	...	1939	987·9
„ „ „ per B.H.P. ..... lb.	18·0	18·2	18·7	19·8	20·0	...	18·6	...	19·9	22·3
	Coupled to Continuous-Current Dynamo.					Coupled to Alternator.				
Mean effective pressure per square inch reduced to low-pressure cylinder ..... lb.	36·0	24·2	19·2	10·5	2·2	...	28·4	23·0	...	...
Mean revolutions per minute ..... revs.	367·6	365·3	362·6	365·2	364·8	...	350·2	351·0	...	...
Mean indicated horse-power ..... I.H.P.	186·7	129·4	98·2	54·1	11·6	...	144·8	114·4	...	...
Mean electric horse-power ..... E.H.P.	168·6	115·1	83·8	40·9	...	...	126·8	98·5	..	...
Combined efficiency $\frac{E.H.P.}{I.H.P.}$ ..... per cent.	90·3	88·9	85·3	75·6	..	...	87·5	86·1	...	...

friction, it is clear that the effect on the economy by the reduction of journal friction should prove considerable at low loads; and with these double-acting self-lubricating engines, as compared with single-acting engines, it is certain that this is so. It was first pointed out by Mr. Alexander Siemens in a Paper read before the North of England Institute of Mining Engineers (November 24, 1894, p. 212), in which he compared the results of the first Belliss 300 H.P. self-lubricating engine with a Willans engine of similar power, the

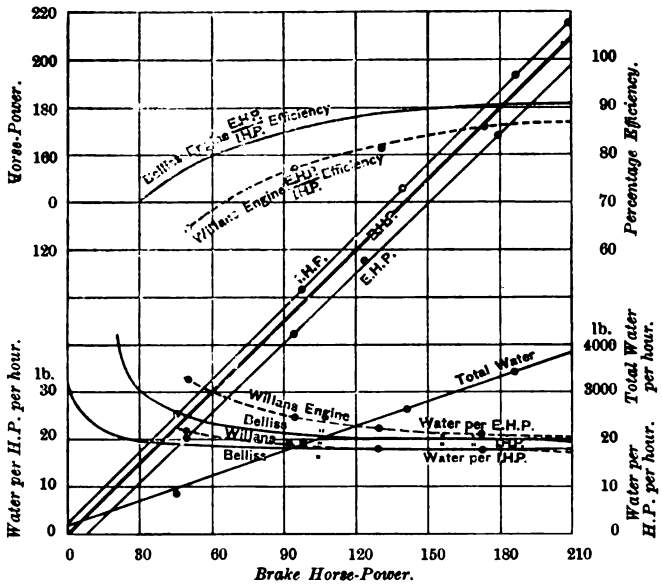

FIG. 4.—Belliss 200 H.P. High-Speed Self-Lubricating Engine (Condensing). Sunderland Electric Supply Engine. Coupled to Continuous-Current Dynamo.

two working alongside eace other at his Charlton Works; his results showed that the gain due to the diminished friction increased considerably as the loads were reduced.

In dealing with high-speed engines it is impossible to avoid referring to the admirable work which has been done by Messrs. Willans and Robinson in determining the conditions for economical working under various circumstances. Their trials, however, were made with single-acting engines; and although the results in general will apply to any engine, the reduction of friction in the double-acting self-lubricating engine should qualify them to some extent in detail. If the lubrication is accomplishing the purpose for which it is intended, the efficiency of the engine provided with forced lubrication ought to stand out high; and that this is so for all loads has been proved by results from some hundreds of engines. By the courtesy of Prof. Kennedy the author is enabled to give in Table 4 the results of a trial made by him of one of these engines, supplied to the Sunderland Corporation Electric Supply Station, which will serve as an example. Here the engine efficiency at maximum load, it will be noted, works out at 96·3 per cent. The results are also plotted as a diagram in Fig. 2. The following comment upon the figures in the Sunderland tests was added by Prof. Kennedy: "The most singular point about them is the extraordinary high brake efficiency of the engine, which is altogether much higher than anything I have previously found. I do not know the special cause of this. I have been extremely suspicious of the figures, and have had everything checked repeatedly. The different figures taken at different periods are quite consistent with each other, and there is nothing in the records to suggest error, except the figures themselves. I can only place these on record, without saying more about them." There is no doubt that the efficiency is remarkably high; but the conditions, as already pointed out, all tend in this direction, and similar results have been proved over and over again with the self-lubricating engines tested at the author's works. In order, however, to establish the results obtained by Prof. Kennedy, a further trial was conducted with a similar engine made for the Cheltenham electric light station from the same drawing as that at Sunderland; and it will be seen that the results given in Table I, and plotted in Fig. 3, entirely bear out those of the other trials. The high efficiency that can thus be obtained makes itself felt in the economical working of the engine; and as it is due to an absence of friction, a far greater saving will probably arise from the diminished necessity for adjustment and repair on account of wear. In the writer's opinion there is too much difficulty in obtaining the necessary accuracy in indicating a high-speed engine to render efficiency alone a useful standard of comparison. The consumption of steam for work done is what the customer looks at; and results given per indicated horse-power, which take no account of the heavy losses through friction, are useless in comparing engines of different kinds. It will be seen from Fig. 4, giving the curves of the combined efficiency and consumption in the subsequent tests of the Sunderland engine coupled to a continuous-current dynamo, that the previous brake tests are fully borne out. These subsequent tests were made immediately after the others, in the presence of Prof. Kennedy and Mr. Snell, the electrical engineer to the Sunderland Corporation. The results throughout are undoubtedly good; and for the sake of comparison curves have been added showing the consumption and efficiency of a Willans engine of about the same power combined with a Holmes dynamo, in a trial made by Prof. Kennedy and reported in *Engineering*, June 2, 1893, page 783.

Governing.—Amongst the many admirable Papers emanating from Messrs. Willans and Robinson on the subject of high-speed engines is a recent Paper read to this Institution by Capt. Sankey (*Proceedings* 1895, p. 154), in which governing by expansion valve is compared with ordinary governing by throttle valve. This important contribution to the subject is chiefly remarkable for the tendency of the results presented to displace the expansion valve governor from the high position it has hitherto held as an economical appendage for reducing power. The disadvantages due to the higher initial pressure with consequent leakage, the frictional loss due to compression, and the increased losses due to liquefaction, are clearly pointed out; and the resulting efficiencies of the two modes of governing, especially when determined by work done and not by indicated horse-power, are shown to be not greatly in favour of the expansion-valve governor. Expansion gear of this sort is also far more liable to wear; and a small amount of wear, or of wrong adjustment after repair, might lead to a steam distribution yielding at low loads considerably worse economy than that obtained in the official trial at the works. As in the case of economical results, the comparative efficiency of the two methods of governing will also depend in detail somewhat on the kind of engine; and for this

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reason the trials that have been made by the author for determining the value of the two kinds of governor with the self-lubricating engine may be of interest. The results given by Capt. Sankey are also based entirely on the indicated horse-power; but as the output of the engine is largely modified by frictional and other losses due to the action of the governor itself, the indicated horse-power results are of little practical value. The circumstance that the "Crescent" engine, Fig. 1, is arranged with both the valves driven by a single eccentric naturally led in the direction of expansion governing, owing to the ability of this governor to act simultaneously on both high and low-pressure valves. Trials made in 1891 with a number of sets of dynamo machinery of about 80 H.P., constructed by the writer's firm for the Cunard steamships "Campania" and "Lucania," gave excellent results as far as governing went; but at low powers the results in respect of economy and efficiency were by no means as good as anticipated; and although in consequence of its effective action the use of the governor was continued, the poor economical results led to special trials being made further on for determining this point more exactly. So far as the governing itself is concerned, since the above machinery was built, the throttle governor with ordinary flywheel has been made by the reduction of friction to give exceedingly steady results, with a permanent variation of only 2 to 3 per cent., and a momentary run up to about 10 or 12 per cent., when all the load was suddenly thrown off. With the ordinary flywheel it is not possible to get much finer governing without introducing a tendency to hunt. The effect of a large flywheel permits the fitting of a much more sensitive governor; and with a flywheel of suitable dimensions governing by throttle can be made as fine and steady as may be required. Alternators of ordinary design have, of course, in themselves quite enough flywheel effect for enabling the usual engine flywheel to be dispensed with; and with these there is no difficulty in keeping the run up below 5 per cent., with permanent variation of 2 per cent. The reputation of the expansion-valve governor has been much increased by the value set upon it in the United States, where it is almost universally used; but this fact is largely qualified by a consideration of the high flywheel effects employed in conjunction with the governor in order to obtain the maximum results. The following Table II. gives a few typical examples for enabling a comparison of these flywheel effects to be made for various services. For the Waterloo and City Railway, where it is desired to light the trains steadily direct from the motor currents, a flywheel of about 5½ tons has been fitted on each of 300 H.P. sets in order to obtain the required results, namely permanent variation not exceeding 1¼ per cent. and momentary not exceeding 2½ per cent. when all the load is suddenly removed. As far as governing is concerned, therefore, it may be allowed that the advantage, if any, is on the side of the throttle-valve governor, because it is equally powerful in governing, far less liable to derangement and wear, and much easier to adjust.

Table II.—*Energy stored in flywheel and revolving parts of dynamo per electric horse-power at full load, for various services.*

	Foot-tons.
Ordinary high-speed engines for electric lighting with continuous-current dynamos	0·2 to 0·3
Ditto, with heavy alternator	1·5 to 3·5
Electric traction, Continental example	2·0
" " Montreal Street Railway	4·0
" " Brooklyn Electric Tramway	4·7

In respect of economy, the matter will naturally be looked at from two points of view:—firstly, for electric lighting and electric power supply, where the maximum economy is required at about full load; and secondly, for electric traction, where the normal load will probably be a much smaller fraction of the full load than in electric lighting. For electric lighting and power supply, there is no question in the author's mind as to the superior efficiency of the throttle-valve governor. For electric traction, his experiments seem to show that with the double-acting self-lubricating engine there is little if any benefit to be derived from the expansion-valve governor; and this benefit will probably be neutralised by the mechanical difficulties, which the extra wear on the expansion governor will subsequently entail. To determine this point a number of experiments have been made, of which the results are shown in Table III. and in the curves in Fig. 5. These trials were made with a self-lubricating engine of 250 H.P., fitted with an expansion governor actuating an eccentric common to both valves. The dotted curves show the results with the expansion governor, and the continuous curves the results from the same engine when governed by the throttle-valve. It will be noticed that, whilst the expansion-valve governor has a slight advantage when indicated horse-power is considered, the advantage is all on the side of the throttle valve when the output or electric horse-power is considered; and this of course is the only matter of importance in practice.

From all the diagrams it will be seen that the characteristic curve of water consumption for the Belliss engine is more horizontal than those for single-acting engines. This is due, as already pointed out, to the action of the forced lubrication in reducing the amount of friction, and consequently the amount of steam used per brake horse-power. In order to elucidate this point more fully, there is

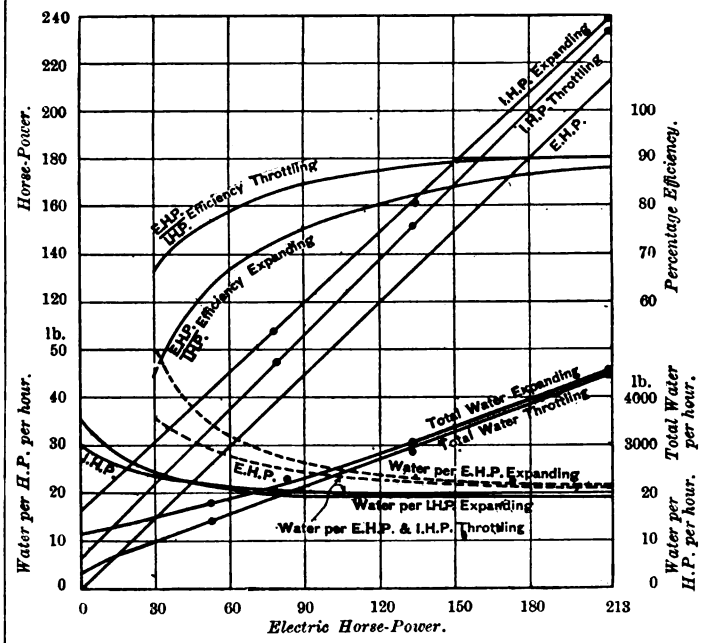

FIG. 5.—Efficiency and Consumption Curves of Steam-Dynamos at Sunderland.

added in Fig. 2 for comparison with Sunderland, as shown by the dotted lines, the comsumption per brake horse-power for a Westinghouse engine of about the same power, fitted with an expansion-valve governor, for which the data are taken from the *Proceedings* of the Institution of Civil Engineers, Vol. CXIV., p. 68. It will again be seen that, while with the expansion governor in the Westinghouse engine the result at half load is better than at full load, it is not better than the result obtained at half load with the throttle governor in the Belliss engine, which has moreover a decided advantage at full and low loads.

For the sake of further comparison another curve has also been added to Fig. 2, showing the efficiency of the Willans 150 H.P. engine, reported in the same volume of the Civil Engineers, pp. 89-90.

Table III.—*Comparative Trials of Belliss 250-H.P. High-Speed Self-Lubricating Engine, Condensing, when governing by Expanding and by Throttling.*

Cylinders 12in. and 20in. diameter, with 10in. stroke. Boiler pressure 150lb. per square inch above atmosphere.

Governing by Expansion Governor or by Throttling.	Expanding. Expansion Governor *in* action.				Throttling. Expansion Governor *out of* action.			
Load	Full.	Five-eighths.	One-third.	One-quarter.	Full.	Five-eighths.	One-third.	One-quarter.
Mean effective pressure per square inch reduced to low-pressure cylinder..lb.	41·0	27·0	16·4	12·4	40·1	25·9	15·7	10·9
Mean revolutions per minute ..... revs.	370	373	380	380	370	370	380	382
Mean indicated horse-power ..... I.H.P.	240·9	161·0	99·0	75·3	235·4	152·2	95·0	66·2
Mean electric horse-power ..... E.H.P.	213·0	132·8	77·8	53·0	213·0	132·2	77·8	53·0
Combined efficiency $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ ..... per cent.	88·3	82·4	78·5	70·3	90·4	86·8	81·9	80·0
Water per hour, total ..... lb.	4,579	3,041	2,209	1,818	4,473	2,871	1,992	1,505
" " " per E.H.P. ..... lb.	21·5	22·9	28·5	34·3	21·0	21·7	25·6	28·4

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PHYSICAL SOCIETY.

At the ordinary meeting of the Physical Society on Friday last, Mr. Shelford Bidwell, President, in the chair, Mr. A. A. Campbell Swinton read a Paper and showed experiments upon "The Circulation of Gaseous Matter in a Crookes Tube." The stream-lines within a Crookes tube are investigated by observing the direction and speed of rotation of a mica radiometer-mill, mounted on a sliding rod, so that it can be moved along a line at right-angles to the line joining the electrodes. The axis of the mill is at right-angles to both these lines. If the mill is adjusted to a position between the flat-plate and the cup electrodes, with its axis just sufficiently low to prevent equal and opposite actions or simultaneous actions on the top and bottom vanes, it rotates, always in the direction indicating a stream from cathode to anode. The speed is greater when the flat-plate is the cathode. If, however, the mill is now moved below this line, a point is reached at which rotation ceases, and below this neutral point the rotation is suddenly reversed. Reversal is only to be observed with high degrees of exhaustion; the rotation is never so rapid here as in the first position. The mill rotates, and the reversal may be observed, whether cup or plate is made cathode, and the direction of rotation below the neutral point is always opposite to that in the position above it. A small Wimshurst machine is as effective as an induction coil in producing these effects. The experiments are intended to establish the existence, at high degrees of exhaustion, of a true anode-stream, *i.e.*, a stream that travels from anode to cathode just in the same manner as the cathode-stream flows from cathode to anode. This anode-stream is charged positively; it is exterior to the cathode-stream; its velocity is less than that of the cathode-stream, but its velocity increases as the vacuum is improved. It seems probable that, at high vacua, some portion of the positive electricity passing through the tube is carried by the positively-charged atoms or particles that constitute the anode-stream. At lower degrees of exhaustion, the discharge passes through the tube chiefly by interchange of charges from molecule to molecule—a Grotthüs chain. At very high vacua, however, when the mean free path is considerable, there may be to some extent a regular and complete circulation of positive and negative atoms, some of which pass from anode to cathode and *vice versâ*, and deliver up their charges, not by interchange, but by direct convection, to the electrodes of opposite sign.

Prof. BOYS said he did not feel altogether convinced by the experiments that the rotation of the mill was due to simple mechanical motion of the particles of matter between the electrodes. The weight of air left in the tube at such high degrees of exhaustion was extremely small; it was difficult to realise that its impact could produce the sudden mechanical effect observed at the moment of the reversal of the rotation of the mill.

Mr. WIMSHURST thought it important to keep in mind the existence of mercury-vapour in the tube. He also referred to some experiments in which a bar of metal was used to explore a focus-tube, by observation of the changes of luminosity produced in different positions.

Dr. CHREE said that if the rotations of the mill could be shown to indicate a velocity of the particles of the same order as that observed in Crookes' experiments, it was safe to assume the existence of a similar cause. This might be important in deciding as to the general truth of the bombardment theory of Crookes. He asked whether the rotation had been investigated within the dark space around the cathode.

Mr. APPLEYARD suggested that in tracing the cause of the rotation it would lead to simpler results if the vanes of the mill were made of some light conducting substance. Mica introduced difficulties owing to its retention of the charges.

Prof. BOYS pointed out that this could be done by gilding the mica.

Mr. CAMPBELL SWINTON, in reply, said that the objection raised by Prof. Boys to the mechanical theory of the rotation would apply equally to the whole theory of electro-radiometry, including the case of the mill used originally by Crookes in the direct path of the cathode-stream. But it must be remembered that, although the mass of matter present within the tube was very small its velocity was proportionately great—it was of the order of 9,000 kilometers per second; hence the contained matter might be conceived as capable of producing the observed acceleration, and Crookes' bombardment theory might with safety be adopted as a safe working hypothesis. In the tubes used for these experiments the exhaustion was carried so high that the negative dark space appeared to fill the whole tube. He had, so far, only tried mica for the vanes, but he thought it would be important to observe the result with a substance that did not retain the charges.

Mr. A. STANSFIELD then read a Paper on

"Thermo-Electric Pyrometers."

In obtaining photographic records of the readings of thermo-electric pyrometers the range of measurement is limited by the size of the photographic plate. For long ranges of temperature the sensitiveness of the galvanometer must therefore be small. When it is desired to examine the temperature changes in detail, as, for instance, at the melting-points and freezing-points of metals, it is necessary to employ some device for giving a more open scale for the short temperature ranges that include those particular points. For this purpose two galvanometers are arranged in parallel, and so that they have their deflections recorded on the same photographic plate. The less sensitive galvanometer covers the entire range of temperature throughout an observation; the other is brought into use for magnifying special portions of the range. In this latter case part of the electromotive force of the thermo-couple is compensated by an opposing electromotive force, applied at two points of the circuit, from a battery of Clark cells in series with a high resistance. The recording apparatus consists of a photographic plate mounted on a float that rises steadily when water is admitted into a cylinder. The source of light is a glow-lamp, enclosed in a wooden box. A brass tube, with a rectangular diaphragm at the end nearest the lamp, cuts off all light except that from a selected piece of vertical filament. Light from this filament is reflected by the plane galvanometer-mirror, and is focussed upon the photographic plate by a lens in front of the galvanometer; this method was suggested by Prof. Boys. The "cold" junctions of the thermo-couple are both inserted into a hypsometer. Very serious discrepancies exist between the indications of couples having nominally the same composition; they are too great to be attributed to accidental differences in the constitution of the alloys. Although with platinum alloys, coupled with platinum, 10 per cent. of iridium gives a more powerful couple than 10 per cent. of pure rhodium, the partial substitution of iridium for rhodium very considerably lowers its thermo-electric power. This result suggests that the change in the thermo-electric power of a metal depends upon the extent to which it is saturated with the alloying metal; thus 10 per cent. either of rhodium or iridium would, *per se*, more completely saturate the platinum than would 10 per cent. of a mixture of the two metals. The author discusses a series of curves derived from his experiments. He concludes that, thermo-electrically, there may be two classes of metals, (1) the ordinary metals, for which the curve representing the first differential of electro-motive force with respect to temperature is a straight line, and (2) the platinum metals, together with a few such as nickel and cobalt, for which the curve of that differential multiplied by the absolute temperature is a straight line.

Dr. CHREE discussed the curves, and asked how far stirring affected the results; he was inclined to think that stirring was a mistake.

Mr. A. CAMPBELL inquired whether the galvanometer kept its zero sufficiently well throughout the tests.

Mr. STANSFIELD, in reply, said he had also come to the conclusion that stirring was a mistake; and it was a mistake to use a large quantity of metal. The pyrometers were sensitive to about a tenth of a centigrade degree. He had experienced great difficulty with the zero of the galvanometer.

The President prop sed votes of thanks to the authors, and the meeting adjourned until April 22nd.

THE BROOKLYN BRIDGE TROLLEY LINE.*

The construction of tracts and the operation of the Brooklyn electric surface cars across the great suspension bridge presented a number of difficulties, and required some interesting novelties of design and method. The roadway of the bridge consists of two approaches, which are paved with granite blocks laid on a substratum of concrete, and the bridge section proper, which is floored with 4in. timbers laid on other timbers, the two layers crossing at right angles and being carried upon I-beams supported from the main cables. The track construction on the approaches is the standard "Brooklyn Heights" construction, using a 98½lb. 9in. grooved girder rail, laid upon a concrete foundation, and tied together by 3in. iron straps. No cross ties are used, as the flanges of the rails approach to within 1in. of the top of the arches of the large vaults under the roadways. On the floored roadways of the bridge proper, however, a very different style of construction was rendered necessary by the exigencies of vehicle traffic, which required that the tracks should be flush with the roadway and present the least possible obstacle to the wheels of wagons, &c. The rails here are of a peculiar section, practically rectangular, with a groove in the upper surface for the wheel flanges and another groove at one side for the reception of a continuous bonding cable. These rails weigh 93lb. per yard. They are sunk through the upper planking of the bridge, and are secured to the timbers of the lower tier by countersunk bolts, which pass through the rails at their grooved parts. At the joints the rail ends are bevelled off at an angle of 45deg., and are secured by two bolts in each to a sole plate, 8in. by 24in., which is in turn bolted to the lower timbers of the bridge flooring.

Bonding is effected by a continuous copper cable of 175,000 circular mils section laid in the side groove of the rail. Near each rail end a copper strip is brazed to the rail and its ends wrapped over the cable and soldered to it. At the rail joints the cable is led out of its slot and looped around the outer edge of the sole plate. The overhead construction is of the most remarkable solidity. The

* Abstract of an article in the *Electrical World*, of New York, Feb. 5, 1898.

trolley wire of "figure eight" cross section is supported on flexible pole brackets, spaced only 37ft. 6in. apart. On the approaches it was necessary to mount the iron poles carrying these brackets on the top of a low brick wall separating the roadway from the cable car trucks. The pole is set in a cast-iron base, which is mounted upon the coping of the wall and secured by four long bolts to an iron plate extending through the wall about 2ft. below the coping. On the bridge structure proper the brackets are attached to short poles set in similar cast bases, which are bolted directly to the iron-work of each fifth member of the bridge trusses. At the three expansion joints in the three spans of the bridge the tracks are scarfed, a few feet of flexible cable spanning the joint. The trolley wire is carried across the expansion joints by two bronze links, which slide upon one another, a loop of flexible cable taking the greater part of the current. The feeder cables are eight in number, each of 500,000 circular mils, and are carried on heavy glass insulators mounted on small brackets inside the through trusses in which the cable cars run. Seven of these cables are positive feeders, while one of them acts in conjunction with the rails and rail cables as a return feeder.

At the New York end of the bridge at the street level there are four cross-over tracks, so that cars of the different lines that will use the bridge may be distributed properly. The switches from the west-bound track on the north side of the bridge will be electrically controlled from a signal and switchbox mounted under the western end of the huge plate girder which spans the four ingoing loop tracks and sustains the superstructure of the terminus. It is interesting to note that this girder and its companion at the opposite side of the station are among the largest of their kind in use, being 5ft. deep and 98ft. long. The mechanism for controlling the switches and signals will be very ingenious. The track switches will be electrically controlled by interlocking electric switches in the signal box. At the western terminus of the roadway, just before the straight track divides into its four cross-over branches, will be mounted a signal consisting of four transparent numbers, illuminated by 32 c.p. lamps to designate to the motorman which cross-over he is to take, and three lights, red, green and white. The red light will be normally shown and the numbers normally dark. When the proper switches have been set for an approaching car the red light is extinguished, the green light shown, and the appropriate track number indicated. As soon as the car passes the signal its trolley closes a contact and diverts a portion of the line current into magnets upon the signal switches in the signal box, restoring these to the normal position for all numbers dark and the red light shown. For the present the white-light signals will not be used. Above each of the four out-going cross-over tracks will be located a signal consisting of a red light, a green light, and a bell. The signal for a car to start will be the extinction of the red light, the lighting of the green light, and the tapping of the track number by the appropriate bell.

It is expected to maintain a headway of 15sec. with a speed of seven miles per hour, thus keeping the cars a little over 100ft. apart. All the various Brooklyn lines running to the bridge terminus in that borough will use these tracks, the cost of the work of construction having been divided among them.

CORRESPONDENCE

DISTRIBUTION AT 200 VOLTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have noticed in your report of the discussion on Mr. G. Bingswanger-Byng's Paper on "The Manufacture of Lamps and other Apparatus for 200-volt Circuits," a remark made by Prof. S. P. Thompson as follows:—"One difficulty in the matter not mentioned by Mr. Byng is in the use of flexibles. Is there a decent flexible wire to be found in the market which can be put up safely at 200 volts?" For the information of Prof. S. P. Thompson I may inform him that I have recently advised on and superintended the carrying out of two installations of electric light at a pressure of 200 volts, in both of which cases I had to use a large number of pendants. The flexible cord used for these had vulcanised rubber insulation, and stood satisfactorily every test, both mechanical and electrical, to which I thought it necessary to subject it, and since it has been in position it has given no trouble whatever. The flexible was supplied by a well-known firm of insulated wire manufacturers.—Yours, &c., CHAS. C. WARDROP.

LEGAL INTELLIGENCE.

Leicester Corporation v. Hill.

Judgment was given by his honour, Judge Wightman Wood, on Friday last in this action, which was for the recovery of £4. 19s. for electric light fittings sold and delivered to the defendant, an electric light contractor of Leicester. It was contended for the defendant, who admitted the purchase and delivery, that the Corporation had no legal authority to trade in such goods, and that they could not maintain an action for the recovery of the price of electric light fittings. The present action was therefore treated as a test action. In delivering judgment his honour said that the matter was one of unusual importance to come before a court of limited jurisdiction. After reviewing the facts of the case he said that under the Electric Lighting Act, 1882, the Corporation were licenced by the Board of Trade to supply electricity for public and private purposes, and besides laying wires, erecting the necessary machinery, and supplying the electric energy to such householders as liked to have it. They had also opened an emporium—he supposed they did not term it a shop—for the sale of lamps and such fittings as were required in houses by persons who used the electric light. No attempt was made to confine the sale to householders who took electricity, nor was the defendant such a person. He was an engineer with a similar business of his own, and the articles which he purchased from the Corporation he added to his stock. A corporate body could only do such things as it was authorised to do by its charter, Act of Parliament, or means of Association which brought it into being, or supplementary Acts or Charters including all such things as were necessarily incidental as the expressly-authorised objects. All other things it was prohibited from doing. The plaintiffs' charter was not produced, as it was conceded by their advocate that no right to trade could be deduced therefrom, and he relied entirely on recent electric lighting legislation. Having reviewed the various sections of the Acts of 1882, 1888 and 1890, his Honour said he could see nothing by reasonable implication to authorise the Corporation to supply any internal fittings except meters. For the Corporation great reliance had been placed upon a form of account sent down by the Board of Trade, and it certainly appeared from that form that the person who drew it up contemplated that the Corporation would buy and sell lamps and other apparatus, and it might be that the Corporation had taken their cue from it, and had taken to trading in lamps on the strength of its wording. He was, however, of opinion that a mere indication by a Government department that in its judgment a thing may be properly done, could not have the effect of authorising that which otherwise would be contrary to law. Section 9 gave the Board of Trade no authority to authorise anything at all, but merely to prescribe the form in which the Corporation were to present the accounts of the undertaking authorised by the Act, viz.: supplying electrical energy. He was, therefore, of opinion that the contention of the defendant that the Corporation had acted beyond their legal powers in selling the articles in question was correct. Defendant, however having taken and kept the goods under an implied promise to pay, the question arose could he set up as a defence to an action for the price that it was *ultra vires* of the Corporation to sell? In his opinion, he could not, for the defendant having had the goods, could not be allowed to refuse to pay for them on the ground that the Corporation went beyond their legal right in selling them, and could not have been held to their contract to deliver them had they refused to do so. The defendant had got what he bargained for, and in his opinion, he must pay the price, notwithstanding the flaw which he had rightly called attention to in the capacity of the Corporation to carry on their business. As he was against the plaintiffs on the point on which they relied, and which the parties came there to contest, he would give no costs, and judgment would therefore be entered for the plaintiffs for £4. 19s., but without costs.

Leave to appeal was given.

North v. Elmore's Patent Copper Depositing Company (Limited).

At the West Riding Assizes (Leeds) on Saturday, Mr. Justice Ridley delivered judgment in this action, which was for the recovery of £600, fees alleged to be due to the plaintiff (Mr. John North, of the firm of North and Sons, solicitors, Leeds) as chairman of the defendant Company during 1894-1895 and 1895-1896, and £10. 10s. for expenses incurred in attending two Directors' meetings in London. The defence was that there was no specific agreement that Mr. North should receive £300 per annum, that the sums set out in the balance-sheets of 1894-1895 and 1895-1896 as Directors' fees had never been allocated as provided by the articles of association, and that the apportioning of the fees must therefore be left to a general meeting of shareholders. A mass of evidence was submitted on behalf of the plaintiff and defendants, and in giving judgment his Lordship remarked upon the conflicting character of this evidence, but he thought the balance was in favour of the plaintiff, for whom he entered judgment with costs, refusing stay of execution with a view to an appeal.

Wilson v. Ellis.

This case was heard at Westminster City Court on Tuesday. Plaintiff sued Mr. H. G. Ellis, electrical engineer, trading as Ellis and Co., to recover £29 commission at the rate of 5 per cent. in respect of orders obtained. The claim, with the exception of one item, was admitted, and had been paid into Court. The plaintiff said that owing to his introduction the defendants obtained the contract for wiring a new building at Croydon, and subsequently were successful in obtaining an order to supply fittings

was that the order for the fittings was obtained quite independently of anything which the plaintiff had done, but after hearing the evidence the Judge found for plaintiff on the ground that the second order was the outcome of the plaintiff's introduction.

Hodges and Todd v. Watson.

This case came before Mr. Justice Wright, on Wednesday and Thursday, and was an action by the plaintiffs, electrical engineers, against Mr. Watson, receiver for debenture holders in Messrs. Priestman Bros., for damages for breach of contract in the supply of an oil engine. The plaintiffs alleged that the engine was purchased for £325 to generate electric power in an installation of electric light. It worked unsatisfactorily, and by reason of having to purchase in its place a Ransomes steam engine plaintiffs had been put to the expense of £800. The question involved was one of damages, as defendants had offered to take back the engine and return the money paid for it. His lordship awarded the plaintiffs £50 damages, but without costs.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. WADE. *In the Press.*

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated.

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young. *Ready shortly.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshal. and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s.. post free.

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." Being a Description of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net 2s. 9d. post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition now ready. rice 2s., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is *now ready.* Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898, and contains about 150 additional pages over last year's book. Supply houses will find the book very reliable and complete for circularising.

Tenders Invited.—The Accrington Corporation invite tenders for supply and erection of (*c*) three sets of steam dynamos, feed water heater, feed pumps, steam, exhaust and water pipes, &c.; (*d*) a storage battery having a capacity of 750 ampere hours; (*e*) switchboards, instruments, apparatus, cables, wires, &c., at the electricity station; (*f*) cables, wires, street boxes and connections. Further particulars appear in an advertisement elsewhere, and specifications, &c, may be obtained after the 4th inst. from the town clerk, Mr. A. H. Aitken. Plans and drawings may be obtained at the office of the town clerk, Town Hall, Accrington, or of the consulting electrical engineer (Mr. J. N. Shoolbred, C.E.), 47, Victoria-street, London, S.W. Tenders must be delivered to Mr. Aitken by Tuesday, the 19th inst.

——— The Shoreditch Vestry invite tenders for the supply and erection of arc lamps and accessories and also for electric cable. Specifications, &c., can be obtained from the chief electrical engineer (Mr. C. Newton Russell), Electricity Supply Department, Coronet-street, Shoreditch. Tenders must be sent in by noon on Tuesday, April 12. Our advertisement columns contain additional particulars.

——— The Corporation of Ashton-under-Lyne invite tenders from firms willing to undertake the free wiring of premises in the Borough. Particulars from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 78, King-street, Manchester, and tenders to the Borough Comptroller, Mr. John Neal, Town Hall, Ashton-under-Lyne, by April 5.

——— The Bournemouth Town Council invite tenders for an electrical installation for the lighting of the Bournemouth Pier and Pleasure Grounds. Tenders to the town clerk (Mr. J. Druitt, Jun.) by 5 p.m., April 4.

——— The Leyton Urban District Council require tenders for the supply and erection of two dynamos, one continuous-current balancing transformer, two gas engines and connections, and switchboards, at the electricity works at Leytonstone. Manufacturers only can tender. Tenders to the Town Hall, Leyton, Essex, by April 4. Mr. R. Vincent is clerk to the Council.

——— The Derby School School Board invite tenders for the electric wiring of their Traffic-street board school. Tenders to the Clerk by the 11th inst.

——— The Midlothian and Peebles Lunacy Board invite tenders for an electric lighting installation (including plant, wiring, fittings, &c.,) for Rosslynlee Asylum. Tenders to the Clerk, 19, Heriot-row, Edinburgh, by 23rd inst.

——— The Blackpool Corporation require tenders for 12

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electricity department. Tenders to the borough electrical and tramway engineer (Mr. Robert C. Quin) by 12th inst.

Tenders Invited.—The Municipal Authorities of Ocano (Toledo), Spain, invite tenders for the electric lighting of the streets, and also for the supply of potable water for 20 years. Incandescents to a total of about 4,000 c.p. will be required. Tenders to el Secretario del Ayuntamiento by the 19th inst.

——— The Municipal Authorities of Valderas (Leon), Spain, invite tenders for the electric lighting of the streets for a period of 17 years. Contractors may employ overhead or underground conductors. Eighty incandescents will be required, for which the Authorities will pay 3,000 pesetas (about £100) per annum. Tenders to el Secretario del Ayuntamiento by the 8th inst.

Tenders Accepted.—The tender of Messrs. Rogers and Co. has been accepted by the West Ham Town Council for wiring the public buildings at £712.

——— The Electric Light Committee of the Bath Town Council have accepted the tender of Messrs. Nalder and Hilton for switchboard extension at the electricity works, at £253.

Plant for Sale.—An advertisement elsewhere gives particulars of a quantity of engineers' machine tools, &c., which Messrs. Fuller, Horsey, Sons and Cassell will offer for sale at the Vulcan Engineering Works, Coventry, on Tuesday, the 5th, and Wednesday, the 6th inst., at 11 precisely each day. Catalogues may be obtained from Mr. C. Martin, solicitor, 18, Hertford-street, Coventry, and of the autioneers, 11, Billiter-square, London, E.C.

Appointments.—The Electrical Committee recommend the appointment of Mr. W. Bates, of London, as borough electrical engineer, at a salary of £300 per annum.

——— The Co-operative Wholesale Society (Limited) have appointed Mr. A. Blackburn, of Dewsbury, to the position of electrical engineer at their works near Manchester. There were 168 applicants.

Appointments Vacant.—From an advertisement elsewhere it will be seen that the Dewsbury Corporation invite applications for the position of borough electrical engineer. Salary, £250 per annum. Applications to the town clerk (Mr. G. Trevelyan Lee), Town Hall, Dewsbury, by Saturday, April 9.

Business Notices.—Messrs. W. P. Theermann and Co., electrical engineers and contractors, have removed from 12, Corporation-street to 22, Devonshire-street, All Saints, Manchester.

——— Messrs. George Piggott and Co. have been appointed sole London agents for Messrs. John Turner and Sons, of Denton.

——— We are asked to state that Mr. Lewis J. Steele has transferred his services from Messrs. Johnson and Phillips to Veritys (Limited).

Dissolution of Partnership.—Messrs. Alfred John Harrison and Elliot Chas. Pringle, electrical engineers (trading as Harrison, Coles and Co.), Hermitage Works, Richmond and Kensington, have dissolved partnership.

Obituary.—The many friends of Mr. Hubert Musgrove will be grieved to learn of his death, which took place at Coolgardie, Australia, on Jan. 26 last. For many years Mr. Musgrove carried on business in Glasgow in the name of Norman and Son. After converting his business into a limited company he became associated with the Electrical Power Storage Company, and ultimately took charge of the Company's business in Australia. The furore of gold mining at Coolgardie attracted him, and he severed his connection with electrical work. Mr. Musgrove's accomplishments as a linguist and violinist of exceptional skill secured him a wide circle of friends both here and in Australia. He was only 37 years of age at the time of his death.

Claims Due.—Claims against Messrs. Bennett and Druce, electrical engineers, 30, Winckley-square, Preston, must be sent to the receiver and manager (Mr. James Todd, 3, Winckley-square, Preston) by 8th inst.

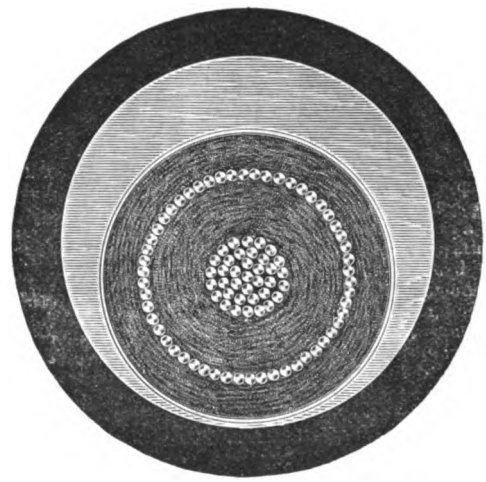
Bankruptcies.—We are pleased to record that the case of Messrs. Paterson and Cooper, electrical engineers and contractors, has reached the final stage. Mr. Registrar Brougham last week granted an unconditional order of discharge to both debtors. The firm failed in August, 1896, with total liabilities £19,514, and assets estimated to be ample to pay the debts and leave a margin of £7,000 odd. Debtors started business as far back as 1882, with £18,000 capital, and a further £6,600 was afterwards provided. Trouble commenced in 1886, when the debtors became possessed of a half-share in the British and foreign patents of the Hermite electrical sanitation and bleaching process, in the exploiting and working of which from £12,000 to £13,000 was expended, and the subsequent failure was attributed to delay in realising the value of these patents. When the discharge was first applied for in January, 1897, the Official Receiver reported that the assets were not equal in value to 10s. in the pound on the unsecured debts. That finding was challenged on behalf of the debtors, and the hearing has been adjourned from time to time to enable the assets to be realised. As previously notified in *The Electrician*, the careful manipulation of the firm's valuable assets by Mr. E. C. Moore, the trustee, has resulted in a realisation of sufficient to show 10s. in the pound on the liabilities, and the Official Receiver did not oppose the granting of the unconditional discharge.

——— Mr. B. T. Norton, 9, Old Jewry-chambers, London, E.C., has been appointed trustee in the bankruptcy of Trehearne, Son and Crump, electrical engineers, 155, Fenchurch-street, E.C.

——— A receiving order has been made against James Fletcher and John A. Hirst, electrical and mechanical engineers (trading as Fletcher, Hirst and Co.), Bankfield Works, Curzon-street, Burnley (late of North Gate Electrical Works, Chester and 17, Full-street, Derby), on their own petition.

Cheesman's Imperial Standard Wire Gauge Table.—There are several errors in the sheet table Supplement issued with *The Electrician* for Jan. 28, and those of our readers who desire to have the corrected sheet in substitution, if they will forward a post-card notifying the fact to the publisher, will find it included in their next copy of the paper. Those who prefer to make the corrections for themselves will find them set out on p. 666 of our issue of March 11.

Brooks' Semi-Solid Underground Cables.—In justification of the claims made by the sole makers and patentees of Brooks' semi-solid system of underground cables (Johnson and Phillips Electric Cable Works, Old Charlton, Kent), this firm issue an illustrated quarto pamphlet dealing with the merits of this system, not the least important feature of which is that many repeat orders have been received from corporations and companies using this type of cable. The Brooks system is a draw-in and draw-out system, in which the cable conductors are closely and thickly covered with two helical bindings of strong fibrous material impregnated with a highly-insulating compound. The cables are drawn into thick iron tubes, which are afterwards filled with a highly-insulating semi-solid dielectric and hermetically sealed, so that a



permanent and reliable insulation is obtained. These cables have been several times referred to in the columns of this journal during the past decade, and before coming into extended use in this country had secured a good name in America. The makers guarantee the complete satisfactory working of every cable on this system, and lines for the transmission of electrical energy up to any voltage are constructed. The cables are used in the public electric lighting at the Royal Observatory, Greenwich, at Worcester, Rochester, Keswick, Chatham and Hong Kong; in the harbour tunnels at Glasgow; and on Mr. Volk's electric railway at Brighton. The pamphlet under review gives many interesting particulars as to the method of laying the Brooks system of cables, and the illustration above shows a full-size section of the '15 sq. in. high-tension concentric cable used by the Worcester Corporation, for which repeat orders have been received by the makers within the last few weeks. For over eight years electric light contractors have used this type of cable, and the makers consider that they are fully justified in looking for an increased demand when it can be shown that on all the lines laid there has never occurred a single fault. The insulation measured in megohms and the insulation as regards dielectric stress is claimed to be in every case higher to-day than when the cables were originally laid. The testimonials from users speak in the highest terms of the suitability of these cables for electric installation work, more especially as to the excellence and permanency of the insulation under severe working tests.

Stewart Enclosed Arc Lamp.—We are informed that Messrs. Newburys (Limited), of Old-square, Birmingham, one of the largest drapery establishments in the Midlands, have given an order for 100 Stewart enclosed arc lamps to be installed on their extensive

premises. The Stewart Electrical Syndicate (Limited), of 5, New Compton-street, London, W.C., report a brisk trade in these lamps.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 23 to 29, with the ports of destination :—

Argentina—Buenos Ayres, £365 (including £100 telegraph material) ; Rosario, £60 (telegraph material). *Australasia*—Launceston, £14 ; Perth, £200 ; Sydney, £441 ; Wellington, £85. *Belgium*—Antwerp, £266. *Brazil*—Rio Janeiro, £20. *Canada*—Santos (B.C.), £26 ; St. John (N.B.), £10. *Ceylon*—Colombo, £848. *Chili*—Boca, £77. *China*—Shanghai, £621 (including £350 telegraph material) ; Tientsin, £35. *Egypt*—Alexandria, £426 (telegraph material) ; Port Said, £13. *Germany*—Hamburg, £10. *Gibraltar*, £700. *Holland*—Amsterdam, £200 ; Flushing, £8. *Hong Kong*—£14. *India*—Calcutta, £196 ; Madras, £218. *Italy*—Spezzia, £650. *Japan*—Yokohama, £585. *Malta*, £54. *Natal*, £2,023 (including £1,945 telegraph material). *Siam*—Bangkok, £467. *South Africa*—Cape Town, £1,437 ; Durban, £2,804 (including £1,097 telegraph material) ; East London, £513 ; Port Elizabeth, £738 (including £707 telegraph material). *Spain*—Bilbao, £1,878 (including £1,790 telegraph material) ; Pasages, £107 ; Saville, £100. *Straits Settlements*—Singapore, £45. *Sweden*—Gothenburg, £133 ; Stockholm, £122 (telegraph material); total £16,509, against £20,511 in the corresponding week last year (March 24 to 30).

Exhibition.—An electrical and industrial exhibition is to be held at Hull in May and June, 1898, and will be established in the Assembly Rooms and Lecture Hall, Kingston-square, Hull. The principal objects of the exhibition are in connection with electrical developments in telephone, electric lighting, transmission of power, and the economical application of electric energy to practical work. The promoters derive encouragement in their enterprise from the extended use of electricity in the borough for lighting and power purposes which has been a notable feature of the last few years. The jurors and referees who have consented to act include a number of well-known electrical experts. Mr. Joseph Davis, 41, Grosvenor-road, Scarborough, is general manager.

Fittings and Accessories List.—The Electrical Sundries Company, of 10, Berners-street, London, W., have just issued a plain but none the less useful list of electrical fittings and accessories, consisting of ceiling roses, switches, cut-outs, lampholders, &c., and a good assortment of fittings for the electric light. Some useful accessories are also shown. The list is strongest in the fittings section, wherein a number of plain and ornamental suspension lights, brackets, lanterns, hand lamps, &c., are illustrated and priced.

Pulleys, Shafting and Friction Couplings.—A very complete catalogue and price list of this class of engineering supplies is issued by Messrs. J. Bagshawe and Sons (Limited), of Batley, Yorks, in the form of "Useful Rules and Tables for Engineers and Architects." The list is fully illustrated, and lucid instructions for the erection of shafting and pulleys for a variety of power purposes are given. The claims of the Bagshawe-Addyman patent friction pulley are fully dealt with.

Electrical Supplies.—One of the most complete catalogues of electrical supplies of all kinds is issued in 8vo. form by Messrs. Binko, Ridsdale and Co., of 34, Leadenhall-street, London, E.C., and consists of nearly 300 pages of illustrations and brief accompanying text. The variety of instruments, apparatus, fittings and sundries here dealt with is too large for enumeration in a passing notice, and we must refer our readers to the catalogue itself for more complete details. The catalogue is very well got up, and (except for the excessive printing in red in Part II., which is very dazzling) is a credit to its compilers.

Fire.—A fire occurred on Saturday last at 24, Newman-street, London, W., which destroyed a portion of the premises of Messrs. Downie and Adams, but we are asked to state that the business of the firm has not in any way been interfered with by the fire.

Outrage at a Telegraph Station.—A dastardly attempt was made to fire the Anglo-American Telegraph Company's station at Valentia, Ireland, on Sunday night, the 13th inst., and a reward has been offered for such information as will lead to the conviction of the offender. The underground cables pass through an opening in the outside wall of the station building. This is bricked up, and a stone cover placed on top. This cover was lifted, and a board soaked in paraffin thrust down among the cables and lighted. Fortunately some of the cable clerks passing along the road noticed the flame, and hurried to the station and gave the alarm. The fire was got under before serious damage was done. No arrest has so far been made.

Aberdeen.—The Gas and Electricity Committee of the Council last week decided to reduce the price of electricity for motive power from 6d. to 4d. for the first hour. The price afterwards will remain as hitherto, 1½d. per unit. The consideration of Prof. Kennedy's report on the lighting of the West End has been deferred.

Adelaide (Australia).—Messrs. Unbehaun and Johnstone, of Adelaide, have put down an electrical installation at the residence of Mr. A. Hewitt, Highford, near Glen Osmond. The generating plant consists of a Crossley 3½-H.P. oil engine and Parker dynamo, and includes a battery of 32 storage cells. Electrically-driven pumps and farming machinery are provided. The lighting includes both arcs and incandescents. It is stated that, thanks to the energetic efforts of the Mayor of Port Adelaide, public electric lighting is shortly to be introduced.

Barking.—The District Council have passed a formal resolution in favour of applying to the Light Railway Commissioners for power to construct an electric tramway from Barking to Beckton. The question of entrusting the work of constructing the line to a company will be considered later on.

Barmouth.—An electric lighting scheme for this district has been projected. The promoters are negotiating for the acquisition of the old reservoir at Ceilwart as a site for the generating station, and offer the public lighting free of charge for a number of years in consideration of certain concessions in connection with the acquisition of this site.

Bath.—The premium on the insurance of the electricity supply works has been reduced from 7s. 6d. to 5s., and the amount of the insurance has been increased from £12,000 to £20,000. The Electric Lighting Committee met last week, when Mr. Hammond presented a report in which he stated that satisfactory progress was being made with the electricity works.

Brighouse (Yorks).—The electric lighting station of Mr. A. B. Brook has been taken over by the Town Council as from the 31st ult. Last year the Council obtained a Provisional Order, but application has not yet been made to the Local Government Board for sanction to borrow the necessary purchase money (£1,535), as no public electric lighting scheme has yet been formulated.

Bristol.—The negotiations between the Bristol Tramways and Carriage Company and the Sanitary Committee of the Corporation with reference to the Company's Bills for the introduction of electric traction on the existing tramways and for the extension of the system, have been broken off.

Chester.—The Chester Corporation have now taken over the electricity supply works from the contractors, Messrs. Thomas Parker (Limited), and Mr. F. Thursfield, A.M.I.C.E., who has acted as superintendent of the station since the date of the commencement of supply (Dec. 17, 1896) will undertake the management of the department.

Chiswick.—The electric tramway scheme of the London United Tramways is one of the principal topics of discussion in local circles just at present. The District Council have declared against the scheme, but there is reason to believe that this position is not popular and that the new Council, which will be elected on Tuesday, will reverse the decision. At all events the Company is showing commendable energy in putting before the electors the true facts of the case, and a four-page sheet containing a number of items relating to electric tramways has been established in order to educate the electors into an appreciation of the many advantages of a good system of electric tramways. Should the new Council prove favourable it is probable that the Company's comprehensive scheme will be carried out in its entirety, as the only other Council which has not given its sanction is the Ealing District Council, but here the position is also somewhat similar to that at Chiswick.

Church Lighting.—The electric light has been installed in St. Matthias' Church, Blackfriars-road, Salford. The work was carried out out by Messrs. William Wilson and Co., of Middleton.

Cuba.—Electric lighting and gas companies in Cuban cities are evidently having a bad time of it just now, as a financial contemporary announces that no money can be collected. If the companies press for payment they are threatened with the confiscation of their plants.

Dingwall.—The amended agreement with the representatives of the company which is to be formed for the electric lighting of this town provides for the erection and maintenance of eight 500-c.p. arcs, nine 32-c.p. and sixteen 16-c.p. incandescents, the installation to be carried out to the satisfaction of the city electrical engineer (Mr. Hill).

Dorking.—A poll of the ratepayers in this Surrey town has been taken as to the advisability of installing the electric light, and a considerable majority has voted in favour of the Council themselves undertaking the work.

Edinburgh.—The Cleaning and Lighting Committee recommend that Calton-road, Corstorphine-road, Inverleith-row and London-road be lighted electrically. The Electric Lighting Committee recommend that the charges for electric current from Whitsunday next should be 3½d. per unit with the ordinary discounts, for each public lamp £14 per annum, and for motive power 1½d. per unit. It was decided to recommend that the salary of the city electrical engineer should be increased from £500 to £600 a year.

Electric Traction in the States.—The *Boston Transcript* states that the total invested capital in electric railways and tramways in the United States is now nearly $1,500,000,000. There were over 900 electrically-operated street railways in the States in 1896, 25 of which show gross annual receipts of over $1,000,000 each. The first commercial electric line was, it is said, opened at Richmond, Va., in February, 1888.

Guernsey.—A special sitting of the States of Deliberation will be held on Wednesday to consider the electric lighting question. The Committee having charge of the matter advise the States not to grant an electric lighting concession to Edmundson's Electricity Corporation, but to themselves establish a system of supply.

Hackney (London).—Various trade and political associations in the district have passed resolutions protesting against the Vestry's proposal to transfer their electric lighting powers to a company. The Vestry have received a communication from Mr. F. H. Medhurst's solicitors asking for a definite reply as to the relation in which he stood with the Vestry on the electric lighting question, and also asking for the name of the solicitor who would accept service of a writ. Consideration of this matter has been deferred for a month, until a decision on the proposal to transfer the Provisional Order has been arrived at.

Hornsey (Middlesex).—The District Council on Monday discussed a request from Mr. F. T. Hide for permission to carry electric lighting cables for a small lighting installation in the Broadway, Crouch End, on the low-tension system, over several thoroughfares, with a view to lighting a number of shops. The application was refused, as the Council is itself applying for a Provisional Order.

Johannesburg (S.A.R.).—The question of the introduction of electric traction on the tramways is still in abeyance. At the recent meeting of the Johannesburg City and Suburban Tramway the Chairman (Mr. J. G. Hamilton) stated that, as announced at the last annual meeting, an application for the right of conversion had been before the Government since April, 1895; and the Company some time back received the assurance direct from His Honour the State President that it should receive precedence when the use of electricity as a motive power should approve itself to the Government. The introduction of electric power for tramway purposes required the approval of the First Volksraad, but this body rejected the Lombaard concession in June last. He felt assured that their equitable rights would receive every consideration from that body; and that, when their legislators should have seen their way clear to permit electric traction, the company which was first to exploit in the State such a public convenience as the present Johannesburg Tramway would also be the first to receive the right of the use of the more modern power.

Leeds.—The question of introducing electric traction on the Headingley, Chapeltown and Hunslet routes has been referred to a sub-committee for consideration and report.

Leigh.—Various public improvements are to be carried out in this district, including the erection of electricity supply works at an estimated capital expenditure of £10,000, and the gas manager has been instructed to prepare plans and details of a scheme.

Leith.—The Dean of Guild Court have sanctioned the erection of the electricity supply station buildings off Great Junction-street.

Light Railways Schemes.—The Board of Trade have granted formal assent for the construction of the light railway and tramway which is to connect Bridlington and Flamborough Head. Apart from the passenger traffic, which is considerable during the season, it is anticipated that the line will have an important bearing upon the development of the fishing industry of the North, for it is stated that frequently boats which cannot enter Grimsby will deliver their fish under the shelter of Flamborough Head, as soon as facilities for transport exist. The civil engineer for this undertaking is Mr. Myers-Beswick, and the electrical engineer is Mr. Bernard Drake. Messrs. Siemens Bros. and Co. are contractors for the electrical plant, and Messrs. Whittaker Bros. for the permanent way.

On Tuesday the Light Railway Commissioners (the Earl of Jersey and Col. Boughey) held an inquiry at Coatbridge into the application of the British Electric Traction Company for an Order to construct an electric tramway or light railway through the main streets of Airdrie and Coatbridge. Objection was raised to the scheme by the Caledonian and North British Railway Companies, and by other companies and local bodies. Mr. Sydney Morse, representing the promoters, said it was originally proposed to have a gauge of 3ft. 6in., and to work the line electrically on the overhead system. It would be a single line with passing places. The length of the line would be nearly four miles, the estimated cost of construction being £15,000. The promoters were willing to concede the request of the Corporation's that the gauge should be altered to 4ft. 8½in., which was the gauge of the Glasgow tramways, and also to extend the line some little distance both at the eastern and western termini. They would also agree to ½d. half-mile fares. Evidence in support of the scheme was given by a number of prominent citizens, and Mr. Stephen Sellon, consulting engineer to the promoters, submitted technical details. The Caledonian Railway Company regard the proposed line as strongly competitive both as regards goods and passengers, and the Chairman said that apparently the scheme was desired in the district and by both local authorities, and therefore the commissioners would report to the Board of Trade in favour of the Order.

Liverpool.—Both the American and the German type of electric tramcar have now arrived, and as soon as the former is put together a demonstration will take place, and the members of the Tramway Construction Committee will be able to select the type of car to be used on the experimental electric line. The American car has been built by Messrs. Brill and Co., of Philadelphia, and is constructed to carry 38 passengers seated, 16 in the enclosed compartment and 22 in the open. There are no outside seats, the car being constructed with side entrances in the centre, passengers turning to the left or to the right as they prefer the open or enclosed portion. The length of the car is 29ft., or 12ft. longer than the horse cars now in use, but still shorter than the car and horses of the present type of tramcar.

London County Council.—At Tuesday's meeting the recommendation, set out in our last issue, that tenders be invited for the supply and fixing complete of the dynamos, engines, switchboard, and principal mains, and also for the supply and fixing of the service mains, wiring and fittings for the installation of the electric light at Crossness outfall, was approved.

The report of the Highways Committee stated that, in connection with applications for electric lighting orders this session, the Parliamentary Committee had prepared a clause protecting the Council's interests, which read as follows: "If and when the London County Council adopt or permit the use of electric traction on any of the tramways of the Council, including tramways in any street in which electric lines have been laid down under this Order, it shall be lawful for the Council to serve on the undertakers notice in writing requiring them to make such alterations in the position of their lines and works as may be required for adapting such tramway for the use of electric traction thereon, and the undertakers shall thereupon proceed with all reasonable despatch to effect such alteration or removal at their own cost, and without having any claim against the Council for compensation. Provided that if any difference arises between the Council and the undertakers as to whether the required alterations are necessary for the purposes aforesaid, such questions shall be referred for determination to the Board of Trade, whose decision shall be final." The Committee now recommend that the Board of Trade should be requested to insert this clause in each of the electric lighting Provisional Orders which may be granted in this or in any future session. Earl Russell said the clause appeared rather bold, and suggested that when it was submitted to the Board of Trade it should be made clear that the clause was not intended to interfere with electrical working, but simply to prevent mechanical interference by an electric lighting company with the Council's system of tramways. Mr. Benn proposed that the view of the noble lord should be made clear. The recommendation was carried.

Nottingham.—An important report from the Tramways Committee will be considered at the meeting of the Town Council on Monday. The Committee visited the Edinburgh, Bristol and Dover tramways, and the report, which deals very fully with the various forms of electric traction, recommends (1) that the permanent way of the whole of the existing tramway system be reconstructed, (2) that six additional lines be constructed as soon as Parliamentary powers can be obtained, and (3) that the whole of the lines be equipped on the overhead trolley system. The generating station will probably be erected on the area which is proposed to be cleared by the Improvement Committee in connection with the new street through the gaol. The estimated cost of the reconstruction of the existing tramways and of carrying out the proposed extensions, including electrical equipment, will be about £425,000. The Committee also recommend the Council to authorise them to obtain Parliamentary powers, &c., for carrying out the works, and to empower the Finance Committee to raise the capital moneys required.

Private Bill Legislation.—The Bill of the Metropolitan Railway Company was considered by a committee of the House of Commons on Monday. Mr. Littler, Q.C., who appeared for the promoters, stated that the chief object of the measure was to obtain authority to introduce electric traction on the railway in order to improve the ventilation of the line and consequently the comfort of the travelling public. The Bill was an omnibus one, but the electrical clauses were taken first, the only opponents being the Great Western Railway Company, who are joint owners of the Hammersmith and City line. Mr. John Bell (chairman of the Metropolitan Company) stated that any difficulty which might arise with the Great Western Company in the event of the Bill being passed could be settled by arbitration under the terms of existing statutes. At this point Mr. Freeman, Q.C., intimated, on behalf of the pro-

moters, that under the Bill as drawn, if the Metropolitan Company satisfied themselves that electric traction was the proper system to use on the railway they should require the Great Western Company to alter their rolling stock to suit the new conditions. Their engines would be under the control of the Metropolitan Company, but if they objected they would then have power under previous agreements to take the matter to arbitration. Mr. Bell stated that the Metropolitan Company had the right to dictate to the Great Western the class of engine they should use. Under the arbitration clauses it would be in the power of the arbitrator to require the Great Western Company to bear the expense of converting their rolling stock. If electric traction were the success they expected it would be they should not extend the electric traffic to Aylesbury. They only proposed to go to the Swiss Cottage. Sir John Wolff Barry (engineer to the Company) and Sir Benjamin Baker gave evidence for the promoters on the engineering aspect of the scheme. An attempt to draw up a clause to satisfy the Great Western opposion led to no satisfactory result. On Tuesday and Wednesday the Committee dealt with the proposal of the Company to construct "blow holes" for ventilating purposes until the work of converting the line into an electric railway had been carried out. The proposal was strongly opposed by the Paddington, Marylebone and St. Pancras Vestries.

Salisbury.—The local company anticipate being in a position to supply electric current about the middle of April.

Southampton.—The electric light mains are to be extended to Portland-street, and application is to be made to the Local Government Board for additional borrowing powers to meet the cost. The mains are also to be extended through Bevois Valley to Brook Vale-road. The Electric Lighting Committee presented at the last meeting of the Council a report from Mr. Manville upon the contract for the supply of low-tension cables for the department. It appeared that about 12 months ago this contract had been let to the Fowler-Waring Company, and as this Company's business had been taken over by another firm he suggested that the contract should be let to Messrs. W. T. Glover and Co., the difference in the estimates of the two firms being only 2d. per yard. The deputy-chairman and Mr. Manville were authorised to make terms with Messrs. Glover.

Southend.—Mr. H. E. Kershaw, the enterprising chairman of the Shoreditch Electric Lighting Committee, has been lecturing on the advantages of the electric light before a meeting of Southend ratepayers. Mr. Kershaw favoured the adoption of a combined electric lighting and traction scheme. He thought that a tramway to Prittlewell and along the Parade would prove a source of income to the Corporation. The question of the erection of dust-destructor works might also be taken into consideration.

Telephone Trunk Line Extension.—Telephone trunk line communication has been extended to Cromer, Norfolk.

Telephone Trunk Service in France.—The Paris-St. Malo-St. Servan telephone service was opened in 1897, the tariff charge being 2s. per conversation of five minutes.

Telephony in New South Wales.—The New South Wales Postmaster-General has sanctioned a scheme for the construction of a telephone line from Bourke to Grass Hut, a distance of 45 miles.

The Telephone in Glasgow.—The deputation from the Corporation concluded their recent visit to London by an interview with the Postmaster-General on the subject of the granting of a telephone licence to the Corporation. The Duke of Norfolk was accompanied by Mr. J. C. Lamb. The conversation naturally turned upon the report of Sheriff Jameson on the telephone question, and the deputation desired to impress upon the Postmaster-General that the Corporation of Glasgow had never admitted that it would be "a grave public inconvenience to have a telephone exchange confined to the area of the municipality of Glasgow." They believed it would be a great public benefit to have such an exchange, although it would be a still greater benefit to have it for the wider area embraced in their second application. The alleged difficulty of the Corporation obtaining the necessary wayleaves for underground wires outside the limits of their own jurisdiction, which the granting of the second application would render necessary, was a purely imaginary difficulty. The outside authorities might, and probably would, object to the National Company, or any company working for private profit, obtaining such wayleaves; but they were ready, and nearly all of them had expressed their readiness, to grant facilities to the Corporation of Glasgow, whose only object was the public interest. In the next place, the deputation urged, assuming that the opinion which the Postmaster-General had obtained, that the Corporation, in the present state of the law, had no power to carry on the business of a telephone exchange, was correct, that His Grace should exercise the discretion vested in him and grant the application of the Corporation for a licence, subject to the condition that the Corporation should secure the necessary powers from Parliament. They contended that in any possible application to Parliament they should not be prejudiced by a pronouncement of the Postmaster-General which might be pressed by opponents into an argument for refusing the Parliamentary application. The Postmaster-General expressed his desire to act impartially, and asked if the granting of a licence conditionally might not be held to prejudice any opposition. The deputation replied that they were perfectly willing that the granting of a conditional license should be so safeguarded and hedged in as to leave most unfettered discretion to Parliament in dealing with the Corporation's proposals. In the course of subsequent conversation the deputation repeated the decision of the Town Council under no circumstances to grant the telephone company the right to utilise the streets. The Postmaster-General said he would give careful consideration to the views of the Corporation and would communicate with them shortly.

Traffic Facilities in London.—A Paper on "London Traffic Problems and their Solution" was read by Mr. Douglas Young on Tuesday at the Auctioneers' Institute. He advocated the construction of underground electric railways in the more densely populated districts as means of relieving the present congestion of traffic, and as they got out into the suburbs they might rise and form part of a system of electric tramways, which before long he hoped would take people at quick and cheap rates into the far suburbs, enabling workers to travel and live in purer air and under better conditions than was possible in the towns. He did not see any objection to the use of the overhead system from any æsthetic point of view. In conclusion, he thought that the advent of the motor car would effect a great saving of space as well as a vast improvement in the hygienic condition of the roads.

Concert.—A very successful Bohemian concert was given last evening at the Grand Hall, Freemasons' Tavern, London, by the staffs of the City of London, the Metropolitan and the London Electric Lighting Companies, Mr. Frank Bailey acting as Chairman and Mr. J. Cecil Bull as Vice-Chairman. The grand hall was densely packed, and the company included a large number of ladies, who appreciated one of the best of the Bohemian concerts given in London.

BOOKS RECEIVED.

"Die Benutzung einer und derselben Elektrischen Leitung für Verschiedene Betriebe." By Oberingenieur Kohlfürst. (Stuttgart: Ferdinand Enke.) Price 2 marks.

"A Popular Guide to Commercial and Domestic Telephony." By M. Byng and F. G. Bell. (London: The General Electric Company and Whittaker and Co.)

"A Treatise on Magnetism and Electricity." Vol. I. By Prof. Andrew Gray, F.R.S. (London: Macmillan and Co.) Price 14s.

"The Official Gazette of the United States Patent Office," Nos 11 and 12, Vol. LXXXII. Published by authority of Congress. (Washington: Government Printing Office.)

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

February 19, 1898.

4,278. J. A. BUSHER. London. Improvements in or relating to railway electrical signalling apparatus.

4,282. G. BYNG and A. E. ANGOLD. London. Improvements in automatic cut-outs for arc electric lamps.

4,287. H. V. JAMES. Salford. Improved electric arc lamp.*

4,306. P. W. NORTHEY. London. Improvements in electrodes for secondary batteries.

February 22, 1898.

4,339. H. S. MAY. Blackpool. Improved coin or prepayment attachment for electrical meters.

4,371. J. FINLAYSON. Glasgow. Improvements in electric meters applicable also to instruments for testing the magnetic properties of iron.

4,398. J. M. MURPHY. London. Improvements in electric railway systems.*

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4,409. W. H. Wheatley. London. Third-rail underground electric railway system. (L. E. Watkins and G. M. Jewett. United States.)*
4,414. W. H. Witham. London. Improvements in lamp globes or apparatus for distributing and modifying the light of oil gas and electric lamps or burners.
4,416. R. F. S. Venner and Chamberlain and Hookham (Limited). London. Improvements in or relating to electricity meters.
4,435. C. S. Davy. London. Improvemement in electric signalling apparatus for use on railways.
4,441. H O. Duncan. London. Improvements in or relating to electric motors. (Date applied for under Patents, &c., Act, 1883, Section 103. January 14, 1898, being date of application in France.)
4,455. F. C. Esmond. London. Electric railways.

February 23, 1898.

4,468. C. G. Howard and A. W. Sclater. London. Improvements in conduits for wires carrying electric current.
4,471. E. Wareham. Chelmsford. Wareham's electric clock or time recorder.
4,508. W. A. Price. London. Apparatus for metering electrical current.
4,516. J. Matthews and G. B. Cruickshank. Birmingham. Improvements in holders for the brushes or collectors of dynamo-electric generators and motors and other revolving electric machines.
4,549. H. H. Leigh. London. Apparatus for electrically controlling the hoisting mechanism of elevators or any other type of machinery. (F. J. Sprague, United States.)
4,550. E. Edwards. London. Improvements in telephone signal systems. (W. Stillwell and A. Barneck, United States.)

February 24, 1898.

4,588. F. Bathurst. London. An improved method of and means for holding the bases of electrical fittings within boxes or upon other surfaces.
4,621. A. F. Spooner. London. Improvements in electric arc lamps (P. Vassia, France.)
4,624. J. Heibling. London. The electrolytic manufacture of alkaline bichromates.
4,635. H. Edmunds and A. H. Howard. London. Improvements in apparatus for travelling through pipes or conduits ; more especially intended for use in threading through electric conductors.

February 25, 1898.

4,646. J. A. Ewing. Cambridge. Improvements in apparatus for magnetic testing.
4,678. C. E. Hearson. London. Improvements in insulation of wire for electrical purposes.
4,683. A. Schanschieff. London. Improvements in electric accumulator grids.
4,742. C. M White. London. Improvements in devices for lighting lamps by electricity. (H. M. Brigham and S. M. Meyer, United States.)*
4,746. Siemens Bros. and Co. (Limited). London. Method of and means for measuring the work performed in a rotary-phase current system. (Siemens and Halske, Actien-Gesellschaft, Germany.)
4,747. Siemens Bros. and Co. (Limited). Improved means for counterbalancing the frictional resistance in alternating current motor-meters. (Siemens and Halske, Aktien-Gesellschaft, Germany.)

February 26, 1898.

4,761. W. Emmott. Halifax. Improvements in electric controlling and regulating apparatus.
4,764. N. P. Andersen, J. Westengaard, and H. Zerener. London. Improved process and apparatus for tanning by the aid of electricity.
4,791. W. H. Clegg, J. S. Richardson, and S. Jevons. London. Improvements in connection with the mechanism of electrically illuminated devices.
4,812. A. Heyland. London. Improvements in or connected with alternating current electric motors.
4,819. Electric Reduction Company (Limited). London. A method of electrically heating materials in closed chambers and apparatus for that purpose. (W. T. Gibbs, Canada.)
4,820. Siemens Bros. and Co. (Limited) and F. Booker. London. Improvements in electric arc lamps.*
4,825. C. Junge. London. Improvements in and relating to electric accumulators. (R. Knoschke, Germany.)*
4,828. H. H. Lake. London. Improvements in electro-magnetic couplings for shafts, pulleys, and the like. (W. Dierman and Co., Belgium.)

February 28, 1898.

4,895. F. T. Woodcock. London. Improved manufacture of insulating conduits for electrical conductors and appliances employed in connection therewith, and for laying the conductors therein.
4,900. A. A. Common. London. Improvements relating to joints of telegraph wires.
4,903. J. E. Fuller. London. Improvements in primary batteries.*
4,910. C. Koenig. London. Improvements in and relating to primary batteries.*
4,926. H. H. Lake. London. Improvements in and relating to portable electric lamps and batteries therefor and for other purposes. (L. Paget. United States.)
4,929. A. J. Boult. London. Improvements in or relating to electric railway conduits and conductors. (R. Sayers. Belgium.)*

March 1, 1898.

4,995. J. N. Thomas. London. Improvements in electro magnets or magnetic closers for use on electric railway vehicles.*
4,999. W. M. Brown. London. Improvements in and relating to electric railways.*
5,001. S. H. Short. London. Improved controlling system for electric railway vehicles.*
5,029. H. Leitner. London. Improvements in regulating apparatus for arc lamps.
5,034. C. O. Bastian. London. Improvements in or relating to electrolytic electrical meters.
5,048. Evershed and Vignoles (Limited) and S. Evershed. London. Improvements in electric meters
5,049. W. Stanley. London. Improvements in alternating-current motors.*
5,054. G. W. Nell. London. Improvements in current collectors for dynamo electric machines.*
5,062. W. P. Thompson. Liverpool. Improvements in incandescent electric lamps. (J. T. Lister and W. S. Chamberlain. United States.)*
5,064. R. Belfield. London. Improvements in non-synchronous electric motors. (B. G. Lamme. United States.)
5,065. R. Belfield. London. Improvements in arc lamps. (H. P. Davis and F. Conrad. United States.)
5,066. R. Belfield. London. Improvements in electric switches. (H. P. Davis and E. F. Harder. United States.)
5,067. C. Wood. Birmingham. An improved means for feeding the carbons in electric arc lamps.
5,068. C. Wood. Birmingham. Improvements in and relating to the carbon feeding mechanism of electric arc lamps.

March 2, 1898.

5,083. R. Hope-Jones. Birkenhead. An improved means of and apparatus for varying the strength of electrical currents.
5,130. L. Bishop-Salford. Method of utilising the interior of electric incandescent lamps for advertising purposes.
5,133. J. M. Huisman and H. C. Gover. Glasgow. Improvements in electric lamp fittings.
5,162. C. J. Grist. London. Improvements in the manufacture of waterproofing coating compositions for wearing apparel covers, engine and other packings, acid tank linings, electrical insulating compositions, and for other uses.
5,172. J. V. Collingwood. Liverpool. Improvements in telephone transmitters.
5,176. J. H. Holmes. London. Improvements in means or apparatus for starting and regulating electric motors.
5,177. W. B. Sayers and Mavor and Coulson (Limited.) Improvements in dynamo electric machines.
5,178. A. F. Berry. London. Improvements in the manufacture of electrical transformers and other alternating-current apparatus having iron cores.
5,185. C. F. P. Steudebach. London. Improvements in electrical conducting apparatus for tramways, railways and the like.*
5,186. R. Haddan. London. Improvements in or relating to secondary batteries. (H. Dolter. France.)*

March 3, 1898.

5,208. The Actiengesellschaft für Fabrikation von Broncewaaren und Zinkguss, vorm. J. C. Spinn and Sohn and S. J. von Romocki. Manchester. Improvements in electrically-operated gas valves for burners.
5,260. E. A. Mitchell. London. An improved primary battery.
5,287. R. Haddan. London. Improved coin-freed mechanism for making and breaking electrical contacts. (M. Vidal. France.)

March 4, 1898.

5,300. R. R. Meacock and A. J. Harper. London. Improved means for lighting railway trains electrically.
5,343. F. P. Foster and G. (Bodo) Puchmüller. London. Improvements in fluids for impregnating bodies or suitable fabrics, threads, fibres or the like for electric incandescent lighting purposes.
5,379. W. T. Henley's Telegraph Works Company (Limited) and G. Sutton. London. Improvements in the manufacture of deep-sea telegraph and telephone cables.

March 5, 1898.

5,418. C. Adams-Randall. London. Improvements in electric telephony
5,423. J. Goddard. Ashton-under-Lyne. An automatic electric switch for hoists and cranes.
5,449. W. Du Bois Duddell. London. Improvements in "Oscillographs" or apparatus for indicating or according rapidly-varying electric currents or potential differences.*
5,469. A. J. Boult. London. Improved system of electric traction and apparatus therefor. (J. P. Anney. France.)*
5,478. J. A. McMullen. London. Improvements in alternating electric current transformers.

March 7, 1898.

5,501. J. S. Highfield. Stafford. Improved apparatus for regulating the pressure on electric mains chiefly in connection with storage batteries.
5,533. W. A. Malson and S. R. Malson. Sheffield. Improvements in electric high and low-tension fuse-heads for blasting purposes.
5,544. J. Woods, Essex. An electric fog-signalling apparatus.

5,550. M. T. Pickstone, R. S. Portheim and A. C. Peebles. Improvements in and connected with dynamo electric machinery.*
5,560. A. L. Armstrong. London. An improved holder for carbon and other brushes for electric motors, dynamos and the like.
5,371. W. T. Carter, J. A. Dawson, and T. Gray. London. Improvement in or connected with the application of electricity to marine propulsion.
5,584. A. B. Kistritz. London. Improvements in switches for electric glow lamps.
5,596. S. Bergmann. London. Improvements in electric arc lamps.

March 8, 1898.

5,624. G. T. Moore. Dublin. Improvements in and in relation to electrical alarms.
5,644. W. C. Cubbin and G. E. Johnston. Liverpool. Improvements in electric lamps for photographic and similar purposes.
5,663. P. C. Middleton and F. Huggins. London. Improvements in metallic conductors for protecting electric wires and cables.
5,672. H. H. Lake. London. An improved electric safety lamp for miners. (O. Siedentopf, Germany.)*
5,686. S. G. Brown. London. Improvements in and relating to dynamo-electric machines and electromotors.
5,693. W. Von Labern. London. Innovation in electric lighters (pyrophore).
5,703. H. Pieper Fils. London. Improvements in electrodes for secondary batteries or accumulators.
5,704. H. Pieper Fils. London. Improvements in electrodes for secondary batteries or accumulators.
5,705. H. Pieper Fils. London. Improvements in the manufacture and production of electrodes for secondary batteries.

March 9, 1898.

5,729. R. A. Miles. Coventry. Improved apparatus for the electric ignition in internal combustion engines.
5,750. J. E. M. Stewart. Bournemouth. An improved form of automatic transformer switch.
5,783. W. C. C. Hawtayne. London. Improvements in electric tram and railway systems.
5,806. H. H. Lake. London. Improvements in the manufacture of metal bases for electric incandescence lamps. (La Compagnie Général des Lampes à Incandescence, France.)*
5,810. W. P. Thompson. Liverpool. Process for making an electrical conductor and an insulating body of tar asphalte and the like materials. (A. Lessing, Germany.)
5,823. E. Heyl-Dia. London. Improvements in and in connection with underground conduit electric railways.
5,830. E. Heyl-Dia. London. Improvements in and in connection with incandescent electric lamps.

March 10, 1898.

5,863. W. L. Voelker. London. Improvements in incandescent electric lights and in processes therefor.*
5,912. G. Laura. London. Improvements in electrical galvanic batteries.*
5,934. J. J. Bate. Liverpool. Improvements in conduits for electric conductors.*
5,950. W. T. Carter, J. A. Dawson and T. Gray. London. Improvements in or connected with the application of electromotors to propulsion.

March 11, 1898.

5,959. H. N. Moody and A. L. Davis. London. Improvements in guards for flames or fragile objects, such as incandescence electric lamps, glass globes, &c.
6,014. L. Bertgues. London. The springless contacts bayonet holder for electric incandescent lamps.
6,022. P. Laffargue and E. Droult. London. Improvements in primary voltaic or galvanic batteries.
6,024. W. Sykes. London. Improvements in and relating to conduits for electric cables.
6,025. W. Sykes. London. Improvements in and relating to draw and junction boxes for electric mains.
6,026. R. J. Crowley and C. H. Preston. London. An electric drill.
6,028. J. Holloway. London. Improvements in the method of and apparatus for the electro-deposition of metals.
6,032. O. Waratka and E. Sachs. London. Improvements in electrical or electromagnetic therapeutic apparatus.*
6,039. A. E. Honey. Birmingham. Improved apparatus for electro-plating and polishing various small articles.
6,044. A. Wernee. London. Improvements in secondary batteries.
6,049. A. U. Alcock. London. Improvement in electrical measuring and indicating apparatus.
6,058. Siemens Bros. and Co. (Limited). London. Apparatus for transmitting motion to a distance by means of electrical energy. (Siemens and Halske Actien Gesellschaft, Germany.)

March 12, 1898.

6,103. P. Richter and T. Weil. Brussels. Movement mechanism for electric apparatus.
6,109. P. Richter and T. Weil. Improved electric arc lamps.
6,110. P. Richter and T. Weil. Improvements in blades for electric-current collectors.
6,135. W. Nernst. London. Improvements in electric incandescence lamps.
6,145. R. von Barby. London. Process for hardening and rendering tenacious the active mass of electric accumulators.*
6,147. H. Riecken. London. Improvements in the electrolytical treatment of ores and slimes for the recovery of precious metals therefrom and apparatus therefor.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

29,590. The British Thomson-Houston Company (Limited) (Priest) Dynamo-electric m achines and motors.
29,710. Browne and Kamperdyk. Electric accumulators.
30,211. Thompson (Jungbluth). Insulating conduits for electric conductors.
30,626. The British Thomson-Houston Company (Limited) (Steinmetz and Rice). Method of and means for regulating the phase relation between current and electromotive force in alternating-current systems of electricity distribution.
30,627. The British Thomson-Houston Company (Limited). (Potter.) Electric railways.
30,628. The British Thomson-Houston Company, Limited (Thomson and Pratt). Induction watt-hour meters.

1898.

67. Gover, Proctor and Pipkin. Holders for electric glow lamps.
305. Meyersfield. Device for preventing the displacement of the roller receiving the current from the cables of electric railways with overhead conductors.
1,017. Ginisty. Method of and apparatus for signalling or advertising by electricity.
1,379. Justice (the Lithosite Manufacturing Company). Electrical insulation conduits and method of and apparatus for making same.
1,391. Peckham. Electromagnetic brakes for cars.
1,416. Price, Phillips and Weiny. Telegraphic transmitters.

COMPANIES' MEETINGS AND REPORTS.

Direct Spanish Telegraph Company (Limited).

The forty-sixth ordinary general meeting was held on Tuesday at the offices, Winchester House, Old Broad-street, London, the Most Hon. the Marquis of Tweeddale presiding.

The MANAGER (Mr. Charles Gerhardi) having read the notice calling the meeting and the minutes of the last meeting,

The CHAIRMAN said: The first duty I have to discharge is to express the sincere regret of the Directors—a regret which I feel sure will be shared by everyone connected with the Company—at the death of our esteemed colleague, Mr. Edmund Etlinger. He was not only a most agreeable colleague to work with, but also an admirable man of business, and he was a Director of the Company from its commencement in 1872. We have every reason therefore to deplore his loss. The Directors, in the exercise of their judgment, appointed Mr. F. Alexander Johnston to fill the vacancy so caused. Mr. Johnston is a very able man of business, and is happily a good deal younger than some of us, and I hope he will have a prosperous career in connection with the Company. Turning to the accounts, you will observe that the balance to the credit of the revenue account amounts to £12,975. After adding £5,000 to the reserve fund the Directors recommend a dividend of 10 per cent. on the Preference shares and 4 per cent., free of income tax, on the Ordinary shares, absorbing £5,486. Half of this amount, as you are aware, was distributed in October as an interim dividend. Last year the balance to the credit of revenue, after deduction of interest and redeeming debentures, was £10,818, or £2,157 less than this year, a considerable amount having been repaid to the reserve fund out of revenue during the year 1896. The traffic receipts—a very important item—show a decrease of £2,927 as compared with those of the year 1896. With respect to this decrease I would observe that only £674 of it was applicable to the first half of the year 1897, when the same rates as in 1896 were in force, the remainder of the decrease—namely, £2,253, took place in the second half of the year; and no less than £1,944 of this decrease was due to the reduction in the rates agreed to at the International Telegraph Conference at Budapest and to the mode of counting words and figures in extra-European telegrams agreed to at that time. Up to June 30, 1897, ten letters or three figures were counted as one word, whereas since July 1, 1897, fifteen letters or five figures are admitted as one word. A great number of the extra-European telegrams we carry over our cables are in cipher, generally in groups of four or five figures. For each group we were paid at the rate of two words previous to July 1st last, but now we only receive the rate for one word. This alteration alone represents a considerable portion of the decrease in the receipts. Without the reductions of rates, &c., the decrease in the traffic for the year would only have been £983, which would have been very satisfactory, I think, considering the quite exceptional traffic of the year 1896. The working expenses are £223 in excess of those of 1896. The increase on salaries amounts to £204. That is consequent on the conditions of the service which provide for certain regular increases of salary up to a maximum. Your former Chairman, Sir John Pender, referred to this matter in 1893, pointing out that it was absolutely necessary that some arrangement of this sort should be made if we were to expect to secure the services of good men. There is a small increase of £39 for repairs and renewal of instruments and landlines. I need hardly point out to you the necessity of our machinery being kept up in first-rate condition. Travelling expenses show an increase of £45, owing to there having been more removals of clerks from one station to another than in the previous year. Office and incidental expenses also exhibit an increase of £32. There is a considerable

decrease in stationery—namely, £60; and the cost of printing and advertising is £27 less, while the legal expenses are also £24 less than during the previous year The sum of £52 had been expended in further deviation of the Company's underground lines at Bilbao, such deviation being made compulsory by the local authorities. Taking into consideration the bonus granted to the staff—to which I shall further allude presently—it will be seen that the extraordinary expenditure is only £118 in excess of that for the year 1896. I am glad to be able to say that the Company's cables and the landlines are in good working order. On the occasion of the last general meeting I referred to the litigation connected with the Bilbao breakwater, and mentioned that the case would be tried before the Tribunal de Contencioso at Madrid on April 10th, and on that date this tribunal gave its decision, which, as you are probably aware, was adverse to the Company. The decision of the judges was mainly based, it appears, on points of law. It is final, and the Directors have, therefore, transferred the balance of revenue, amounting to £2,489, to the reserve fund, towards the repayment of the cost of the removal. With respect to Her Majesty's Diamond Jubilee, you are probably aware that all the leading telegraph companies thought it right and proper to commemorate the event by granting a bonus to their employés. We were of opinion—which I hope will be endorsed by the shareholders, both present and absent—that it would not be fair to make an exception of the employés of this Company, who are in no way inferior in zeal and attention to their duties to those to whom the bonus had been granted in other companies. The bonus was equal to 10 per cent. of the annual salaries to all the members of the permanent staff having more than five years' service, and to five per cent. to those having less than five years' service. The whole sum is not a very important one, and I am sure that the granting of the bonus will act as a stimulus to the employés of your company. I do not think it is necessary to add any further remarks, but I shall be very glad to answer any questions. I think, however, that I may mention that since January 1st last, and up to the present date, the traffic is in excess of that during the corresponding period of 1897; but the receipts are not quite as large, owing to the reduction of rates, &c. We have, therefore, begun the year prosperously on the whole, and I trust that this condition of prosperity may last. He concluded by moving the adoption of the report and accounts.

Mr. JOHN DENISON PENDER seconded the motion.

Mr. GEO. STIMPSON said he quite endorsed what the Chairman had said respecting the staff, but he thought that the Jubilee of Her Majesty might also have been marked by an increase of dividend to the shareholders, and he regretted that the Directors had not seen their way to propose a larger dividend. The reserve fund was already a considerable percentage on the paid-up capital, and he desired to know whether it was an understood thing that £5,000 per annum was to be placed to the reserve fund. In the abstract, a reserve fund was a most admirable feature, but, in his opinion, it could be carried to excess.

The CHAIRMAN: We share as much as the hon. gentleman who has just spoken in the wish that the dividend might be larger, and now that we have got rid of the Bilbao expenditure I hope that the accounts will show better next year. I believe that the principle has been adopted and acted upon of paying a regular dividend rather than a large dividend. A principle upon which all the cable companies have gone has been to strengthen in every possible way their reserves, and I hope that this policy will meet the approval of the shareholders in the future as it has done in the past. He then put the motion, and declared it carried. Continuing, he proposed the payment of the dividends for the half-year at the rate of 10 per cent. per annum, less income tax, on the Preferred shares, and at the rate of 4 per cent. per annum, free of income tax, on the Ordinary shares.

Mr. J. DENISON PENDER seconded the motion, which was carried unanimously.

Resolutions were afterwards passed re-electing the retiring Director, Mr. F. Alexander Johnston, and the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

On the motion of Mr. M. B. PEARSON, seconded by Mr. J. S. ANDERSON, a vote of thanks to the Chairman and Directors was passed.

Metropolitan Electric Supply Company (Limited).

The eleventh ordinary general meeting of this Company was held on Tuesday, at Winchester House, Old Broad-street, under the presidency of Sir Eyre M. Shaw, K.C.B.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.) having read the notice convening the meeting, the report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, in rising to move the adoption of the report and accounts I desire, as usual, to offer a few remarks, though I think that these accounts are given in sufficient detail to obviate the necessity of detaining you very long in explaining them. Dealing first with the capital accounts, as shown in Statements 1 and 2, you will see that the only capital raised during the year has been £62,500, the balance of the £125,000 new capital which was issued in 1896, and which from June 30, 1897, became part of the Ordinary share capital of the Company. Statement No. 3 deals principally with the expenditure on capital account amounting during the year to £93,795. 16s. 10d., with a grand total of £850,831. 10s. 9d., and a balance of £29,597. 18s. 10d., which is now practically expended, a matter to which I shall have to refer later on. The principal items of expenditure have, as usual, been the continually-extending mains, which account for £38,869. 12s. 5d., and the expenditure on transformers and meters for the supply of the increasing list of our customers, who now number about 6 000. These two items, transformers and meters, with their connections, absorb £15,823. 4s. 2d., making, with the mains, an expenditure of £54,692. 16s. 7d., or considerably more than half of the total sum expended during the year. The remaining items of any importance are lands, £12,801. 8s. 5d. being the cost of purchase of our new site for generating works at Willesden; buildings £9,445. 18s. 11d. represented by extensions at Amberley-road, Sardinia-street, and Manchester-square; and machinery £15,367. 16s. 1d., which has been expended on account of equipment of those extensions, an equipment which, when completed, will materially increase our facilities for supplying our customers. We will now turn to the revenue account which shows the result and cost of our working during the year, and from this account it will be seen that the income from current is steadily increasing, giving a total revenue of £138,267. 14s. 6d., as against £116,459. 4s., an increase of about £22,000, or 19 per cent. The expenditure to earn this larger income also shows, as will be expected, an increase, but not to so great an extent, being for cost of generation £58,604, against £52,619, an increase of £5,985, or 11½ per cent., principally due to the increased consumption of coal and oil; and a total revenue expenditure of £79,546 against £70,267 in 1896, being a total increase of £9,279, or 13 per cent. as compared with 19 per cent. increased income, as already stated. The increases shown in distribution have arisen from the extensions of mains and developments of the system of low-pressure distribution, while the growth of management expenses has been caused partly by necessary additions to the Company's staff in order to cope with the rapidly-increasing work, and partly by the larger amount of the Directors' fees. With regard to these fees, I think it right to remind you that some years ago the Board agreed among themselves to take a very considerably-reduced remuneration from that allowed by the Articles of Association, until the Company should be earning substantial dividends, and that even at the present time the full amount allowed by the articles is not drawn. As I informed you at our recent extraordinary general meeting the number of new customers continues at even greater rate of increase that at any former period in our history, and there are many indications tending to point to a still more rapid growth in the immediate future. Believing, as we do, that to be truly a success the electric light must be regarded less as a luxury and more as a necessity we have, after the most careful consideration, decided to make substantial reductions in our rates of charge from the commencement of the present year, which, though they may affect our revenue to some extent for a little time, will, we feel convinced in the long run, amply justify our policy by the extended business which it will bring to us. This continual increase, while it is extremely satisfactory as pointing to the continued growth of our business, involves us in the obligation of making adequate provision for our future requirements. I have already informed you of the reasons which led us to procure a most advantageous site at Willesden, on which it is intended to erect large generating works, the establishment of which will relieve us from any anxiety for many years to come. By gradually extending these works as occasion may arise (and there is ample space at our disposal for doing this) we can place no limit to the amount of power which can be produced. Intimately connected with these extensions as affecting our cost of manufacture and distribution, which it is our earnest desire to reduce to their lowest possible figures, is the development which we have now in progress for changing our system of supply in those portions of our areas where the lamp density warrants the laying down of low-pressure mains, and we have every reason to hope that a large portion of this work will have been completed before the close of the present year. The mention of these new works leads me naturally to the question of new capital. Before, however, dealing with this matter I propose to lay before you, as briefly as possible, the result of our recent negotiations with the holders of the Founders' shares. You will remember that at the last general meeting an undertaking was given by me that efforts would be made to come to an arrangement with the Founders for the conversion of their rights. We accordingly gave the subject our most careful consideration, and after taking the opinion of our financial and legal advisers we prepared a scheme which had as its basis an allotment of 140 new Ordinary shares at par in exchange for each Founders' share. This was met by a proposal on behalf of the holders of Founders' shares that the exchange should be in the basis of 300 shares instead of 140. This the Directors could not see their way to accept, and the demand was then reduced to 250, still much too high a figure in the Directors' view. We very greatly regret the failure of these negotiations, for it would manifestly have been to the best interests of the Company as a whole that they should have succeeded. In our circular to the Founders we indicated that in our opinion the Ordinary shareholders could not be asked to pay a premium on any issue of new shares, seeing that the effect of this premium would be, as we think, unreasonably to improve the position of the holders of the Founders' shares at the expense of the Ordinary shares. To this opinion we adhere, and unless within a very short time we are able to come to terms with the Founders, we shall probably issue a large portion of the new capital to the existing shareholders at par, though it is our intention to postpone dividends on these shares until the new works can fairly be expected to be earning their proper proportion of revenue. We have been informed that at least one of the Founders intends to attempt to restrain us by legal means from adopting this course, on the ground that by so doing we are prejudicing the rights of the Founders. Well, gentlemen, much as we regret the possibility of this course being taken, we think it best that once and for all the discretion of the Board in matters of this kind should be clearly defined. Exception has also been taken to the way the Directors have dealt with "Premiums on Debenture Stock and New Shares, &c." (£35,429. 9s. 7d.), which we propose should be added, less 10 per cent., to reserve. Mr. Orrell, (a Founders' shareholder), asks us to place the whole of the premiums already received (less 10 per cent.) to revenue account, and a little further on he requests us to gives the Founders an assurance that the Board will obtain the best price they can get for the new shares, feeling sure (though

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he only speaks for himself) that the Founders will agree to the placing of such future premiums to reserve. With regard to the sum of £35,000 this has not been treated, and in our opinion ought not to be treated, as a revenue profit for any dividend purposes whatever, and the same remark applies to any future premiums. If Mr. Orrell's contention be valid that it is the duty of the Board to treat premiums as profits divisible as dividend after deduction of 10 per cent. as reserve, it will be seen that, the dividends being immediately forced up above the 7 per cent. limit, the Founders will obtain a very large proportion of such premiums at once, while the security of the Ordinary capital in respect of its future repayment will be proportionally diminished. Of course, whatever Mr. Orrell may say, the holders of Founders' shares cannot treat premiums both as revenue profits, and as reserve as well; but it is clear that in either case the issue of shares at a premium will be more to their benefit than to that of the Ordinary shareholders. With these remarks, gentlemen, I beg to move the following resolution:—

"That the report and accounts for the year ended December 31, 1897, presented to this meeting be and are hereby approved and adopted, and that, in addition to the interim dividend of 5s. per share paid on October 15, 1897, a further dividend of 7s. per share on the whole of the original Ordinary shares and of 6s. per share on the new shares of the Company be and the same is hereby declared, such dividends to be payable on March 30, 1898, to all holders who were on the Company's registers on March 19, 1898."

Admiral of the Fleet Lord JOHN HAY, G.C.B., seconded the motion.

A discussion followed, practically entirely with reference to the Founders' shares, and the price at which they should be acquired, and whether the new capital referred to by the Chairman should be issued at a premium or at par, those who took part in the discussion being Mr. Harris, Mr. Young, Mr. Orrell, Mr. Baldwin, Mr. John Newton, Mr. Jeffries and Mr. Sheild.

Mr. W. HARRISON CRIPPS (a Director) stated that he had listened with great interest to the speeches which had been made. It had been objected that there were Founders at all in the Company, but he thought it must be remembered that if there had been no Founders there would have been no Company, and in that case those who had bought Ordinary shares at £10 each would not find them worth, as they were now, £20. Although, therefore, the Founders had been a necessary evil, yet, after all, it was they who originated the Company. He had himself only recently been made a member of the Board, but years ago he fancied that the Company had got prospects before it, and he therefore invested no inconsiderable sum in the undertaking. He was the largest holder of the Founders' shares, and he was nearly the largest holder of the Ordinary shares, so that he had an interest practically on both sides. When he bought his shares he had no idea of being a Director of the Company. He might say, as showing that his interests and those of the shareholders were nearly identical in the success of the Company, that if he were now to sell his shares—Founders' and Ordinary—in the open market they would realise not far short of £70,000. He believed in the future of the Company, and that if they could only adjust the differences which had arisen in the Company, it would be one of the most successful electric concerns in London or in any part of the kingdom.

The CHAIRMAN, in further reply, stated, in answer to Mr. Young, that they had considerable competition in two or three places. The Marylebone Vestry was applying to Parliament for certain powers for supplying electricity in a portion of the Metropolitan Company's district, and the opposition of the Chelsea Vestry was on account of some detached portions of that parish through which this Company went. The purchase of current, to which Mr. Young had referred, came from two Companies—the City Company and the London Company. In regard to the remarks of Mr. Jeffries, he was afraid that some doubt existed in the minds of some of the members regarding the subject of depreciation; but the Directors were advised that they were compelled, before dealing with the profits, to lay aside a sufficient amount for depreciation, after which they dealt with the profits. As to settling with the Founders' shares, the Board had gone as far as they had felt justified, and he did not, in fact, know how much further they could go. He then put the motion, and declared it carried.

Resolutions were afterwards passed for re-electing the retiring Directors (Lord John Hay, Mr. Cripps and Mr. Lubbock) and the auditors (Messrs. Deloitte, Dever, Griffiths, and Co.).

On the motion of Dr. Haden-Haden, a cordial vote of thanks was passed to the Chairman, Directors, Secretary, and Staff.

The CHAIRMAN briefly acknowledged the vote, and the proceedings terminated.

Willans and Robinson (Limited).

The ordinary general meeting of Willans and Robinson (Limited) was held on Wednesday at the Cannon-street Hotel, under the presidency of Mr. Mark Robinson.

The SECRETARY (Mr. C. S. Essex) read the notice calling the meeting, and the minutes of the last meeting were taken as read and signed as correct by the Chairman. The report of the Directors was also taken as read.

The CHAIRMAN then said: Gentlemen, in moving the adoption of the report and accounts I think I may say that, regard being had to the many difficulties we worked under last year, the accounts are equally satisfactory for the past and promising for the future. We have not had easy times since our last meeting, for if the great strike passed us by, so far as concerns the relations between the Company and its own workpeople—which relations were never better—yet many firms upon whom we depended for assistance, in the form either of stores or of finished engine parts, or of tools for our works, had their shops brought wholly or partly to a stand, and their labour troubles reflected heavily upon us, and kept down our output of engines. Tools which we ordered over a year ago are still undelivered, and thus a part of our capital has been idle for a year, drawing interest while producing no engines. The unsettlement of the labour market made it difficult to get additional men last year, and now with every engineer's shop filled with arrears of work, and with the strongest inducement to take on every man available, the question of increasing the number of workmen—that is, of the right sort—is almost as difficult as it was six months ago. However, we are gradually surmounting the many troubles entailed by the move to new works and by the strike, and I have no doubt you will agree that such a balance-sheet as we now lay before you is even more satisfactory as the outcome of a difficult time, than if it represented a period when all went well with us. As you know, the policy of the Directors has ever been one of caution, and in that they are glad to say they have had the strong support of the shareholders. But they have no fear that you will see any want of caution in the moderate rise of dividend now recommended. Depreciation, you will have noticed, has increased by over £1,100 for the half-year, and this item we must expect to increase further as the new works are gradually completed, and their depreciation has to be provided for. To the debenture sinking fund we carry the usual contribution of £2,000, and to the reserve fund proper the increased sum of £1,500, making £2,500 for the year, or no less than £6,500 reserved out of profits, in one form or other, during the 12 months. This is no mean record, in such times as we have had to contend with. As I have already said, the accounts are not only satisfactory in themselves, but of excellent augury for the future. The prospects of work before us are all we can desire. It is no longer doubtful that electric traction is about to receive a great development in this country, and in this the Willans engine will play a leading part. Its suitableness for the work has been amply proved. Already an engine to indicate up to 1,500 H.P. is under construction for traction work, and we have been called upon to prepare designs for an engine of 2,500 H.P.; in fact, the patterns for this engine will be in hand immediately. The size of the engines we make has indeed increased to a startling extent, and I am glad to say it is becoming clear that the larger the Willans engine is made the more successful it proves. This development in size threatens, in fact, to go beyond the utmost anticipations of the Directors, and to involve additions to our plant beyond what the present capital provides for in order that we may deal with heavier weights and larger work. The question is not immediate, but it is well to mention it, because the Directors until lately believed (in accordance, I may say, with their own strong desires), that a point of comparative finality had been reached, and that there was at least a long halt before us. The success of the engine has defeated such calculations before and it may do so again. When a new branch of work offers itself unsought, as one may almost say—work which shows every sign of permanence, and of a magnitude which promises to exceed that of all our other sources of business—then we must prepare to welcome it, or bear the penalty of those who will not rise to the occasion. As I have said, there is no immediate question of extensions; we are well able to deal with any demands which are probable in the near future. But if the demand continues to grow in the way which now seems probable, then other ideas will have to prevail. Fortunately, at Rugby, we are at last in a position where extensions, when necessary, can be made rapidly and economically, and it is to our interest to have it known that we shall not hesitate to make them, when the real and permanent needs of a new and most important industry demand it. As has been mentioned before, the great engineering strike did not affect the relations of the Company with its workpeople. Nevertheless the Directors felt strongly that the Federated Employers were in the right, and they did not conceal their opinion that no more mischievous movement, from the point of view of the interests of the country, had ever been undertaken by the leaders of the men. In their opinion the real question was not whether hours should be longer or shorter, or even whether the masters, as the phrase went, should manage their own works, but the still more serious question whether men should do honest work at all: whether they should do a fair day's work, or whether they should act almost avowedly on the principle of turning out as little work as possible. On these grounds the Directors' sympathies were with the employers, but they felt that they could not honourably join the federation, for they had no possible ground for difference with their workmen. No demands were made by them, nor was there probability of any being made, because for many years this Company has enjoyed to the fullest extent, that liberty in arranging the work of their shops, and in settling the conditions of labour, which other employers have now only obtained after a disastrous struggle. The firm of Willans and Robinson fought its battle, and won it unaided, many years ago, and not only have its relations with its workmen been uninterruptedly cordial from that time to this, but there is ample evidence that its methods of working, and its insistence upon honest work have the approval of the workmen and are in no danger of challenge from them. We hope these excellent relations will now be even better still; for in pursuance of a long-desired scheme for binding our older hands more closely to us, we have instituted (since the close of the strike) a system of long-service bonuses, which we think will give our men a strong inducement to remain with us, and the offer of which, I am glad to say, was received with much satisfaction. Turning to the details of the accounts, I think there is little which does not carry its explanation on its face. The balance of the premiums on the last issue of shares is still carried forward, as it is impossible as yet to close the removal account, and until that is settled we shall not know how much we can afford to write off from our Ditton premises, in accordance with the arrangements of which the shareholders have already signified their approval, or what balance will remain for the reserve fund. It is proposed to carry the premiums upon the last new issue to the same account. On the other side of the balance sheet there is a small diminution of "Work in progress"; we were naturally in a better position for getting out work in December than in June, when there was a plethora of unfinished work which we could not complete. Increase in materials and

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stores is always unwelcome, and it is watched and resisted by the Directors with the utmost jealousy, but it is an inevitable accompaniment of larger business. In the Profit and Loss Account the most noticeable change, I am happy to say, is in the amount of Gross Profit. Royalties have fallen, but this is mainly the result of payments being made at times which do not correspond with our half-years. On the expenses side, there are some natural and inevitable growths, and some reductions, of which, however, I should be sorry to guarantee the permanence. On the whole there is an increase of nearly £1,000, but this is more than accounted for by the single item of depreciation, increase in which is rather an evidence of prudence than an increase of working expenses. On the other hand, this half-year escapes the contribution to the Fire Insurance Fund, which is annual, so there is upon the whole a moderate increase in the charges. I will anticipate a question which will doubtless be asked respecting the success of the recent small issue of shares which were offered, of course, to the shareholders only. 3,000 Preference and 3,000 Ordinary shares were to be issued. Owing to the effect of fractional holdings, only 2,838 Preference and 2,854 Ordinary shares were provisionally allotted– subject, that is, to acceptance. The numbers accepted were 2,447 Preference and 2,296 Ordinary. The balance was applied for ten times over by our own shareholders alone, and I trust those who may have been disappointed in the allotment will accept my statement that the Directors did their best to treat everyone fairly. The Directors cannot but feel gratified by the success of the issue, considering that it has been made at a time when confidence is by no means universal, and when all engineering enterprise has been to a certain extent discredited by the great strike. He concluded by moving the adoption of the report and accounts.

Mr. ALFRED R. HOLLAND (a shareholder), in seconding the motion, said the way in which the business was carried on reflected the greatest possible credit on the Directors, and particularly on the Managing Director.

Mr. BRYAN DONKIN and Mr. COUSINS afterwards addressed the meeting, their remarks being entirely of a congratulatory nature regarding the progress, the position and prospects of the Company.

The CHAIRMAN, in answer to questions, said that they would all be glad to see the reserve fund larger, but he hoped it would be remembered that what they carried to Debenture sinking fund was virtually carried to reserve fund. Their relations with their men were just as good now as they were before the strike. What he had said as to the opinion of the Directors regarding the unwisdom of the action of the men had no application to their own employés, who had nothing whatever to do with the strike. The bonus which they gave to their men, to which he had referred, was in recognition of their long and faithful services, and was not in substitution for increased wages. The work done by the men was not piece-work, but was more or less related to it. The essence of it was that the fixed prices were never altered, and it was understood that they were not to be altered unless the conditions of work changed. Since the shareholders' meeting last year at Rugby the foundry had been started, but there was not much doing there at present. The boiler shops were not yet working, but they did not think that they had suffered from the delay. They had thus been able to gain more experience of the Niclausse boiler, and the greater knowledge they had obtained was all in its favour. As regarded the market price of the shares this was a matter which he did not know much about, but the latest transfers were at 8¼. They would like to concentrate everything at Rugby, but pending their getting a good offer for their Thames Ditton works the latter would do the Company good service. He then put the resolution, which was carried unanimously. He afterwards proposed the payment of dividends for the half-year ended December 29 last at the rate of 6 per cent. per annum on the Preference shares, and at the rate of 8 per cent. per annum on the Ordinary shares.

Mr. BRYAN DONKIN seconded the motion.

Mr. G. W. ANDERSON said he was sure that all the shareholders would agree in expressing satisfaction at the result of the year's business and the able management of their affairs, but in view of additional capital requirements he thought it a pity that an increased dividend had been paid.

Mr. HOLLAND and Mr. ERSKINE dissented from this view.

The CHAIRMAN, in reply, said that the Board had considered both sides of the question, and it had appeared to them that the balance of advantage was in the direction of a moderate increase in their dividend. They had made what were ample reserves, and in fact there was a reserve which did not appear on the surface, owing to prudent valuation. He then put the motion, which was carried *nem. con.*

Resolutions were afterwards passed, re-electing the retiring directors (Mr. Robinson and Capt. M. H. P. R. Sankey) and the auditors (Messrs. Cooper Bros. and Co.)

A cordial vote of thanks to the Chairman and the officials of the Company was afterwards passed.

The CHAIRMAN acknowledged the vote, and the proceedings then terminated.

Brockie-Pell Arc Lamp (Limited).

The adjourned second ordinary general meeting of this Company was held on Tuesday at Winchester House, London, E.C. Lord Suffield presided, and said the Board regretted that the results shown by the accounts were not more satisfactory. Great difficulty was, however, experienced in securing suitable workshops, and, as he informed them at the statutory meeting, it was only after considerable delay that they obtained what they wanted. On Mr. Brockie the task, then, devolved of fitting the workshops up with suitable machinery. Most of the English houses were at the time full of orders and could not undertake to supply machinery within less than four or five months. Recourse had, consequently, to be had to firms abroad, and from these some of their most important machinery was obtained within a reasonable time. The first 100 lamps made entirely at their factory were not, however, completed until the end of July last, so that only about six months remained up to the date of closing the accounts in which to make manufacturing profits. As showing the estimation in which the Company's lamps are held, it might be stated that the whole of the first 100 made by them were erected in the principal streets of the City of Glasgow. Among the numerous customers of the Company during the period under review were several departments of Her Majesty's Government, corporations, vestries, railways, &c. The orders received by the Company from month to month had shown a steady growth, which must be regarded as satisfactory. It must be obvious to the proprietors that until their workshops were completed the Company was not in a position to supply the public with the lamps. The Board, therefore, allowed the late makers to continue to manufacture the lamps for some months, and to execute the orders they received on payment of a royalty to the Company. It would thus be seen that the Company had not the benefit of any manufacturing profit on the greater part of the business transacted since its formation. After lengthy negotiations the Directors signed a contract in October last for the sale of the French and Belgian patents for £3,000 in cash; and shares in a company to be formed. Alluding to the prospects of the Company for the current year, he said at the present time they had in hand unexecuted orders amounting to between £8,000 and £9 000 although they had not yet reached the first quarter of the year, and he had no doubt that in succeeding months they would have a great many more orders. He concluded by moving the adoption of the report and accounts.

Sir DIXON-HARTLAND, M.P., in seconding the motion, said he could not but feel that the accounts were very disappointing, but he could assure them that they at least showed the true position of the Company. There had been no attempt made to keep anything back, and so they knew the real state of the Company's affairs. He did not think that anyone not a Director of the Company could appreciate the trouble and anxiety the Board had experienced to accomplish as much as had been done. They had, to a certain extent, been environed by difficulties which were unforeseen at the time the Company was brought out, but he honestly believed that they were now on the road to success. Referring to certain disputes which had arisen between the Company and Messrs. Johnson and Phillips, the late manufacturers of the lamps, he said the Board had been compelled to move for an injunction against that firm to restrain them from infringing the Company's patents. The system of dual management, which was at first tried by the Company, had proved a failure, and they had put an end to it. He had never believed personally in such a system, and was glad to say they now had one responsible managing director. If they had failed in earning a profit during the period under review, it was not through lack of diligence or attention to the Company's affairs, but because, as in most new companies, unforeseen difficulties had had to be overcome.

Mr. CLEMENT thought, in view of the expenses, that there was very little chance of the Company ever paying a dividend.

Mr. HILL criticised the accounts, and drew attention to the low price of the shares.

Mr. SKIPWITH said he never knew a company started with such wonderful prospects on paper which had such a bad record to show as this one, and he moved, as an amendment, the appointment of a committee of shareholders to inquire into its affairs.

Mr. CLEMENT seconded the amendment.

Mr. E. L. WAUGH thought if those shareholders who had written letters of complaint to the newspapers had only been aware of the difficulties which the Board had to overcome they would not have been so ready to find fault. It was not his experience that companies of this nature did great things during the first year of their existence. The mere fact that Mr. Pell and the Directors held between them two-thirds of the total capital was some surety that those gentlemen would do the best that was possible to make the Company a success.

Sir DIXON-HARTLAND, replying to the discussion, remarked that as their business grew the expenses of which Mr. Clement complained would not grow in anything like the same proportion. They had not let their French and Belgian shares go for a paltry £3,000, as some shareholders appeared to think. In addition to receiving that sum in cash they were to have 25 per cent. of the shares of a company which was to be formed to acquire such patents.

After further discussion the amendment was withdrawn, Mr. SKIPWITH expressing himself satisfied with the explanation of the Chairman and Sir Dixon-Hartland on various matters.

The resolution was then passed and the retiring Director (Mr. H. W. Maynard) re-elected.

British Electric Traction Company (Limited).

The report of the Directors of this Company for the period from Oct. 26 1896, to Dec. 31, 1897, is as follows: –

Capital Account.—The Company was registered in October, 1896, and 20,000 of the 30,000 Ordinary shares offered for subscription were allotted. The subsequent issue of the remaining 10,000 Ordinary shares produced a net premium, after payment of expenses, of £1,218. 15s., which has been applied in reduction of preliminary expenses account. Since the closing of the books an issue has been made of 10,000 Six per Cent. Cumulative Preference shares of £10 each, at a premium of £2. 10s. per share. The proceeds of this issue will be brought into next account.

Profit and Loss Account.—The gross profits amount to £14,422. 14s. 9d., and, after deducting the proportion of general expenses chargeable to revenue and the expenses incurred in connection with schemes not proceeded with, there remains a net profit of £9,804. 9s. 6d., which the Directors propose should be carried forward.

Contracts and Undertakings.—Arrangements for the adoption of electric traction at the following, among other places, are in various stages of progress:—Coatbridge and Airdrie, Cork, Crewe, Dudley, Stourbridge and

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District, Gateshead-on-Tyne, Hartlepool, Lake District, Kinver, North Shields, Tynemouth and District, North Staffordshire, Oldham, Ashton and Hyde, Kidderminster and Stourport, Middleton and District, Paisley and District, Potteries District, South Staffordshire, Swansea and Wolverhampton and District. Provisional arrangements have also been made, and negotiations are pending in regard to a number of other places; but it would be premature or inexpedient to refer to them in this report. In some of the above cases agreements have been made for the purchase or leasing of existing tramway undertakings, while for other undertakings, Parliamentary powers or orders under the Light Railways Act have been secured or applied for. In some instances the Company has acquired the majority of the shares of existing tramway companies, and controls the business of such companies with with a view to the adoption by them of electric traction. In a few cases the arrangements have been made in co-operation with other parties. With regard to South Staffordshire, the existing electric tramways are being worked by the Company, and are a source of income. Contracts have been placed with responsible parties for the work of construction and electrical equipment at Dudley, Stourbridge, Hartlepool, Kidderminster and Stourport, North Staffordshire, Oldham Ashton and Hyde, and Potteries, and the work is being proceeded with.

Rand Central Electric Works (Limited).

The report of the Directors of this Company for the year 1897 states that steady progress has been made in completing various installations and connecting them with the main service, and it is expected that the revenue from the constantly increasing power supply will show a satisfactory return for the current year. Up to Dec. 31 last the station had only been in partial operation, supplying but a comparatively small proportion of the power contracted for, and therefore the revenue derived from power supply during the past year is no criterion of future earnings. The earnings of the past year do not, however, affect the dividend payable to the shareholders, because Messrs. Siemens and Halske guaranteed that the net profits available for dividend in the financial year under consideration would be at least 6 per cent., which is the amount the Directors have decided to recommend. The contractors' guarantee commenced as from Jan. 1, 1897, and the Directors considered it advisable that the financial year of the Company should run concurrently with the period of guarantee.

The amounts due to the contractors under the equipment contract have now been paid. Under the existing contracts Messrs. Siemens and Halske guaranteed net profits for the year ended Dec. 31, 1897, sufficient to provide a dividend of 6 per cent. on the share capital after the Company had carried to reserve a sum which for that financial year would amount to £2,000. The Directors contended that the contractors were in strictness bound to provide this reserve. Inasmuch, however, as the Company had already created a reserve fund considerably in excess of £2,000, which the contractors urged ought to be considered as legitimate revenue in diminution of their guarantee, and in view of the expediency of settling various outstanding differences with the contractors, the Board waived their claim to a further increase of the reserve fund for the past year. The sum of £262. 5s. 6d. has been applied out of the reserve fund, to which it was temporarily carried, towards the payments due to Messrs. Siemens and Halske under the equipment contract in connection with the administration of the Company.

NEW COMPANIES, STATUTORY RETURNS, &c.

GLOBE ELECTRICAL ADVERTISING SYNDICATE (LIMITED).—This Company was registered on March 26, with a capital of £1,000, in £1 shares, to carry on the business of advertisers by means of electric light or otherwise, electrical engineers, &c.

IMPROVED TELEPHONE PATENTS (LIMITED).—This Company was registered on March 28 with a capital of £300,000, in £1 shares, to enter into an undescribed agreement, and to manufacture, purchase, adapt, prepare, alter, improve, repair, use or otherwise deal in or with any materials, machinery, apparatus, appliances, tools, articles, requisites, supplies and things connected with all or any part of the working of telephones, telegraphs or other means of communication.

MID-AIR BULLETIN SYNDICATE (LIMITED).—This Company was registered on March 15, with a capital of £6,500, in £1 shares, to acquire, develop, work, and deal with any inventions relating to advertisements, signalling or communicating information by means of electric lamps or otherwise, and in particular the letters patent already granted to Mr. Lucien S. Crandall for improvements in electric signalling and other apparatus, and to enter into an agreement with Mr. W. H. Ryle. The first subscribers (each with one share) are: Frederick Brown, electrical engineer, Walsall; Lucien S. Crandall, J. E. Sheldon, W. H. Ryle, H. A. Pepper, E. M. Rudland, and J. S. Remington. Mr. W. H. Ryle is chairman.

MUTUAL TELEPHONE COMPANY (LIMITED).—This Company was registered on March 23, with a capital of £250,000 in £5 shares, to establish, work, control and regulate telephone exchanges and works for the supply of electric light, heat and motive power, to enter into an agreement with the Mutual Telephone Syndicate (Limited), and to carry on the business of a telephonic, telegraphic and electric light company in all or any of its branches. The first subscribers with one share each, are:—N. Bradley, B. Robinson, W. Lees, G. Evans, A. Macnair, W. Thomson and F. Scott (all of Manchester and district).

NATIONAL ENGINEERING SUPPLY COMPANY (LIMITED).—This Company has been registered in Edinburgh, with a capital of £2,000, to carry on business at Glasgow as steam and electrical engineers.

SIMPLEX STEEL CONDUIT COMPANY (LIMITED).—This Company was registered on March 26, with a capital of £10,000, in £1 shares, to manufacture, sell, and deal in all kinds of fittings for electrical wiring and any other apparatus and accessories used, or capable of being used, in connection with the erection and fitting up of electrical installations, plant, and apparatus, and to carry on the business of metal tube manufacturers, wire-drawers, electrical, mechanical, and hydraulic engineers, &c. The first directors are: Henry Huggins and Frederick Huggins, and Peter C. Middleton.

F. W. SMITH AND CO. (LIMITED).—This Company was registered on March 22, with a capital of £5,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The first subscribers are:—Frederick W. Smith, electrical engineer, G. F. Travis, S. R. Park, J. Richmond, J. White, W. H. Hall and R. F. Stephenson.

NEWCASTLE AND DISTRICT ELECTRIC COMPANY (LIMITED).—The annual return to March 8 has been filed. The nominal capital is £100,000 in £10 shares, of which 9,918 have been taken up. £8 per share has been called on 5,000, and £4 per share on the remainder.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return to February 24 states that out of a capital of £100,000 in £5 shares, 9,259 have been taken up. 301 have been issued as fully paid, and the full amount has been called on the remainder.

NEWMARKET ELECTRIC LIGHT COMPANY (LIMITED).—The annual return to March 21 has been filed. The capital is £30,000 in £10 shares, of which 36 have been taken up and paid for in full.

NORTHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return to March 10, has been filed. The capital is £50,000 in 10 "A" and 49,990 "B" shares of £1 each. All the "A" and 22,000 of the "B" shares have been taken up and the full amount has been called on all the former, and 17,710 of the latter, while 10s. per share has been called on 4,290 "B" shares.

OKONITE COMPANY (LIMITED).—The annual return to January 14 has been filed. The capital is £320,000 in £10 shares (of which 16,000 are Preference). All the Ordinary and 15,995 Preference have been taken up, and 9,332 have been issued as fully paid. The full amount has been called on the remainder, resulting in the receipt of £225,665.

CITY NOTES

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 25 1/16d. per oz. (March 31). Consols (2¾ per cent.) 111⅜—111⅝ for money, 111⅜—111⅝ for account; 2½ per cent. 104½—105 (March 31). Stock Exchange Settling Days: Consols, April 1; Stocks and Shares Continuation Days, April 13 and 27; Ticket Days, April 14 and 28; Pay Days, April 15 and 29; Mining Share Carry-over Days, April 12 and 26.

SIR W. G. ARMSTRONG, WHITWORTH AND CO. (LIMITED).—The Directors of this Company have declared an interim dividend at the rate of 5 per cent. per annum on the Ordinary shares and 4 per cent. per annum on the Preference shares, being at the same rate as last year.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY COMPANY (LIMITED).—The statutory meeting of this Company was held on Monday, the Right Hon. Lord Rathmore presiding. The Chairman said: This is the statutory meeting. There is no special business to be transacted, and there is no resolution to be proposed. I may state that the Company's liability to the vendor company in respect of the purchase price has been discharged, and the purchase has been completed. An official settlement and quotation on the Stock Exchange have been applied for, and we are expecting to hear that it has been granted. A vote of thanks was passed to the Chairman and Directors.

BRITISH AND FOREIGN DU BOIS COMPANY (LIMITED).—In the early part of the week this Company, which has been formed, with a capital of £150,000 in shares of £1 each (of which 90,000 are Seven per Cent. Cumulative Preference), to acquire and carry on the business of the British Du Bois Manufacturing Company (Limited) and of amalgamating with it a similar business carried on in Germany by the Du Bois Manufacturing Company (Limited) under the style of C. Herbert Torrey, invited applications for the whole of its Preference shares. The list closed on Wednesday.

CHADBURN'S (SHIP) TELEGRAPH COMPANY (LIMITED).—As intimated in our last issue this Company has this week invited applications for 50,000 Six per Cent. Cumulative Preference and 50,000 Ordinary shares of £1 each. The total capital of the Company, which has been formed to acquire and carry on the businesses of Chadburn and Son (Limited) and Thomas Bassnett (Limited), is £120,000 in £1 shares (of which £60,000 are Preference). The lists closed on Wednesday.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—Notice is given that a drawing of 451 Five per Cent. Australian Government Subsidy Debentures in this Company will take place on Monday, April 4, at the offices of the Company, Winchester House, Old Broad-street, London, E.C.

NORTH STAFFORDSHIRE TRAMWAYS COMPANY (LIMITED).—At the meeting of this Company on Wednesday the Chairman (Mr. E. J. Hammersley, J.P.) referred to the steps that had been taken to improve the system and to introduce electric traction. He announced that Mr. V. B. D. Cooper had been elected to a seat on the Board. Resolutions approving certain agreements with the British Electric Traction Company, in connection with the electrical equipment of the lines, were submitted and agreed to.

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BRITISH ELECTRIC TRACTION COMPANY (LIMITED).—The transfer books and register of members of this Company are closed from 28th ult. to 7th inst., inclusive.

CROMPTON AND CO. (LIMITED).—The petition for the confirmation of the special resolution reducing the capital of this Company from £280,000 to £162,000 will be heard before Mr. Justice Wright in London on the 6th inst.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—An interim dividend of 3s. per share, free of income-tax (being at the rate of 3 per cent. per annum), has been declared by the Directors of this Company for the quarter ended March 31, payable on and after the 26th inst.

ELECTRICAL COPPER COMPANY (LIMITED).—Mr. William Jacks has been elected chairman of this Company in succession to the late Mr. H. M. Matheson.

ELEKTRICITATS AKTIEN GESELLSCHAFT VORMALS W. LAHMEYER AND CO.—A dividend of 10 per cent. has been declared by the Directors of this Company.

ELECTRIC SUPPLY COMPANY OF WESTERN AUSTRALIA (LIMITED).—During the week this Company, which has been formed for the purpose of taking over the electricity supply undertaking of the Westralian Electric Lighting and Supply Company at Coolgardie (Western Australia), invited applications for 100,000 shares of £1 each, the entire share capital. The directors include Mr. Bennett Fitch, M.I.C.E. (a director of the St. James's and Pall Mall Electric Lighting Company, Limited), who is to be chairman, and Messrs. W. Marriner Brigg, E. K. Muspratt, J.P., and J. E. Pearson (directors of the British Insulated Wire Company, Limited). The list closed on Wednesday.

FOLKESTONE ELECTRICITY SUPPLY COMPANY (LIMITED).—A prospectus inviting applications for 5,500 Ordinary shares of £5 each (balance of £50,000 in £5 Ordinary shares) has been issued this week. Four of the directors are members of the Folkestone Town Council, and the other two are managing director and director respectively of Edmundson's Electricity Corporation. The consulting engineer is Mr. E. M. Lacey, A.M.I.C.E. (Lacey, Clirehugh and Sillar). The lists closed on Wednesday.

GLOBE TELEGRAPH AND TRUST COMPANY (LIMITED).—A contemporary states that the Directors of this Company have declared an interim dividend of 3s. per share on the Preference shares, and 2s. 6d. per share on the Ordinary shares.

GUILDFORD ELECTRICITY SUPPLY COMPANY (LIMITED).—The annual meeting of this Company was held last week at Guildford. The Chairman (Dr. F. R. Russell) said that during the last quarter of 1897 they made the very fair profit, considering the Company had only been running a year, of £67. The Company had now reached the maximum expenditure, and they could double the number of lights without spending any more money, except in the way of coal. But it was absolutely necessary during the present year that they should add to their plant and lay extra cables, and they would, therefore, have to raise further capital to the extent of £3,000 or £4,000 at least. Mr. Money Kent gave an analysis of the accounts, and compared the figures with those of other stations.

MUTUAL TELEPHONE COMPANY (LIMITED).—This Company has given the public an opportunity of subscribing for 8,000 Five per Cent. Cumulative Preference and 12,000 Ordinary shares of £5 each (out of a total capital of £250,000, two-fifths being preference). The prospectus states that the Company has been formed by a number of gentlemen in Manchester, who believe that with proper management Manchester and district might be supplied with an improved system of telephone service at greatly reduced rates. The New Mutual Telephone Syndicate (the pioneer company) have, it is stated, received promises to apply for more than 2,000 telephones and upwards of £50,000 of shares. The consulting engineer to the Company (Mr. A. R. Bennett) estimates that £50,000 is sufficient to equip upwards of 2,000 telephones, but the Directors will not proceed to allotment unless subscriptions are obtained for at least £80,000. Major-General C. E. Webber and Prof. A. C. Elliott have also reported on the Company's scheme. Seeing that the Company has not yet obtained the Postmaster-General's licence to equip a telephone exchange, it is not quite clear what real marketable asset the pioneer syndicate has to dispose of, or why an appeal has been made to the public for capital. In any case, surely the issue might have been limited to Manchester, which, if it is keen on this business, would have subscribed the entire capital ten times over. The lists opened on Tuesday and closed on Wednesday.

OXFORD ELECTRIC COMPANY (LIMITED).—A meeting of this Company was held on the 18th inst. at Oxford. The Chairman (Sir Henry C. Mance, C.I.E.) said that the additions which had been made to the plant would increase the capacity of the generating station to the extent of about 15,000 8-c.p. lamps installed, and this left them with a sufficient margin at present as far as dynamos and engines were concerned. Their expenditure on mains of £2,237 included the cost of cables necessary to connect 47 new customers, and carry out extensions which had been made in the north of Oxford in the Bevington and Woodstock roads. Two thousand new shares were issued during the year at a premium. The old 5 per cent. debentures were paid off, and 4 per cent. debenture stock had been successfully issued. This operation would result in a considerable saving to the shareholders in future years. The bank loan, which stood at £8,300 at the end of 1896, was increased during the year to £10,000, but on the issue of the extra £10,000 of debenture stock this loan was paid off. With regard to their assessment, the Directors had felt compelled to appeal against the amount at which the Corporation at first proposed to assess them, in which, he was glad to say, they were successful. The gross revenue for 1897 was about £1,000 in excess of that for 1896. The revenue account had been debited with one-third of the cost of the new issue of debenture stock. The remainder would be debited in the accounts for 1898 and 1899. The response to the reduction made in the price of current, from 8d. to 7d. per unit, on January 1, 1897, had not been quite so great as they hoped for, but the Directors felt that they were acting in the interests of the Company, and it would be their aim in the future as it had been in the past, as far as was consistent with justice to the shareholders, to bring the light within the reach of all—to popularise it as far as possible. The number of consumers connected on January 1st was 316, and the number of 8-c.p. lamps connected to the system at the present moment was equivalent to about 22,000. There had been no extensions to the public lighting, which, he was glad to say, continued to give general satisfaction. The most important addition to their system during 1897 was that of the municipal buildings. They had thoroughly overhauled the boilers, and the dynamos, engines and mains were, he thought, in as good, if not better, order than they were when they were put into generating station. Their efficiency during the year was slightly higher than it was during the previous year, and if they compared the figures for the consumption of coal with those of any of the companies throughout the country, he thought they would find Oxford stood very high in the list, notwithstanding the high price of coal and the larger revenue-earning power of the lamps in many other towns where they did not have such long vacations as they had in Oxford. Their revenue for the last two months and a half had been good, and compared very favourably with that of the corresponding period of the previous year. They were approaching the colleges with a view to endeavouring to get some of those who are not already on the system, and they had also carefully considered the question of free wiring which had been successfully introduced in other places. They were perfectly willing, as regarded any householder or owner of a house, to wire his premises for a limited number of lamps, on condition that he would pay a very small annual rental for each lamp for, say, ten years, after which the installation would belong to the house. The details of this proposition would be circulated for the information of the public in the course of a few days, and they were not without hope that it would bring a substantial increase in their business.

ROCKHAMPTON (QUEENSLAND) GAS AND COKE COMPANY (LIMITED).—The report of the Directors for the half-year ended Dec. 31 states that the Company's Order-in-Council under the Electric Light and Power Act of 1896 is still under consideration. An arc lighting contract has been entered into with the Rockhampton Harbour Board. The operations of the electrical department show a return of £156. 9s. 3d., which has gone towards the payment of the interest upon the debentures, leaving a deficiency of £143. 10s. 9d.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed Tuesday, the 5th inst., a special settling day in 6,000 Four and a-Half per Cent. fully paid Cumulative Preference shares of £10 each (Nos. 7,501 to 13,500) and 6,000 fully-paid Ordinary shares of £10 each (Nos. 1 to 6,000) of the Bournemouth and Poole Electricity Supply Company (Limited), and have ordered the same to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 25 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited), were £2,622.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Mar. 26	3,370	−160	...	...	...
Bristol Trams & Carriage	„ 25	2,380	+172	12	28,279	+ 4,068
City & South London Ry.	„ 27	1,066	+ 92	13	13,891	+ 100
Dover Tramways	„ 26	111	...	29	3,209	...
Dublin United (Southern)	„ 25	415	− 62	12	4,793	− 353
Liverpool Overhead Rly.	„ 27	1,303	− 33	13	17,443	+ 736
Sheffield Tramways	„ 27	822	− 64	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price March 23.	Price Wednesday, March 30.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 26. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.			£ s. d.			
£19,126	£10	3/0	Central London Ordinary	10½ 11	10½ 11	2 14 1	June and December	10⅝	10⅛
143,106	10	1/0⅝	Do. (£6 paid)	6½ 6⅝	6½ 6⅝	2 13 4	„ „	6⅝	...
£880,000	Stock	1¾	City and South London Railway Con. Ordy.	66 68	66 68	2 15 2	January and July	68	67½
8,419	£10	5½	Do. 5% Perpetual Preference	15 16	15 16	3 2 6	„ „	...	...
£135,701	Stock	4½	Do. 4% Perpetual Debenture	138 140	138 140	2 17 2	May and November	138	...
540,000	100	3½	Waterloo and City Ordinary	135 138	135 133	2 8 6	June and December	137½	135½
87,500	10	2½%	Liverpool Overhead Railway Ordinary	10⅜ 10⅝	10⅜ 10⅝	3 0 6	February & August	...	...
10,000	10	5½	Do. 5% Preference	15½ 16½	15½ 16½	3 1 6	„ „	...	...
125 000	Stock	4½	Do. 4% Debenture	109 111	109 111	3 19 0	January and July	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 23.		Price Wednesday, March 30.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 26.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£923,960	Stock	19/6	Anglo-American	59	62	59	62	4 16 9	Feb., May, Aug., Nov.	59	58½
£3,038,020	Stock	39/0	Do. Preferred	109½	110½	110	111	5 8 1	" "	110½	109
£3,038,020	Stock	5/0	Do. Deferred	11¾	12¼	12½	13	—	—	12 1/16	12 1/16
£137,400	£100	4%	*African Direct Telegraph (Red)	100	104	100	104	3 16 11	January and July	—	—
£25,000	10	—	Amazon Telegraph	7	8	7	8	—	—	—	—
130,000	10	3/0	Brazilian Submarine xd	16¾	17¼	16½	17½	4 0 0	Mar., June, Oct., Dec.	16¾	—
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	112	116	4 6 2	June and December	112½	—
10,000,000	$100	$1½	Commercial Cable Capital Stock xd	187	192	185	190	4 4 3	Jan., Apr., July, Oct.	—	—
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock xd	106	108	104	106	3 15 6	" "	106¾	106¾
16,000	10	6/0	Cuba Submarine	6½	7½	6½	7½	9 6 8	February and August	6¾	—
6,000	10	10%	Do. Preference 10 per Cent.	14½	15½	14½	15½	6 9 0	" "	—	—
12,931	5	2/0	Direct Spanish (fully paid) xd	4	5	4	5	4 8 11	April and October	—	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference xd	10	11	10	11	4 12 10	" "	—	—
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103%	106%	103%	106%	4 4 11	January and July	—	—
60,710	£20	3/0	Direct United States Cable, 1877	10¾	11¼	10¾	11¼	5 15 7	Jan., Apr., July, Oct.	11¼	10¾
400,000	£10	2/6	Eastern	17¾	18¼	17¾	18¼	3 11 3	" "	18 1/16	17¾
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18¾	19¾	18¾	19¾	3 1 6	" "	19	18¾
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	128	131	128	131	3 2 0	May and November	129	—
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	—	—
250,000	10	2/6	Eastern Extension	18¾	19¼	18¾	19¼	3 13 8	Jan., Apr., July, Oct.	19	18¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	128	131	128	131	3 1 8	February & August	—	—
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99	103	99	103	4 17 3	January and July	—	—
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99	103	99	103	4 17 3	" "	—	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 16 2	February & August	—	—
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	107%	110%	107%	110%	3 13 9	May and November	167	—
180,227	10	1/9	Globe Telegraph and Trust	11¾	12¼	11¾	12¼	3 17 7	Jan., Apr., July, Oct.	12 1/16	11 13/16
180,042	10	6%	Do. 6 per Cent. Preference	17½	18	17½	18	3 6 8	" "	17½	17 1/16
150,000	10	5/0	Great Northern of Copenhagen	29½	30½	29½	30½	3 5 7	January, April, July	—	—
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	100	103	100	103	4 17 1	March & September	—	—
17,000	25	12/6	Indo-European	52	55	52	55	4 10 11	May and November	52	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	106	109	106	109	5 10 1	March & September	—	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105	108	105	108	3 13 5	June and December	—	—
11,839	8	4/0	Reuter's	8	9	8	9	4 8 11	April and October	—	—
3,381	£100 Cert.	6%	Submarine Cables Trust	140	145	140	145	4 4 3	" "	143½	—
15,609	10	6/0	West African Telegraph	3½	4½	3½	4½	—	—	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	99	102	5 8 5	March & September	101½	—
80,000	10	—	West Coast of America	½	¾	½	¾	—	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	104	107	105	108	3 14 9	June and December	108½	104¾
88,321	10	1/0	West India and Panama	½	¾	½	¾	—	May and November	—	—
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7½	8	7½	8	7 10 0	" "	7¾	7 1/16
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	6¾	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 2	January and July	—	—
64,256	15	3/0	Western and Brazilian	11¾	12¼	12	12½	2 8 0	May and November	12 1/16	11¾
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7½	8	7¾	8¼	3 12 9	" "	8	7 11/16
33,129	7½	1/6	Do. Deferred Ordinary	4¼	4¾	4½	5	—	—	5¼	4¼
£382,230	—	4%	Do. 4 per Cent. Debenture Stock	106	109	106	109	3 13 9	June and December	108¼	107¼
£1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	—	—
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3	3¼	3	3¼	5 14 4	August	—	—
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	July	—	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	—	—
484,597	5	3/0	National	6½	6¾	6	6½	4 12 4	February & August	6¾	6½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	—	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	15	17	15	17	3 10 7	" "	—	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	5¾	6¼	5½	6	4 3 4	" "	5¾	—
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	102	107	102	107	3 6 0	June and December	103¾	—
171,504	1	0/4	Oriental	⅜	¾	⅜	¾	6 13 4	April and October	—	—
58,000	5	5/0	United River Plate	4	4½	4	4½	5 11 1	July	4½	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105	108	105	108	4 13 6	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
£200,000	5	4½%	Birmingham Electric Supply (fully paid)	10½		10½	10¾	—	March	—	—
50,000	£10	20/0	City of London Electric Lighting (fully paid) xd	26	27	25½	26½	3 15 6	February & August	26¾	26½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid) xd	17½	18½	17½	18½	3 4 10	January and July	17 15/16	—
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	—	—
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	13½	14½	13½	14½	2 8 6	February & August	—	—
20,000	5	2/3	Do. 4½ per Cent. Preference	6¼	6¾	6	6½	3 9 3	" "	6 1/16	6½
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	—	—	January and July	—	—
£26,000	5	3/0	Chelsea Electricity Supply Ordinary xd	10¾	11¼	10½	10¾	3 9 9	March	11	10¾
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	115	117	115	117	3 17 5	June and December	—	—
£30,000	£10	—	County of London & Brush Prov. Ord. (fully paid)	14¾	15½	14¾	15½	—	—	15½	14¾
20,000	£10	6%	Do. 6% Cumulative Preference xd	15½	16½	15½	16	3 15 0	March & September	15 1/16	—
10,000	£5	4/0	House-to-House Electric Lighting Supply Ord. xd	14	15	10½	11½	1 14 9	—	11½	—
10,000	£5	3/6	Do. 7 per Cent. Preference xd	11¾	12½	11½	12	2 18 4	March & September	—	—
111,000	£5	..	London Electric Supply Ordinary	4	4¼	3½	4½	—	—	—	—
48,050	£5	..	Do. Preference	6½	7	6½	7	—	—	—	—
49,900	10	7/0	Metropolitan Electric Supply Ordinary xd	21	22	20	21	2 17 2	April and October	21⅝	20½
12,500	10	6/0	Do. issued at 2 prem. (fully paid) xd	20½	21½	20	21	2 17 2	" "	21¼	20⅝
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	—	—
6,452	10	12/0	Notting Hill Electric Ordinary	19½	20½	19½	20½	2 18 6	March	20 1/16	20¼
275,000	1	—	Rand Electric	1 7/16	1 9/16	1 7/16	1 9/16	—	—	—	—
£125,000	Stock	5%	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90	95	90	95	5 6 6	"	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares	145	147	145	147	—	—	—	—
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	—	—	—	—
31,980	5	11/0	St. James and Pall Mall Electric Ordinary	18	19	18	19	4 4 1	April and October	—	—
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 16 4	February & August	19	18½
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	107	110	107	110	3 3 6	" "	10½	—
67,900	5	8/0	Westminster Electric Supply (fully paid)	17	18	17	18	3 13 1	June and December	—	—
								3 6 8	March & September	17 1/16	17⅛
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	5%	Brush Electrical Engineering	1¾	2	1¾	2	—	—	1 1/16	1⅛
90,000	2	1/2⅔	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0	—	2⅜	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110	114	110	114	3 18 11	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 8 2	June and December	—	—
10,000	£10	..	British Aluminium Ordinary	—	—	—	—	—	—	—	—
20,000	10	..	Do 7% Cumulative Preference	—	—	—	—	—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	9	10	9	10	5 0 0	June and December	9⅛	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	110	113	110	113	4 0 0	" "	—	—
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1	1½	1	1½	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	1¾	2¼	—	—	2	1⅝
£82,350	100	5%	* Do. 5% First Mortgage Debentures (red.)	86	91	86	91	5 12 4	January and July	—	—
99,261	5	1/6	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2¼	2⅜	6 0 3	February & August	2⅜	2¼
17,139	5	2/6	Do. (£5 paid)	4	5	4	5	5 10 0	" "	—	—
£200,000	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.)	103	105	103	105	3 16 2	June and December	—	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅝	2¾	2⅝	2⅞	3 13 1	February & August	2¾	—
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3⅝	3½	3⅝	4 3 4	August	—	—
91,196	1	10/0	Elmore's Patent Copper Depositing	⅜	½	⅜	½	—	—	—	—
12,500	10	18/0	Henley's Telegraph Works Ordinary	22½	23½	22	23	5 4 4	February & August	23	22½
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	19	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 8	" "	—	—
50,000	£10	15/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "	22⅛	21½
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	104	108	102	106	3 14 6	March & September	—	—
37,350	12	24/0	Telegraph Construction and Maintenance	36	39	35	38	4 12 4	March and July	—	—
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 8	January and July	—	—
£22,500	£5	3/6	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	—	—
£12,500	£5	3/0	Do. 6% Cumulative Preference	7	7½	7	7½	4 0 0	" "	—	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	107	109	3 19 0	May and November	108	—

* In calculating the yield on this security the interest accrued since the last dividend has been deducted from the price.

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NOTES.

IT is announced that the negotiations of the Danish Government for the laying of a submarine cable to Iceland *viâ* the Faröe Islands have been practically completed, and that the cable will be laid during the coming summer. Our German contemporary, the *Elektrotechnische Zeitschrift*, in making this announcement, further states that the British Government has agreed to pay a subsidy of £5,000, in consideration of the use of the cable for meteorological purposes; but as a matter of fact nothing has been decided by the British Government, and negotiations are, we believe, now proceeding in regard to this step. Our German contemporary also states that the Danish Government has guaranteed an equal sum for official telegrams, and that the Icelandic Parliament during its last session decided to grant a considerable subsidy.

A DEBATE on the Telephone question engaged the attention of the House of Commons for four hours on Friday last. Mr. CALDWELL, who had moved a resolution censuring the Post Office for refusing to grant municipal licences, expressed himself satisfied with Mr. HANBURY'S answer and his promise that a Select Committee should be appointed to consider the question. It is to be hoped that this will lead to a more useful result than a similar step taken in 1895. The Select Committee then appointed sat eleven days, between March 22nd and May 28th, for the examination of 31 witnesses, over five thousand questions were put and the evidence filled a blue-book of 370 pages. On June 25th, the Committee reported that, in view of the approaching dissolution of Parliament, they had not sufficient time to consider their report, and they recommended their re-appointment in the next session; and, in reply to a question in the House, in August of the same year, Mr. HANBURY stated that it was probable that the Government would carry out this recommendation. The Government subsequently announced that it did not intend to take over the telephone system before the expiry of the National Telephone Company's licence in 1911, and that opposition exchanges would be opened by the Post Office where necessary; the Committee, however, was not re-appointed.

THE situation at present is briefly this:—The market value of the National Telephone Company's undertaking is about six millions, and the Post Office calculates that the plant could be replaced for but little over two millions. If this latter figure, which appears extremely low, be taken as correct, an enormous sum must have been spent in pioneer work, in buying up other companies and in replacing obsolete apparatus. The Government made a mistake in not acquiring the telephone system from the first, and a second mistake in 1890, when they might have bought the Telephone Company's undertaking; last year they were not willing to pay for this mistake in hard cash, and neither will they do so in 1904, says Mr. Hanbury, when the next option of purchase comes due. One sentence in Mr. Hanbury's speech is not clear. He is reported to have stated that he could not suppose that anybody would buy by arbitration in 1911, and even if a bargain was come to in 1904, the Company would still have control for seven years. In the first place, if the Telephone Company's plant is not to be bought in 1911, is the public to be put to the inconvenience of being connected to an entirely new exchange system, and is all the Company's apparatus to be "scrapped" and the money spent in erecting it wasted? If this is to be done, and the change-over effected without causing the public unnecessary inconvenience, and without an arrangement with the National Company for the sale of its plant, either as a whole or in part, we venture to express the opinion that the expenditure will considerably exceed two millions. Secondly, if the Government were to buy the Company's business in 1904, would it not thereby acquire "all the rights, powers, privileges, works and other property appur-

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tenant to or forming part of such business," and would not this include the licence itself?

Mr. HANBURY'S opinion appears to be that the solution of the difficulty lies in giving the Post Office facilities for starting competing exchanges as early and as actively as possible on the same lines, as to preferential rates and otherwise, as the Telephone Company, though no more licences are to be granted to companies. This course would mean a cutting of rates on both sides; and, assuming that the Post Office exchanges this time are successful, we should have the inconvenience of two exchange systems—an inconvenience which can be lessened but not eliminated by the Post Office going to the additional expense of providing inter-connection facilities between the two systems. The service, though cheaper, would then be more troublesome than at present; there would be no chance of its reaching perfection for another thirteen years at least; the Government would pay less for its initial blunder than if it had decided to purchase in 1890 or 1904; and the deleterious effect on the Post Office telegraphs revenue would be as great, or greater, than ever, although the endeavour to avoid a diminution of the telegraph receipts has been at the root of all the mischief.

A PAPER on "Wireless Telegraphy," read by Capt. KENNEDY, R.E., at the Royal United Service Institution, on Wednesday last week, although of an elementary character, yet gave some interesting particulars of what had been done more recently in England towards the realisation of a practical method of signalling by means of Hertzian waves. In the course of the lecture it was stated that the Post Office had severed its connection with Signor MARCONI, and was making independent experiments. The most recent experiments carried out by the Post Office officials have been between Bournemouth and the Isle of Wight, over a distance of 18 miles of sea, the height of the vertical wires at each end being about 90ft. Distinct and legible signals were obtained with simpler and more portable apparatus than that employed hitherto, the transmitter being merely a 6in. coil worked by a portable dry battery, instead of the 18in. coil originally used in the Cardiff experiments. Oil around the spark-gap has been discarded, and the size of the knobs considerably reduced. Capt. KENNEDY spoke of the favourable experience he had had with Capt. BADEN-POWELL'S tail-less kites as a means of elevating the vertical wires at the transmitting and receiving stations. These kites require very little wind to raise them, and it was found in some experiments on Salisbury Plain that the average time taken to set up the kite and receiver was only three minutes. Unsuccessful experiments had been tried from Bath to Salisbury Plain (a distance of 35 miles) on a very stormy day. Of the five kites used that day, only one remained up for any length of time, and it required a pair of horses and six men to bring it down again. Capt. KENNEDY drily added, "There is no doubt whatever about the lifting properties of Capt. BADEN-POWELL'S kites." The reader of the Paper also referred to reflectors, and regretted that further experiment had not been made with them. He suggested that a reflector might be tried around the vertical wire instead of behind the spark-gap.

A SHORT discussion followed the reading of the Paper. Capt. BRETT, who has himself done a good deal of experimental work, said that MARCONI'S coherer was the only one which would give intelligible Morse signals, although other forms would perhaps also respond to Hertzian vibrations. Mr. PREECE remarked that the induction method, which was also described in Capt. KENNEDY'S Paper, was working successfully across the mouth of the Severn, and would be handed over to the War Department very shortly. Experiments had been made with this method across the St. George's Channel, using lines from Carlisle to Haverfordwest and from Belfast to Wexford. It was found, however, that the disturbances which it was sought to receive were insignificant compared with those produced by the swaying to and fro of the earthed line in the field due to terrestrial magnetism. Mr. PREECE also made a statement to the effect that he had not heard or read of any description of a method of practical telegraphy by means of Hertzian waves until Signor MARCONI came to him with his apparatus.

WHILE on the subject of wireless telegraphy we would draw attention to a method of connecting the receiving instruments for recording Hertzian wave signals, described in a Paper by Herr K. STRECKER, an abstract of which is given in another column. A second relay is used, which is actuated by the relay in the coherer circuit; but the secondary contacts of this second relay are connected to the circuit of the Morse writer, so that when the relay is receiving current the circuit of the Morse writer is open, and when no current is passing through the coils of the relay the Morse circuit is closed. Thus, if the coherer and its tapper be so sensitive that the tongue of the relay oscillates to and from its contact during the reception of a dash, a continuous dash is yet recorded on the Morse instrument, as the oscillations of the relay do not bring it right over to the other contact, which closes the Morse circuit.

USERS of steam-power frequently wish to know the actua amount of power developed or work done by their plant without being under the necessity to take an immense number of indicator diagrams, and to have the trouble of ascertaining their several areas. It may be argued that a dynamometer will answer this purpose, so far as the external power of the engine is concerned. This is indeed the case, but there are circumstances in which it is desirable to know more than the external or useful power of the engine; where, in fact, it is of importance to know the total or indicated power developed over a period involving several hundreds, perhaps hundreds of thousands, of revolutions. A steam engine in an electric supply station where the highest economy is practised, and where the slightest loss of power is traced to its origin and measured, furnishes a case in point. Another instance occurs in the frequent necessity to ascertain the brake efficiency of a steam engine during a trial run extending, it may be, over several hours. In the latter case taking indicator cards in quick succession is a common but nevertheless tedious method of determining the indicated power; in the first-named instance this method is out of the question, when working

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during weeks or even months is involved. In such circumstances an instrument of the kind described in another column this week should prove of value. We refer to the ingenious continuous indicator of Messrs. W. G. and C. W. G. Little. Though this instrument gives no diagrammatic or other analysis of the distribution of steam in the engine, and is therefore useless for valve-setting and some few other purposes to which the indicator is commonly put by engine builders, it has the immense advantage over the ordinary form of indicator, as regards the measurement of power, that it combines the operation of indicating and integrating, and gives a numerical index of the result as nearly direct-reading as is possible in the conditions of the problem.

Mr. A. H. Gibbings, the electrical engineer to the Corporation of Bradford, and President of the Municipal Electrical Association, commences in our issue this week a short series of articles dealing with the commercial and business aspects of municipal electrical supply in the United Kingdom. So many of our readers are interested in matters connected with electric supply undertakings, and such a large proportion of these undertakings in this country are owned and worked by local authorities, that we are sure the subjects of Mr. Gibbings' articles will prove attractive to a large section of the electrical community. To a considerable extent the interest aroused in these subjects, which relate to the commercial rather than the scientific and technical side of electrical engineering, is due to their highly debatable nature. Technical methods are now fairly well settled, and leave less room for divergence of opinion than they did a few years ago; but in many details of commercial practice, such, for example, as the policy of municipal free-wiring and kindred practices, there is scope for profitable debate. The experience Mr. Gibbings has acquired in matters relating to municipal supply gives weight to his views; but in some of these we think a section of his *confrères* will differ from him. It would be interesting to hear the opinions of others who are learned in the business of municipal electric supply in regard to these matters.

Cable Interruptions and Repairs.—

	Date of Interruption.		Date of Repair.
Latakia—Cyprus	Feb. 10, 1898	...	—
Saïgon—Hong Kong.....	Feb. 28, 1898	...	—
Cayenne—Pinheiro	Mar. 24, 1898	...	—
Odessa—Constantinople	Mar. 28, 1898	...	April 1, 1898

Inter-Urban Telephony in Germany.—From the 14th edition of the German telephone directory it appears that 690 localities in Germany are provided with facilities for long-distance telephony. Berlin is in telephonic connection with 415 towns in and outside the empire, Leipsic with 128, Cologne with 119, Hamburg with 114, Karlsruhe 105, Dresden 98, Hanover 97, Frankfort-on-Maine 91, Magdeburg 74, &c.

Charter-Day Celebrations in New York.—A paragraph is going the round of the New York papers to the effect that the Decoration Committee has secured the use of all the manholes in Broadway and Fifth-avenue for illumination purposes on Charter-Day next month. It is proposed to place searchlights in the manholes, and they will be covered with a grid "which will cause the rays to shoot upwards in elongated lines forming the American flag with the stars uppermost."

Communication between the New York Harbour Defences.—Possibly on account of the war scare, the recommendations made by Gen. A. W. Greely in his strongly-worded letter to the Secretary of War (mentioned by our New York correspondent in our issue of March 25th) are to take effect. All the fortifications about New York are to be connected with headquarters on Governor's Island by means of a submarine cable, which will be adapted to both telegraphic and telephonic communication.

The Copenhagen Tramways.—The project for the amalgamation of all the Copenhagen tramways, already referred to in these columns, has been accepted by the municipal council by 20 votes to 11. The company which acquires all the lines undertakes to replace horse traction by electrical, or other mechanical traction if the municipality prefer it, in two years. The fare is to be 10 öre (1·3d.) for any distance. After ten years the municipality may at any time give three years' notice to terminate the contract. The company is to pay the municipality 5 per cent. of the gross receipts, but not less than 150,000 krone (£8,350) per annum.

Obituaries.—We regret to record the death of the Earl of Suffolk and Berkshire, which took place last week at his town house. The deceased Earl was a director of the City of London Electric Lighting Company and of the British Electric Traction Company.——We have also to announce the death of the Russian electrical engineer, Mr. W. N. Tschikoleff. He was for a long time associated with Jablochkoff, and was one of the first, if not the first, inventor of a differential arc lamp. He has also done good work in connection with projectors, and was the original editor of the first Russian electrical paper *Elektritschestwo*.——The death is announced, on the 27th ult., of Mr. John Willis Jaques, late chief officer of the Eastern Telegraph Company's cable ship "John Pender." Mr. Jaques, who was only 34 years of age, was on his way home from the East Coast of Africa at the time of his death.

Patent Litigation.—In giving judgment in the House of Lords last Friday on a patent case, in which the hearing of the appeal alone lasted four days, the Lord Chancellor made an important statement of opinion as to patent litigation:—

> At the same time, I am desirous of expressing my great regret that a case which apparently turned, as may be seen from the judgment of the Court below, in a great measure upon two or three sentences in the specification should have taken the period of time which it has taken both in the original Court and in the Court of Appeal. I think it is worthy of the consideration of those engaged in such cases to remember that the Legislature has provided a tribunal for protracted scientific investigations, to which cases of this sort will have to be remitted if this case is to be taken as an example. The question to be determined in this case by a Court of Law is comparatively a short one, but if professors on every subject under Heaven are to be brought to confront each other and give evidence on questions of this sort it is quite manifest that the ordinary principles which guide Courts of Justice cannot be adhered to, and what is called the scientific part of the case will have to be remitted to a totally different tribunal. I throw this out for the consideration of those who are engaged in something which is called litigation whether what I have suggested renders it possible to continue to try patent cases in the ordinary course of law.

Post Office Telegraphs.—An account showing the gross amount received and expended on account of the telegraph service during the year ended March 31, 1897, and the balance of the expenditure over receipts, prepared in pursuance of Section 4 of the 39th Vict., c. 5, has been issued as a Parliamentary paper. The gross amount received was £3,287,611 1s. 8½d., less amount paid to cable companies, &c., £360,553 17s. 7d., and telegram moneys refunded, &c., £4,608. 5s. 8½d., leaving a total of £2,922,448. 18s. 5d.; and the value of telegraph services performed for other public departments without remuneration, £44,904. 11s. 6d. The amount expended was £3,111,809. 18s. 1½d., making a balance of expenditure over receipts of £144,456. 8s. 2½d. The amount expended on account of the annual charge for the securities created for the purpose of the Telegraph Acts, 1868 to 1870, was £298,888. 5s. for the year ended March 31, 1897. The deficiency of telegraph revenue in the year ended March 31, 1897, to meet expenditure and the interest on telegraph stock created was £443,344. 13s. 2d. The total of the deficiency to March 31, 1897, from the year 1872 was £6,629,890. 13s. 4d.

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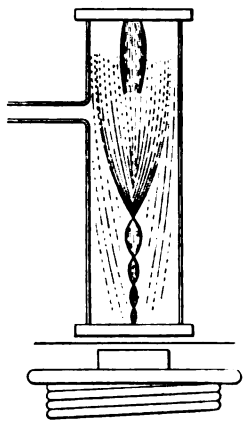
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Nodular Cathode Rays.—When cathode rays do not pass across a magnetic field, but along it, they suffer a deformation which has been recently studied by E. Wiedemann and A. Wehnelt, who succeeded in showing that it is completely explained by the projected-particle theory. When a magnet is placed opposite the cathode, as in the diagram, the rays curve inwards and then out again in a succession of nodes which bear a striking resemblance to those of a vibrating string. A phenomenon corresponding to this was noticed some two years ago by Birkeland, who found that when the pole of a magnet was taken along the path of the cathode rays, the luminescent patch on the pole became alternately larger and smaller. Poincaré at that time attempted the explanation of the phenomenon on the projected-particle hypothesis. He showed that every cathode ray moves on the



surface of a cone, one of whose tangents coincides with the central ray. Wiedemann and Wehnelt express the semi-vertical angle of the cone by—

$$\sin\omega = C\frac{\epsilon}{e}\frac{V}{\mu}\rho$$

where μ is the pole strength, e the mass of a projected particle, ϵ its electric charge, V its velocity, and ρ the radius of the circle whence the rays proceed. The nodes or points of intersection of the rays with the axis occur at intervals, $\frac{\rho}{\sin\phi}$, $\frac{\rho}{\sin 2\phi}$, $\frac{\rho}{\sin 3\phi}$ . . . . , where $\phi = 2\pi\sin\omega$. The feebler the pole strength, and the higher the velocity of projection (*i.e.*, the higher the potential and the lower the pressure) the longer will be the corresponding segments. All these theoretical deductions could be amply verified by experiments. Instead of placing a magnet at the end of the tube, the latter was surrounded by a solenoid, and the diminishing segments could be seen to extend far into the interior. A final test was made to see whether the glow-light was similarly affected. This was done by bending the cathode aside so as to make the cathode rays impinge upon the wall instead. But the glow-light did not show the characteristic appearances. It is interesting to know that the phenomena, striking as they are, are completely within the grasp of the prevailing theory.

[Wiedemann and Wehnelt, *Wied. Ann.*, No. 3, 1898.]

Acoustic Coherers.—F. Auerbach shows that metallic coherers acquire a diminished resistance, not only by the impact of electric waves, but also by the impact of sound waves. He placed coherers of various kinds on a table, and noted the fall of resistance on planting a vibrating tuning-fork with its foot on the table. The effect was precisely that produced by electric waves. Roughly speaking, the effect of a strongly vibrating tuning-fork is about equivalent to that of a Righi exciter fed by six secondary cells, and giving sparks of 15cm. length when placed 20cm. away from the coherer. The diminution of resistance follows the same laws in both cases. The greater the original resistance the greater is the percentage diminution. Small hard-steel balls, as used for ball-bearings in bicycles, show a diminution of resistance down to 0·8 per cent. by acoustic influence, and to 2·2 per cent. by electrical waves, the original resistance being about 2 ohms in both cases. When the original resistance is 0·07 ohms the final percentages are 21 and 49 respectively in the two cases. These results were obtained in every case by continuing the impact until the resistance showed no further diminution, or the diminution was even converted into an increase. That the acoustic effect is mechanical can hardly be doubted. The pulsations, no doubt, increase the adhesion between the bodies. Whether the electrical impulses work in a similar mechanical manner is a matter for further investigation, but there is now at least a *primâ facie* probability that they do. Organ pipes disturb the coherers through the air direct, and if no other result follows from these experiments they will be useful in warning wireless telegraphists to surround their coherers with silence.

[Auerbach, *Wied. Ann.*, No. 3, 1898.]

Visibility of Röntgen Rays.—The experiments made by Brandes and Dorn, purporting to demonstrate the visibility of Röntgen rays, have been criticised by a good many physiologists on the ground that they were deceived by subjective light effects, especially by the "accommodation phosphene" accompanying strained attention of the eye. That the light effect is not due to the act of accommodation has now been proved by E. Dorn, with the aid of a medical friend, who intentionally paralysed the accommodation capacity of one of his eyes with homatropine and then looked for the Röntgen light, which, after due precautions, he saw just as well as before. Another objection, that the visual effect was due to electrical discharges in the neighbourhood of the head, was disposed of in a similar manner by allowing the 10cm. sparks of the induction coil which had fed the X-ray tube to cross within 10cm. of the observer's head. No visual effect was produced. But the most decisive experiment is made by reversing the tube so that the back of the anti-cathode faced the eye. Again, nothing was seen. Röntgen himself has since verified the visibility of X-rays, and shown that when a metallic plate with a small slit is held between the eye and the source, a bright line is seen which is straight or bent, according to the position of the eye with respect to the rays. Dorn noticed that a brass rod sometimes gave a bent shadow in the Röntgen rays. This can only be due to the peculiar property of these rays in not being refracted by the humours of the eye, but producing straight lines on the retina which could ordinarily only be produced by objects of a peculiar curvature.

[Dorn, *Wied. Ann.*, No. 3, 1898.]

Electrolytic Resistance.—An important contribution to this subject is made by F. Kohlrausch, L. Holborn and H. Diesselhorst, of the Reichsanstalt. With the thoroughness characteristic of everything coming from that national laboratory, the authors not only bring to bear upon their subject the latest improvements in resistance measurements, but they also do valuable work in the way of recalculating the mass of older material accumulated by Ostwald, Nernst, Grotrian, Sheldon, Tammann and others, so as to bring their figures into line with the now universally adopted C.G.S. units. Then, in order to enable future observers to rapidly compare the conductivities of liquids with certain standards they carefully determine the conductivities of certain standard liquids like sulphuric acid and magnesium sulphate solution (both at the point of maximum conductivity) and of saturated sodium chloride, whose conductivity happens to be a maximum very near the point of saturation. Unit conductivity is defined as possessed by a liquid which has a resistance of 1 ohm in a cubical shape of 1cm. side. This

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conductivity multiplied by 10^9 gives the ordinary electromagnetic conductivity. Unit conductivity is approximately possessed by the strong monobasic acids at 38deg. or 40deg. Accumulator acid stands about 0·7, concentrated copper sulphate at 0·05, and mercury 10,630 at 0°C. The point of maximum conductivity in sulphuric acid prepared by Kahlbaum was found to occur at a density of 1·224. Its conductivity was then 0·7400 at 18°C. A 20 per cent. solution of $KHSO_4$ had a conductivity of 0·30259 at 19·3deg., and a saturated solution of NaCl a conductivity of 0·21740 at 18·315°C.

[KOHLRAUSCH, HOLBORN and DIESSELHORST, *Wied. Ann.*, No. 3, 1898.]

NOTES ON THE BALLISTIC DETERMINATION OF THE CAPACITY OF COILED CABLES.

BY ARTHUR DEARLOVE, M.I.E.E.

When the length of a coiled cable in one circuit exceeds 200 nautical miles, it has until of late years been generally accepted that the ballistic method of determining the capacity is little better than useless, giving results quite valueless as regards accuracy; and, in fact, this is the case whether galvanometers of long or short period are employed in making the test.

In reviewing Mr. Wilkinson's recent book on "Submarine Cable Laying and Repairing" the writer mentioned that "the practically correct value of the capacity of a coiled cable of 1,000 nautical miles length had been obtained using the ballistic method of determination," the only difference in making the test being that *both* ends of the coiled cable were joined to the galvanometer as in Fig. 1, whereas the more usual way of connecting up was to join up one end only.

The result of "double-ending" the cable, as shown (Fig. 1) was in my own experience first noticed five or six years ago, but opportunities of repeating the experiment on 1,000 mile lengths of cable are not every-day occurrences, though 300 or 400 miles of cable have been frequently tested for capacity in this way, with satisfactory results. The reasons why the "double-ending" of the cable gives trustworthy figures are:—

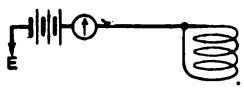


FIG. 1.

1. The effect of the self or electromagnetic induction of the circuit is eliminated.

2. The resistance of the circuit to charge is very sensibly reduced.

The combined result is, within limits, dependent naturally to some extent on the period of the galvanometer and on the length of the cable under test; but the true capacity of lengths of 400 to 600 nautical miles of coiled cable can be accurately determined by this, the simplest of all methods.

Some experiments in connection with this test were made by the writer and Mr. T. Clark, of the Telegraph Construction and Maintenance Company, and the details are perhaps worth recording. The object was to ascertain by how much the gain in accuracy was due (1) to the elimination of the effect of self-induction in the circuit, and (2) to the reduction of the mean resistance of the circuit charged.

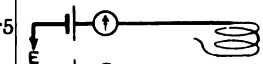
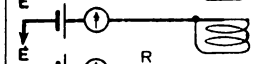
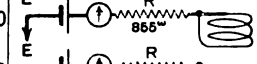
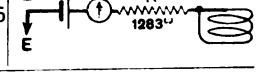
The following figures represent the result of observations made on a coiled cable of 444 nautical miles in one length, under conditions which are fully explained by diagrams:—

Ballistic Tests on a Coiled Cable.

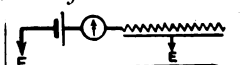
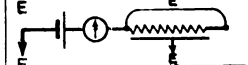
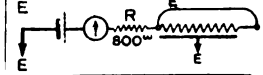
Length in circuit, 444 nautical miles.
Resistance of cable, 8,420 ohms.
Capacity of cable, 155·4 microfarads.
Resistance of galvanometer, 6,420 ohms.
Period of galvanometer, 3·12 seconds.

R is a non-inductive resistance inserted between instruments and cable.

It is assumed that the mean resistance to charge is approximately equal to half the resistance in the circuit, and the figures in the third column have been calculated on this basis.

Test.	Length.	Mean resistance to charge.	Shunt with galvanomtr.	Deflection.	Observed capacity per knot.	True capacity per knot.	Error.	
	N. M	ohms.	o'ms	divs.	mfds.	mfds.	%	
I.	444	1,710	10	494	0·286	0·350	18·5	
II.	„	855	8	486	0·351	„	nil	
III.	„	1,710	9	494	0·318	„	9·40	
IV.	„	2,138	9	470	0·300	„	14·5	

Tests on an Artificial Cable with no Self-Induction Resistance = 3,200 ohms. Capacity = 282 microfarads.

V.	...	1,600	35	423	258·0	282	8·7	
VI.	...	800	„	456	281·3	„	...	
VII.	...	1,600	„	423	258·0	„	8·7	

Test I.—Single ended. The self-induction and resistance of the circuit are at a maximum.

Test II.—Double ended. Both the self-induction and resistance of the circuit are at a minimum.

Test III.—Double ended. Resistance of the circuit the same as in Test I., but the self-induction neutralised.

Test IV.—Double ended. Shows the effect of increasing the resistance of the circuit.

The above figures go to show, in this particular instance, that under the conditions existing during Test I. the total error is 18·5 per cent., of which 9·1 per cent. is due to the self-induction of the circuit, and the remaining 9·4 per cent. is due to the high mean resistance of the circuit. In Test II., when the self-induction is eliminated and the resistance of the circuit reduced by "double ending," the correct capacity of the cable is obtained.

Tests V., VI. and VII. are taken on an artificial cable having no sensible self-induction, and they confirm what has been assumed with regard to the inserted resistances R, viz., that they may under these circumstances be treated as if uniformly distributed in the circuit; for it will be seen from the first and last tests on this artificial line that the total mean resistance of the circuit is the same, though distributed quite differently, and that the final results in each case being identical, the error is due solely to the high mean resistance of the circuit.

The following figures serve as an illustration of the influence which the "period" of the galvanometer used has upon the results obtained when testing a cable of 429 nautical miles length:—

Period of galvanometer. Seconds.	Observed capacity per knot. Microfarads.	True capacity per knot. Microfarads.
0·85	0·299	0·350
1·20	0·310	„
2·00	0·336	„
3·125	0·353	„

Both on cable repairing ships and in cable factories the D'Arsonval type of galvanometer has come into very general use for testing, but it should be remembered that this instrument is quite unsuitable for the comparison of capacities of different magnitudes when the ordinary shunt is employed. The universal shunt devised by Prof. Ayrton and Mr. Mather, the merits of which, I think, are not sufficiently recognised by "cable people," entirely removes any difficulties, and renders the instrument as accurate for the comparison of capacities as it is for steady deflections.

The figures given below plainly indicate that this is so, and also that the use of the ordinary type of shunt is to be avoided, when the D'Arsonval form of galvanometer is employed for the determination of capacities by the ballistic

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method. In order to keep the maximum deflections the same in each case, the charging potential was varied as required. Resistance of D'Arsonval galvanometer 750 ohms.

No shunt used but charging potential varied.			Ayrton's universal shunt used.				Ordinary shunt used.			
Potential = v.	Throw = d.	$\frac{v}{d}$	Resistance of shunt.	Multiplying power of shunt.	Throw = d.	$d \times$ M.P. of shunt.	Resistance of shunt.	Multiplying power of shunt.	Throw = d.	$d \times$ M.P. of shunt.
			ohms.		divs.	divs.	ohms.		divs.	
1·0	367·0	367·0	10,000	1·00	367	367·0	∝	...	367	367·0
0·8	293·0	366·25	8,000	1·25	293	366·25	3,000	1·25	131	163·7
0·6	219·0	365·0	6,000	1·666	219	365·0	1,125	1·666	90	150·0
0·5	182·5	365·0	5,000	2·00	183	366·0	750	2·00	65	130·0
0·4	146·5	366·25	4,000	2·50	147	367·5	500	2·50	47	117·5
0·2	73·0	365·0	2,000	5·00	73	365·0	188	5·00	19	95·0

THE COMMERCIAL AND BUSINESS ASPECTS OF MUNICIPAL ELECTRICITY SUPPLY.

BY ALFRED H. GIBBINGS.

Introduction.

Up to the present time municipal electricity committees in the majority of cases have given attention chiefly to the erection of works, the establishment of a system of supply, and the necessary additions and extensions of existing works consequent upon the rapid manner in which the demand for the electric light has progressed. This fact was amply borne out in the discussion on a Paper read by the author at the 1897 Convention of the Municipal Electrical Association, and entitled "Municipal Aids to Wiring." In the course of that discussion Alderman Higginbottom, Chairman of the Electricity Committee of the Manchester Corporation, said: "The subject hardly touched them at present there, as their difficulty was to supply consumers as fast as they came on, but he was of opinion that a municipality ought not to deal with wiring or contractor's work. Large things, in which there could be no general competition like tramway work and gas, water, or electricity supply, were different." From these remarks it will be seen that, notwithstanding the high price at which electricity is sold, the demand during the first few years from its inauguration has been greater than could be readily and conveniently met.

To prepare for and cope with this rapid increase of business has for the time absorbed the attention of municipal electrical engineers, to the exclusion of many interesting matters, and it has certainly precluded any necessity *pro tem.* to offer inducements by way of further popularising the electric light. Such a rush of applicants, however, cannot continue in any place for more than the first year or two. When the enthusiastic eagerness has subsided consumers begin quietly to count the cost, and are already in many a town lifting up their voices against the prices charged. Happily in most of the larger cities and towns this outcry has been neither ignored nor neglected, but movements have already been made, and some of them involving great innovations, with a view of giving the consumer greater advantages and of helping to reduce the bill for current at the same time. It is my intention and purpose in this series of articles to consider what has already been attempted or accomplished in the direction just indicated, pointing out those instances in which any particular apparatus, or any special method of charging, has been found successful or otherwise. In addition to these subjects other phases of electricity supply will be touched upon, and references will be made to standard works and Papers which have been read before scientific societies, in order to bring more prominently than hitherto before the members of electricity committees the ever-widening possibilities in connection with the use of electrical energy.

As a matter of fact there are at present many of the smaller towns which have shown a true municipal enterprise in starting an electric supply station, but which are still in the unfortunate position of having to keep up a high price per unit, and of not being able even then to pay all revenue charges. This state of affairs is likely to remain unless some further incentive to use the current and so to increase the consumers is adopted. The reason is probably not far to seek. It is most likely because the interest, sinking fund and works charges are so much greater in proportion for a small station and town than for a large one; that is to say, the "standing charges" which include interest, sinking fund, wages, rent, rates and taxes, and similar items are fairly "constant" whether the demand is of very short or very long duration, whether customers are many or few.

It is a fact that in most cases where a loss instead of a profit is made, the nature of the demand is of very short duration; shops and business premises, for instance, habitually close early in the evenings. It is also clear that the very highest economy and efficiency which could possibly be effected with the generating plant would not avail much, under these circumstances, towards reducing the percentage of loss. What is wanted to turn the tables from loss to profit is a widening out of the daily "peak," and a more extended use of electrical energy for other purposes than the production of light. It is this aspect of the subject and the various means to this end which it is proposed to dilate upon and to discuss in the following articles.

The Position of the Electricity Department in Relation to other Municipal Departments.

It may be accepted as a general fact that all the main branches of municipal work are considered as entirely separate undertakings, for which, if the necessity arises, distinct and independent rates may be levied upon the public. Each department is conducted and controlled by a separate committee responsible for its acts and deeds to the Council alone. The work of each department, however, must of necessity, in a greater or less degree, overlap and be related to the work of the other departments. Hence it has come about that many special matters are dealt with by sub-committees whose work is supervised and controlled by a general committee. The duties relegated to such sub-committees usually relate to some specific and single subject; and, as an illustration, I may instance a general works committee having under its management such matters as street improvements, drainage, sewage defœcation, street lighting, street cleansing and road making.

The members which constitute a sub-committee are usually delegated on account of their individual qualifications or ability to deal with a specific question, and, with the exception of particular and complicated schemes which occasionally arise, involving largely the interests of other departments, a sub-committee can usually deal exclusively and satisfactorily with the business entrusted to it.

With the advent of electricity it was very naturally assumed that, as a section of municipal work, it could be as easily and readily dealt with by a sub-committee as were similar special and limited matters. It was taken for granted that its application would be confined to lighting purposes only, and hence in many corporations the supply of electricity has been considered merely supplementary to the supply of gas. The business, therefore, naturally fell into the hands of a sub-committee of the gas supply committee. This, of course, was all very well when municipalities were making their first attempts at electric lighting, but as soon as a supply was actually commenced it immediately became apparent that the uses of this new energy, far from being restricted to lighting purposes, were likely to be of even a more extended nature than the supply of gas or water. Its importance indeed grew so rapidly that it soon attained proportions equal to, if not greater than, any other department of the corporation. This has been found to be the case in Glasgow, Manchester, Liverpool, Brighton, Bradford, and in many other cities and towns. Out of all these, however, it has been due to Glasgow that the first attempt has been made to place the electricity committee upon a sound and proper basis for dealing with all the possibilities which come within its sphere.

On September 2, 1897, Lord Provost Richmond, of Glasgow, at a meeting of the Glasgow City Council, dealt at

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length with the problem, and I cannot do better than to quote his remarks. He said :—

I would suggest as a designation for the proposed consolidated committee, "The Tramways and Electricity Committee." It would be composed of 26 members—one from each ward, with the addition of the Lord Provost to make the even number. For the present the 25 members would be taken from the existing committees in question. This would form a general, or parent committee, which would, first of all, be divided into two standing sub-committees, named respectively the "Sub-Committee on Tramways" and the "Sub-Committee on Electricity," and it might be well in each case to secure continuity by retaining members on these sub-committees respectively who are acting on the corresponding committees at present. The parent committee could again be equally divided transversely by appointing 13 members to form a "Sub-Committee on Finance," which would deal with all the accounts of the various sections, and 13 members to form a "Sub-Committee on Production." Each of these two sub-committees would be composed of six members from the Sub-Committee on Tramways and six from the Sub-Committee on Electricity, and in each case there would be the convener in addition The parent committee would, while guiding and reviewing the entire policy of the whole (acting both under the Tramways Acts and the Electric Lighting Order, 1890), take up and deal directly with the production of electric current for all purposes; the delivery of the current required by each of the two standing sub-committees at the proper voltage at their respective switchboards, or as may be arranged ; and the fixing of all charges for current supplied to or through these respective sub-committees, and the apportioning of all common or general charges. The Sub-Committee on Tramways would receive from the parent committee, at such points as may be arranged, all the current required for tramway traction. In all other respects this sub-committee would control and operate the Tramways Department just as the Tramways Committee does at present. The Sub-Committee on Electricity would likewise get current supplied by the parent committee at given points, and would distribute it in the supply of current for public and private lighting and for power, thus practically carrying on the work of the present Electricity Committee, apart from the production of current. The Sub-Committee on Finance would take charge of the accounts of all the departments of the committee. Separate books and accounts would, of course, be kept for the different departments, and each could have its own bank account. The Sub-Committee on Production would deal with the power stations and other works directly undertaken by the parent committee. Each of the four sub-committees might meet fortnightly, and the parent committee, as in the case of the Health, Water and Gas Committees, monthly. I would suggest that the present conveners and sub-conveners should occupy in the new department as nearly as practicable corresponding positions to those occupied by them at present. The following rearrangement of committees and sub-committees would give practical effect to this : Tramways and Electricity Committee, convener and sub-convener ; Sub-Committee on Tramways, convener and sub-convener ; Sub-Committee on Electricity, convener and sub-convener ; Sub-Committee on Finance, convener and sub-convener ; and Sub-Committee on Production, convener and sub-convener.

The foregoing remarks clearly show that the position of the electrical undertaking in Glasgow has become of the utmost importance in the affairs of that city, and, at the same time, those remarks are also a clear indication of what must shortly be experienced in other large cities and towns. Mr. Arthur Wright, of Brighton, carefully and ably expounded the speech just quoted, in an article entitled "The Centralisation of Electricity Supply," contributed to the *Electrical Review* of September 24, 1897. In that article Mr. Wright proposes a somewhat different adjustment of the control from that suggested by the Lord Provost. Mr. Wright would form a chief committee and call it *General Purposes Electricity Committee*, entrusting it with the sale of electrical energy for all the requirements of the district. The formation of such a committee by one member from each ward, as proposed in Glasgow, would thus, he thinks, bring in gentlemen serving also on the several committees requiring electrical energy for the purposes of their respective municipal departments, but it is not suggested that this electricity committee should directly interfere with their sub-committees further than to see that their wants are properly supplied.

Mr. Wright further suggests that the chief committee should be divided into three sub-committees respectively, entitled—*The Sub-Committee on Production*, having charge of the works and sub-stations; *The Sub-Committee on Distribution*, having charge of the mains, feeders, connections, and meters ; and *The Sub-Committee on Finance* having to do with all data, estimates, loans and accounts. To quote Mr. Wright's own words :—

This arrangement is strictly within the natural lines of development of our present practice under which the staff of the largest central stations are divided into departments in the manner indicated. The sub-committee on production should be responsible only for works-costs, regularity of supply, and the delivery of electrical energy into the mains at a proper pressure. The sub-committee on distribution should be responsible for pushing the business, for laying out the system of mains to the best advantage, and for the organisation of the delivery to departments of the corporation and private consumers in different parts of the district. It would be for the sub-committee on finance to determine in regard to the supply of the tramways on the one hand, and the supply for lighting, power, &c., purposes on the other, the correct tariff based in each case on the amount of plant called into play at the works, the units taken from it and the relation of the total distribution expenses to the two sets of mains, &c.

It is immediately apparent from the opinions just quoted, of a recognised authority upon municipal management on the one hand, and of the first President of the Municipal Electrical Association on the other, that it is not possible for one general committee to deal wholly and solely with all the business of any one department of a corporation. In some of the larger towns of the kingdom the attempt it is true is still being made, but in a few years the necessity will arise in all but the very smallest townships to form numerous small sub-committees, each of which will be separately responsible to a main or general committee, as already set forth. In the case of a great many municipal corporations the present position of the Electricity Committee can hardly be stated to be conceived on a broad or independent basis. It is indeed more or less a fact that corporations have been forced into obtaining powers for the supply of electricity, or into using powers already granted to them, through threatened encroachment on their rights or imminent forestalling of their powers by private enterprise.

The inauguration of the business and the consequent formation of a committee to deal with it have thus been approached in a half-hearted manner, and hence small and inefficient "central stations" are the result. In many cases the municipality is also the owner of the gas works, and there appears to exist under such circumstances a great fear that the demand for electricity may seriously affect the welfare, and hence the finance, of the gas undertaking. Whilst this apprehension exists no large scheme of development can, of course, be expected, and the immediate consequence is that neither the best interests of the town nor of the two rival departments themselves will be served. A lame and halting policy is no better for a municipality than it is for an individual or a nation. If, however, we may judge from analogy, with any degree of confidence, the most rapid development of the electric light need give the gas department but little cause for fear. All new enterprises take considerable time in becoming really large undertakings, and meantime existing institutions hold their own with considerable tenacity. One of the London evening newspapers some time ago illustrated the fact very clearly, and it would be well for local councillors to take the lesson to heart. The extract is worth reprinting :—

Consider illumination If you look at the old iron barrows in the Mile End-road you will see offered for sale heaps of old-fashioned snuffers with the box for catching the wick. And the barrow merchants will tell you that there is a market for them. They are not bought by well-to-do "cranks" who use snuffers as a matter of conservative obstinacy or family pride. They are not used by very poor people. The very poor prefer to endanger their already precarious lives by using low-flash oils in unstable lamps. No; there is a public for these archaic implements. There are people in London who have not left off burning the old dip candle, which requires constant snuffing. This takes us a long way back from the electric-light button behind one's pillow ; but it is by no means certain that one could not go back further. Are rush-lights entirely disused in the British Islands ? Anyhow, dip candles are still a cherished illuminator in London itself. After dips come composite candles, which are still in immense use. After composite candles we rise through a hierarchy of oil lamps—each "patent" contemptuous of earlier ones—to gas. We have the ordinary gas flame, the albo-carbon flame, and the wonderful hooded flame. Then we come to the electric light in its many adaptations, not omitting the 'bus ticket-inspector's self-contained apparatus—noteworthy, because it marks the immense difference between the possibilities of gas and electricity. The ticket-inspector can carry his dynamos without inconvenience, but a pocket gasometer is an impossibility.

It matters not where we look in this complex, ingenious, acquisitive, and yet conservative age—anomalies flourish together like flowers that bloom in the spring. We have a dozen ways of sending a message, each representing a stage of our national progress. We have still the rural postman in his cart and blowing his horn or whistle—Cornwall knows him well ; we have the town postman, the express messenger, the telegram boy, and the telephone, the last-named being—so far as London is concerned—a most successful return to primitive unsatisfactoriness.

These observations are at least worthy of consideration, for underneath them there lies a very solid substratum of fact. For very many years to come there is room for both gas and electricity without the unbusinesslike method of crushing one for the sake of the other. The Gas Committee and the Electricity Committee should at any rate be entirely separate and distinct from each other in every township.

(To be continued.)

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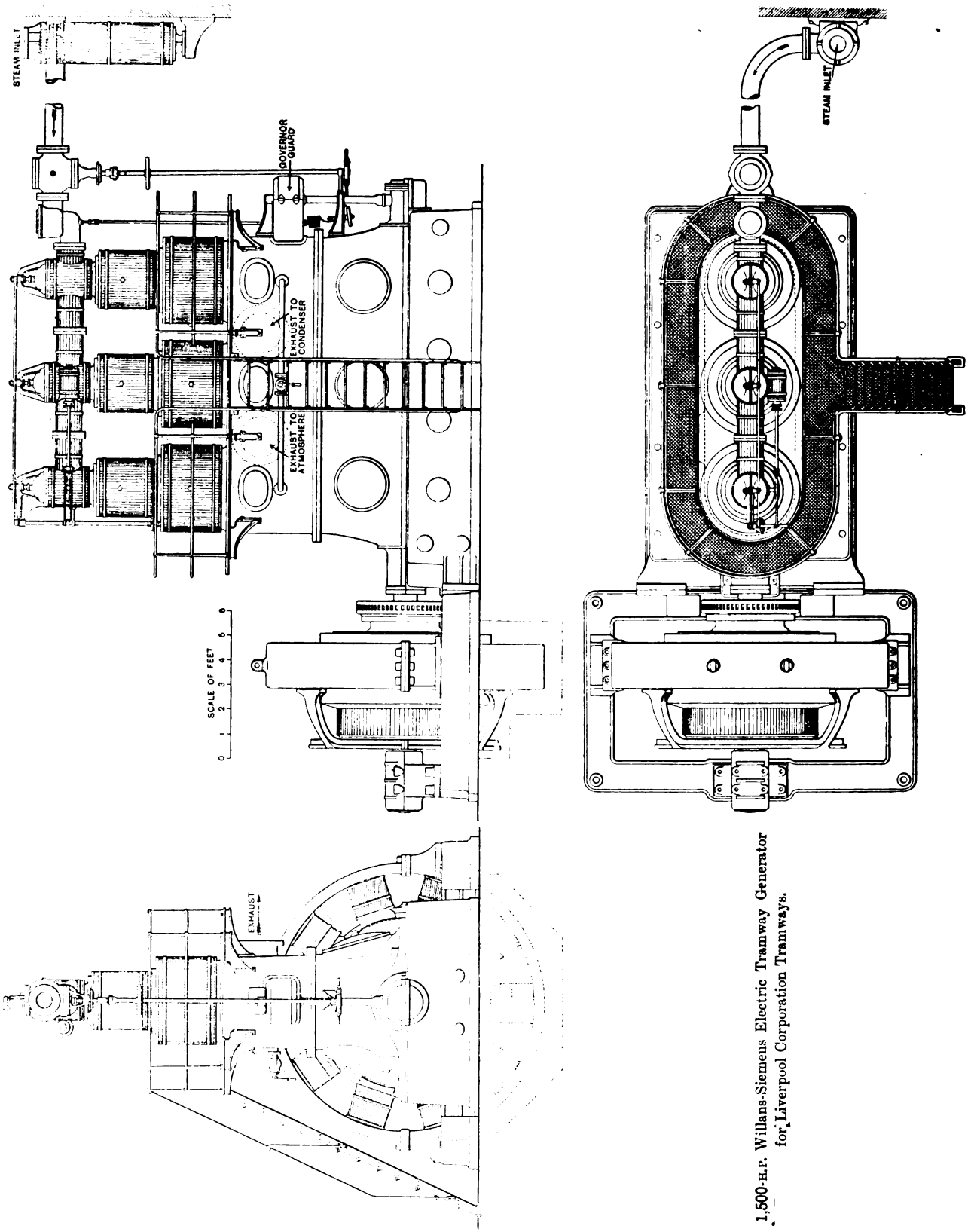
A 1,500 H.P. WILLANS ENGINE.

At the meeting of shareholders of Messrs. Willans and Robinson, Limited, on the 30th ult., it was stated by the Chairman, Mr. Mark H. Robinson, that a 1,500 H.P. engine for electric traction work was being built at the works of the Company. Through the courtesy of the directors, we are now enabled to present our readers with scale drawings and further particulars of this interesting plant, which is the largest Willans engine in existence.

The engine, together with the multipolar generator to which it will be direct-coupled, as shown in the accompanying illustrations, will ultimately be used by the Corporation of Liverpool for electrically driving the tramway system recently acquired by the Corporation. It is of the 3-crank automatic expansion compound type, and is designed to run at 230 revolutions per minute, and to develop, under a pressure of 160lb., a maximum of 1,500 I.H.P. for short periods. The normal power is rated at 1,200 H.P. Among the principal internal dimensions are the following: high-pressure cylinders 20½in. diameter, low-pressure cylinders 34⅝in. diameter, stroke 16⅝in. and the diameter of the crank shaft 11in., this shaft being of Siemens-Martin mild steel. The engine is controlled automatically by Messrs. Willans and Robinson's supplementary cut-off gear, and is provided with regulating gear to enable



1,500-H.P. Willans-Siemens Electric Tramway Generator for Liverpool Corporation Tramways.

Willans Engines employed in Electric Traction Work.

Name of undertaking.	Date of starting	Engines. Number of engines.	Total I.H.P.	Description.	Steam pressure, lb.	Condensing or non-condensing.	H.P. cylinder, diameter.	L.P. cylinder, diameter.	Stroke.	Speed.	Floor space occupied by each set.	System of working cars.
Hobart Electric Tramway Co.	Mar. '93	3	600	2-crank direct-coupled compound, fixed expansion	160	N.C.	14″	20″	9″	350	14′6″ × 5′3″	Overhead trolley.
Dublin Southern District Tramways Co.	Nov. '95	4	660	2-crank belt-driving comp'd. automatic expansion	140	C. or N.C.	12″	17″	8″	380	6′7″ × 4′6″ *not* includ'g dynamo	Overh'd. trolley, partly direct-current, partly alternating with sub-station transformers.
City and South London Railway Co.	Jan. '96	1	240	2-crank direct-coupled compound, automatic expans'n.	130	N.C.	14″	20″	9″	350	15′0″ × 5′3″	Third rail conductor.
Hartlepool Electric Tramways Co.	Mar. '96	2	200	2 crank direct-coupled compound, automatic expans'n.	140	N.C.	10″	14″	6″	460	10′8″ × 4′0″	Overhead trolley.
Chemin de Fer de l'Ouest, France (St. Germain line)	Nov. '96	2	720	3-crank direct-coupled (one dynamo between the two engines), compound automatic expansion	180	C.	14″	20″	9″	350	10′6″ × 6′0″ *not* includ'g dynamo	Third rail conductor.
Liège Municipality Electric Trams	Jan. '97	3	750	3-crank direct-coupled compound, automatic expans'n.	176	N.C.	12″	17″	8′	380	14′0″ × 5′0″	Overhead trolley.
Trams de la Madeleine, Paris	Feb. '97	3	540	3-crank direct-coupled triple, automatic expansion	184	C.	190mm & 280mm	440mm	150mm.	460	13′0″ × 4′0″	Accumulators on cars.
Liverpool Corporation Electric Trams	...	1	1,200	3-crank direct-coupled compound, automatic expansion, fly-wheel is formed by armature	160	N.C. C. later	520mm.	880mm.	430mm.	230	*see* illustration.	...
		19	4,910									

the speed to be varied by hand while the engine is running, and it is intended to reduce the speed of the engine on light load in order to avoid sparking at the dynamo commutator.

To this engine a Siemens multipolar continuous-current generator will be direct-coupled. This dynamo is of the type known as the "10 B, 84/15" and will develop 1,420 amperes at 550 volts. The excitation will allow of a variation between 460 and 550 volts in the terminal pressure, with a slight variation in speed. It will be noticed that the generating set is not provided with a separate flywheel, the moment of inertia of the armature being made sufficiently large to serve as a flywheel. It is stipulated that the energy stored in the flywheel at normal speed shall not be less than 2,000,000 foot-pounds. The following are some further details of the dynamo: The field-magnets consist of a ring of high-permeability steel, made in halves, and strongly bolted together, carrying 10 poles, also of high permeability steel. On each of the above-mentioned poles is fitted a removable bobbin with insulated wrought-iron body and substantial cheeks. The windings on these bobbins consist of insulated high-conductivity copper wire and strip. The armature core is built up of thin plates of best charcoal iron carried on and securely fixed to a cast-iron armature body, which is keyed to the shaft. The armature winding consists of high-conductivity copper bars individually insulated and securely fixed in slots in the core. These slots are also lined with insulating material. The bars are joined up by curved end connections insulated with a specially-treated tape and mica. The commutator is built up of hard drawn copper segments of high conductivity, insulated with mica. The working surface is unusually large, and a large amount of wear is allowed for. The brush gear is of substantial design, and is so constructed that the position of all the brushes may be readily and simultaneously adjusted, a worm and wheel being provided for the purpose. There are 10 sets of carbon brushed round the commutator.

As an impression seems to exist in the minds of some engineers that the Willans and other high-speed types of steam engine are not suited to the severe conditions of electric traction work, the tabulated statement given above of actual cases where Willans engines have been adopted for traction stations may be of interest.

As regards the Hobart tramway, there has never been any complaint since the engines were put down, with the exception that there was some little trouble at the commencement owing to the armature shafts breaking between the armature and the fly-wheels of the engines; but we believe this was as much due to bad foundations and sinking of the end bearings as to anything else. The ground on which the station is built is all made ground, and is very rotten. The difficulty was got over by putting in larger shafts, and the fly-wheels were also reduced in weight The running appears to be very good in spite of the fact that the fly-wheels are not much more than half the ordinary weight. The engines were originally ordered with automatic expansion, but they were eventually supplied with fixed expansion, and this appears to have been no detriment to their working. The Hartlepool tramway engines have run the line continuously since they were put down, under rather disadvantageous conditions, for there are only four or five cars at work and the load is consequently very variable. One engine does the work and the other is a stand-by. The St. Germain engines, in France, serve the line from St. Germain Station to St. Germain Ceinture, and they are coupled directly one to each end of the shaft of a single dynamo. They have now been at work for rather more than a year, and are giving great satisfaction. The Liége electric trams engines were supplied under very stringent conditions of guarantee. Under all working conditions of load the variations of speed were not to exceed 1¼ per cent. above the mean, and 1¼ per cent. below the mean, while when all the load was thrown off suddenly, as by a cut-out going, the momentary variation was not to exceed 6 per cent The trials upon these engines were held two or three months ago, and the conditions were fully adhered to. The municipal authorities are extremely well pleased with the plant. The engines at La Madeleine, Paris, work under rather different conditions from the ordinary tramway engines, and have a much steadier load. The cars are driven by accumulators, which are charged by the engines and placed upon the cars as required. The charging, we believe, takes about 10 minutes or a quarter of an hour, and the load on the engines is regularised by having spare sets of accumulators always being charged ready for the incoming cars.

THE "LITTLE" CONTINUOUS INTEGRATING INDICATOR.

In the accompanying illustration, for the use of which we are indebted to our contemporary, *Engineering*, an ingenious form of continuous steam-engine indicator is shown. This instrument, which differs in many respects from the usual types of indicator, is the invention of Messrs. W. G. and C. W. G. Little. The purpose of the instrument is not to

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draw indicator diagrams, nor in any way to show the shape which a diagram would have if obtained in the usual way, but consists rather in obtaining a numerical index of the work performed by the engine in any given number of revolutions. It will be evident that this index must be multiplied by a coefficient depending on the size and other constants of the engine, but when this operation has been performed the horse-power is simply obtained by dividing the product by the speed of the engine. Thus if C is the coefficient, R is the index reading on the dial at the end of one minute, and N is the speed in revolutions per minute; then

$$\text{H.P.} = \frac{CR}{N}.$$

The instrument is used in the following manner:—The steam cylinder A of the indicator is attached, as usual, to the end of the engine cylinder to be indicated, and by means of a cord and parallel-motion rigging the barrel L is oscillated, the amount of oscillating depending on the length of stroke, and this latter being indicated on a gauge, M. The pulsations of steam pressure in the indicator cylinder cause the piston-head R to rise and fall, thereby correspondingly varying the angle of the integrator disk, or wheel, E. According to the momentary value of this angle the velocity-ratio of the barrel and disk may be high or low, as in all disk-and-roller integrators; and, as a result, the work-diagram corresponding to each stroke of the engine is successively integrated and recorded on the dial F. All that it is necessary to do, therefore, after having attached and started the instrument, is to leave it to go on integrating for as long as may be desired. If the time it is in operation and the total number of revolutions of the engine are noted, either the mean horse-power over the period or the total work done can readily be ascertained.

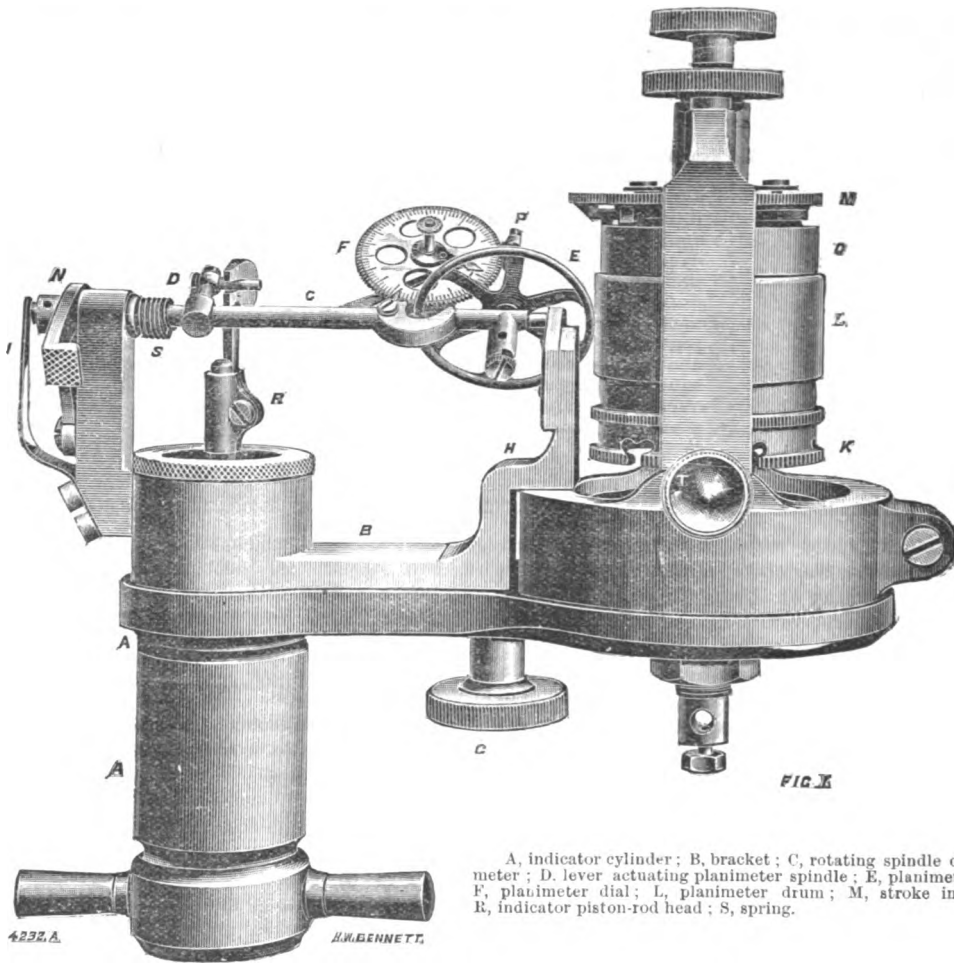

FIG. X.

A, indicator cylinder; B, bracket; C, rotating spindle of planimeter; D, lever actuating planimeter spindle; E, planimeter disk; F, planimeter dial; L, planimeter drum; M, stroke indicator; R, indicator piston-rod head; S, spring.

The "Little" Continuous Integrating Indicator.

THE COST OF GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY.*

BY ROBERT HAMMOND.

(*Continued from page 753*).

C.—*Reliability of Plant.*

Here I feel that I am on dangerous ground, for I lay myself open to the challenge to name any electrical plant manufactured in this country which is not perfectly reliable. My wish to-night is to avoid as far as possible provoking a discussion on the merits of particular engines, boilers, or dynamos. I would rather see the subject discussed on a broader basis. On the other hand, though I desire to acknowledge to the full the indebtedness of the profession to those firms of manufacturers who in this country have placed excellence of workmanship above every other consideration, I trust I may be pardoned the expression of belief that in certain cases the pursuit after *efficiency* has sometimes resulted in the sacrifice of *reliability*. Perfectly reliable generating and distributing plant has a very important bearing on costs. It is my custom, and doubtless that of other consulting engineers, to insist upon very rigid and prolonged tests of the generating plant after the completion of erection on the site. These tests invariably include—

(*a*) Ten or 12 hours' consecutive running at full load.
(*b*) Two hours' running at emergency load.
(*c*) Governing.
(*d*) Whole load thrown suddenly on and off.
(*e*) Limit of temperature rise at end of the 10 or 12 hours' run.

Until all these tests (*inter alia*) have been fully complied with, the plant is not taken over. The almost invariable result is that when the plant has passed this ordeal it can be depended upon to cope with almost every emergency arising in the regular course of its work. Plant that will go on year in and year out doing its duty, without the slightest hitch, is the first essential toward the running of works with the minimum expenditure on oil, wages, repairs, superintendence, &c. If you desire to run your works

* Abstract of a Paper read before the Institution of Electrical Engineers March 24, 1898.

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No. VIII. *Statement of Electricity Generated, Sold, &c.*

Quantity generated in B.T. units.	Quantity sold.				Quantity used on works.	Total quantity accounted for.	Quantity not accounted for.	Number of public lamps.	Total maximum supply demanded.
	Public lamps.	By contract.	Private consumers by meter.	Total sold.					

Statement of Electricity Generated, Sold, &c., Year ending December 31, 1896 (Westminster and St. James).

Board of Trade units generated.	Quantity utilised.			Quantity expended in distribution.			Quantity accounted for.	Quantity unaccounted for.	No. of lamps on circuit Dec. 31, 1896.
	Sold to consumers.	Used on works.	Total.	In batteries.	In feeders.	Total.			

economically, secure first of all, and at almost any cost, perfectly reliable plant.

D.—*The Engineer-Factor.*

This is an item that does not figure in the Board of Trade returns, but I venture to say that in every one of the works in this country where low costs prevail the engineer in charge is distinguished for ability, assiduity, and earnestness, combined with rigid weekly analysis of his works costs. There are, fortunately, a host of such in this country; but as I write the words I cannot help calling to mind an example of the man I mean, in the person of one of our members, Mr. Harold Dickinson, the engineer of the Leeds works. I mention him because I think his career forms an excellent pattern to our younger members. From the position of clerk of works, under me, of the first works at Leeds, he was promoted to the engineering management, and doggedly set before himself the task of running the works so economically that they should be second to none in the kingdom. The result is that, in spite of the low efficiency of rope-driven alternators and house-to-house converters, he has scored the record costs for output of any undertaking in the kingdom. Certainly one of the greatest factors operating towards low costs is the engineer-factor.

E.—*Efficiency of Generating Plant.*

As the number of electricity works has increased, more and more attention has been paid to the important question of efficiency. Valuable Papers have from time to time been read before this and kindred societies, or written for the technical Press, on the most efficient types of boilers, feed pumps, mechanical stokers, forced draught, steam ranges, engines, dynamos, condensers, &c. The persistency with which the electrical engineers' attention is directed to "efficiency" has had important results. Undoubtedly the plant available to-day for use in our electricity works has an all-round efficiency far higher than that which was current 10 years ago, and close consideration is given in most works to the best means of minimising "obscure losses," in order to arrive at the *summum bonum* of the minimum of cost for the maximum of output.

In carrying out my own work, I have made it a rule for some years to stipulate for a minimum consumption of water per kilowatt of electrical energy given off at the dynamo terminals, and to enforce this under a money penalty of about £1 per kilowatt per lb. of steam; that is to say, £100 per lb. in the case of 100-kilowatt plants, £200 in the case of 200-kilowatt plants, £300 in the case of 300-kilowatt plants, &c. I specify that the measurement shall be made during the 10 or 12 hours' test after erection on site, and under the following conditions:—

(*a*) Engine working condensing with not less than 26in. of vacuum.

(*b*) One or two boilers, at contractor's option, solely devoted to running the set of plant under test, and entirely under the control of the contractor; *the basis of the steam consumed to be he weight of water pumped into the boilers*, with the following deductions:—

(1) The steam for driving the feed pumps, the air and circulating pumps, the steam jet for the forced draught, &c., supplied by another boiler.

(2) All water drawn off during the test from the separator and steam range in use for the test to be deducted from the amount of that measured into the boilers.

(*c*) All portions of the range conveying the steam to the plant under test, which are not necessary to the test, to be blanked off.

(*d*) All pipes through which water might accidentally find its way into the boilers to be blanked off.

(*e*) The steam pressure in the horse-power steam chest to be kept as closely as possible at the steam pressure specified in the contract.

Under these conditions I have obtained with slow-speed alternating plants the results set forth in the table below.

The recently-erected 300-kilowatt high-speed alternating plants at Leeds were guaranteed to have a limit of steam consumption of 30lb. per kilowatt hour, self-excited and with separate condensers, but in the preliminary tests this limit has been exceeded. The final "money guarantee" tests have not yet taken place, and the contractors fully expect, with the valves set to the most economical load, to fulfil the guarantee. Under the above-named conditions I have recently, in the case of the plant for the Corporation of Gloucester, obtained a guarantee of 26lb. of steam per kilowatt-hour, with a three-crank nine-cylinder, triple-expansion engine, running at a speed of 350 revolutions, driving direct two 150-kilowatt continuous-current dynamos, and working with a steam pressure of 160lb.; also 30lb. of steam per kilowatt-hour with a two-crank four-cylinder compound engine, combined with two 75-kilowatt continuous-current dynamos. Data as to the "efficiency" of the plant in use throughout the kingdom would prove most valuable, but, except in isolated cases, it is, I am sorry to say, unobtainable; but, in spite of the absence of official data, it is certain that in designing all new works, and in extending old ones, the closest attention is being paid to "efficiency" of generating plant.

F.—*Efficiency of Distribution.*

Form No. VIII. of the Board of Trade accounts is as given above.

If a correct determination be made of the units (*a*) generated, (*b*) used at the works, (*c*) delivered to consumers, it might be presumed that the balance "not accounted for" would represent (*d*) the units used in distribution; and the percentage of (*d*) to (*a*) gives the distribution "losses." This simple view of the matter is, however, not general. Some engineers consider that "magnetising watts" should be treated as "units used on works," and others place the "loss in batteries" in the same category. Some determine by hypothesis or by calculation the "units used in distribution," and then, finding their totals fall short of their metered "generated units," fill in a balance figure under the head of "Units

Rated full-load in kilowatts.	Description of engine.	Type of valves.	Revolutions per minute.	Method of driving.	Type of alternator.	Type of boiler.	Steam pressure at engine.	Vacuum, inches.	Steam per kilowatt-hour.	Remarks.
100	Slow-speed horizontal compound	Piston valves	88	Ropes	Iron cores. Revolving multiple-coil magnets	Lancashire	125	24	33·93	Separate condenser. Self-exciting.
100	Slow-speed horizontal compound	Equilibrium valves. Trip gear	99½	Direct	Iron cores. Revolving single-coil magnets	Lancashire	125	26	25·94	Separate condenser. Self-exciting.
120	Slow-speed horizontal compound	Equilibrium valves. Trip gear	96	Direct	Iron cores. Revolving single-coil magnets	Lancashire	125	25	26·37	Separate condenser and independent excitation.
200	Slow-speed horizontal compound	Piston valves	97·5	Ropes	Iron cores. Revolving multiple-coil magnets	Lancashire	125	25	30·7	Separate condenser. Self-exciting.
200	Slow-speed horizontal compound	Positive Corliss ...	91	Ropes	Iron cores. Revolving multiple-coil magnets	Lancashire	125	...	30·61	Working own jet condense and pump. Self-exciting.

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not accounted for." Some regard the whole difference between the "generated units" and units delivered to consumers as "units unaccounted for," while others urge that no electrical engineer is worthy of the name who is unable to account for all the units he generates, whether they be used in his batteries, feeders, transformers, or delivered through the consumers' meters.

In the case of the Westminster and St. James' undertakings the bold course is adopted of remodelling the Board of Trade form.

This is certainly an improvement upon the standard form. The amendments which I would venture to suggest are the substitution of the heading "Used at Generating Works" for "*Used on Works*," the placing of "Quantity unaccounted for" under "Quantity expended in Distribution," the substitution of the word *units* throughout for that of *quantity*, and the inclusion of a heading under Distribution for tranformers.

As already stated under the heading *Load-Factor*, the custom of metering the units generated is not general, and therefore in many cases the figure upon which to base the distribution losses is not available. Even, however, where the generated units are registered by meter, it is often impossible to accurately determine the distribution "losses," in view of the divergent methods already alluded to. I must confess to some disappointment at finding that the majority of works' engineers appear to be indifferent to the recording of their distribution losses, as it is obvious that a badly-planned or obsolete method of distribution must seriously affect the costs. Some seem to be under the impression that 5 per cent. more or less "efficiency" only affects the coal bill, and this is doubtless the case when the output of the works is small: but as the output grows, the "efficiency" factor tends more and more to affect the whole of the "works costs."

Irrespective, however, of the advantages that a system serving a compact area has over one serving a scattered district, there is a great field open to the engineer working either system to keep his distribution losses to a minimum. In the case of alternating systems house-to-house transformers must be replaced with large-sized transformers in sub-stations, and in the case of direct systems skill must be exercised in the planning of feeders and in the use of accumulators. The fruit of the various improvements made in different works throughout the country is marked by the lower distribution losses of 1897 over 1896.

G.—*All-round Efficiency.*

Here we have a combination of efficiency of generating plant and distribution system. The former is directly under the control of the engineer, and the latter largely so, though modified by the extent of the area to be served. It is often said that a rough test of all-round efficiency of any works can be obtained by a study of the coal bill. Under this method the palm of efficiency would be awarded to the works with the lowest cost of coal per unit; but a general comparison, on this basis, of works situated in different parts of the country would be misleading, since the price of coal varies in various districts. It is no doubt possible to compare with safety the coal results of the undertakings at Kensington, Westminster, and St. James', or of those drawing from the same coalfields, such as Cheltenham and Worcester, Blackpool and Southport, Huddersfield and Halifax, Bradford and Leeds. But how is it possible to compare Bradford with Cheltenham, or Leeds with St. James'? Some reply, "Disregard cost per unit, and rely on *pounds per unit*." Unfortunately, however, the statistics of coal consumption are only of partial use, as an indication of "efficiency," due to the fact that in different districts the coal differs in calorific value. In some works it is possible to obtain low-class fuel at a very cheap rate, and in those the *pounds per unit sold* are much greater than in works where only high-class fuel is obtainable.

If it were possible to obtain statistics of the consumption of British thermal units, we should have a basis of comparison for the whole of the works in the kingdom. I have indeed at various times endeavoured to obtain these data, but I have found it impossible to do so. It appears that very few engineers analyse their coal. They are content to go on putting forth their endeavours to reduce the *cost* of fuel per unit sold, and they disregard the anxiety of those individuals, like myself, who desire to see all the coal bills of the country put upon a scientific basis. When they are dissatisfied with one class of coal they make a careful trial of another, and judge its merits on the amount of duty they extract from it. In the course of my analytical work, however, it has frequently been suggested to me that, in spite of these drawbacks, I should make an attempt to classify coal results; and, as the first step in that direction, I have asked each works engineer to favour me with a note of the *quantity used* and the *average price paid* over the year. Though I am not able to set out calorific values, I am inclined to think that those who are acquainted with the price of the highest class coal in each district will be able to form a fair idea of the relative calorific values of the coal used in various works. In any case, however, the statistics which I have been able to collate will prove of service in comparing the all-round efficiency of plant and distribution, in places, like the metropolis, where similar coal is used by almost all the works.

Coal Statistics of Metropolitan Undertakings.

Metropolitan Works.		Coal—1896.		
Name of works.	Units sold.	Per unit sold.	Lb. per unit sold.	Average price per ton.
		d.		s. d.
Charing Cross	1,944,402	0·87	9·0	17 6
Chelsea	813,764	0·88	8·4	19 5
City of London	5,488,500	0·81	Information	unobtainable.
Crystal Palace	118,316	1·88	15·7	20 8
Hampstead	547,920	1·36	13·4	14 3
House-to-House	643,693	0·99	Information	unobtainable.
Islington	297,834	1·50	Information	unobtainable.
Kensington	1,514,729	0·67	6·6	18 6
Metropolitan	4,075,000	1·82	Information	unobtainable.
Notting Hill	230,787	0·71	7·0	18 9
St. James'	2,401,431	0·50	6·4	14 0
St. Pancras	1,201,229	0·99	Information	unobtainable.
Westminster	3,503,054	0·53	6·5	15 4
Woolwich	75,929	1·75	18·1	18 0

Again the "alternating works" stand at the head of the list, while among the direct systems the St. James' Company comes out lowest, combined, curiously, with the lowest price paid for coal, viz., 14s. per ton.

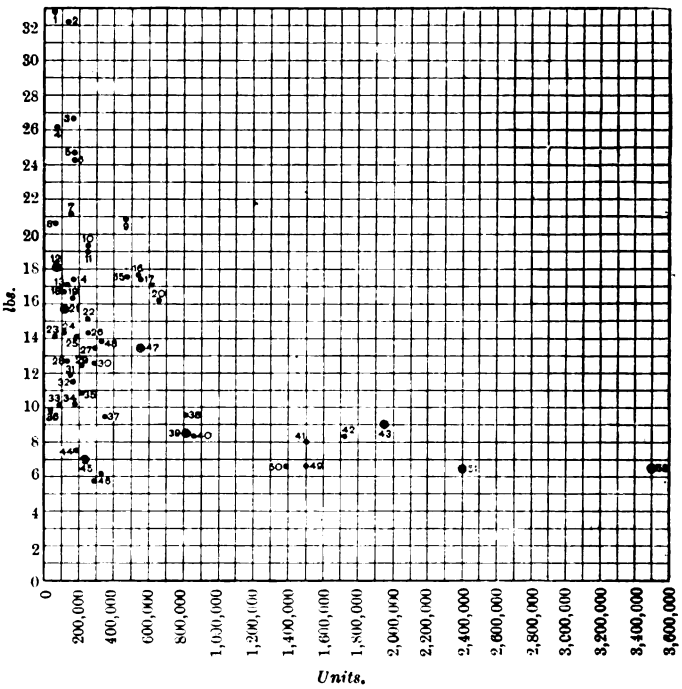

DIAGRAM IV.—Curves showing relation between lbs. of coal consumed per unit and units sold.

1. Coventry.
2. Ayr.
3. Kingston-on-[Thames
4. Reading.
5. Halifax.
6. Leicester.
7. Dover.
8. Walsall.
9. Dublin.
10. Hanley.
11. Ealing.
12. Woolwich.
13. Taunton.
14. Yarmouth.
15. Sheffield.
16. Newcastle-on-[Tyne.
17. Newcastle Dis-[trict.
18. Cheltenham.
19. Sunderland.
20. Bristol.
21. Crystal Palace.
22. Dundee.
23. Kelvinside.
24. Lancaster.
25. Newport.
26. Southport.
27. Nottingham.
28. Southampton.
29. Eastbourne.
30. Hastings.
31. Dewsbury.
32. Blackburn
33. Richmond.
34. Whitehaven.
35. Aberdeen.
36. Pontypool.
37. Hull.
38. Bradford.
39. Chelsea.
40. Portsmouth.
41. Glasgow.
42. Edinburgh.
43. Charing Cross.
44. Hove.
45. Notting Hill.
46. Oxford.
47. Hampstead.
48. Preston.
49. Kensington and Knightsbridge.
50. Brighton.
51. St. James' and Pall Mall.
52. Westminster.

I have shown in Diagram IV. the relation of coal consumption per unit to units sold in all the works in respect of which I have received the data, and I leave the figures to speak for themselves.

(*To be continued.*)

Telephones and the Ohio Disaster.—During the recent disaster caused by the bursting of a retaining wall on the Ohio river assistance was summoned from Evansville by telephone, a man bravely venturing upon the flood in a skiff in order to reach the telephone call office.

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EXPERIMENTS WITH SPARK TELEGRAPHY.*

BY K. STRECKER.

Experiment with the Hughes Type-Printer.—If Morse signals are to be transmitted by means of Marconi spark-telegraphy, it is of no importance if a dot is a tenth shorter or longer, the space 50 per cent. larger, or the dash a little longer. In fact, in many cases long dots and dashes have had to be used, and with perfect justice. But a Hughes instrument works, as is well known, with current impulses of equal duration, lasting in the German type of apparatus 0·07sec. It is also necessary that the time between the sparks shall be always the same to within one-hundredth of a second, an accuracy which is attained with a wire conductor. Fig. 1 further explains what is necessary. The current impulses of the transmitter are represented as elevations in the line ab, and the time between them by the length cd. The action of the current in the receiver is shown by the line $a'b'$. It is not necessary that the elevations in $a'b'$ should be exactly below those in ab, but the current impulses must both be retarded the same amount so that $c'd'=cd$ to within one-hundredth part of a second; otherwise wrong letters are received. The following experiment (which was demonstrated at

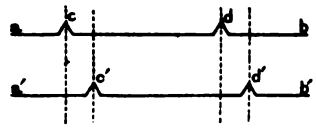

FIG. 1.

the reading of the Paper, the transmitter and receiver being placed 42ft. apart) has been made to investigate with what accuracy one can work with these sparks, and at the same time to see what apparatus can be used for such effects. The transmitting and receiving apparatus, which are, of course, not connected together, are shown diagrammatically in Fig 2. The transmitter sends currents to a local circuit in which is a relay, and the contacts of this relay close the primary circuit of the induction coil. The latter gives quite small sparks. The two spheres have side wires fixed to them to lessen the damping of the vibrations. One pole of the spark-gap is connected to earth. At the receiving end the coherer is connected and supported by two sheets of aluminium, one of which is put to earth. The coherer is simply a glass tube, 7mm. internal diameter and 10cm. long, loosely filled with coarse brass turnings, and closed with two corks, through each of which a bronze wire 1·5mm. diameter projects into the filings. It was found that tubes of far greater sensibility worked less well. This tube is

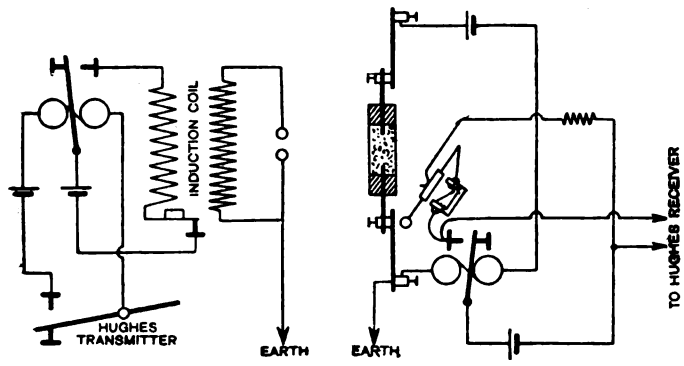

FIG. 2.

connected in circuit with a relay and a source of current, so that each time a spark occurs and the tube becomes a conductor, the relay closes the local circuits of the Hughes instrument and the tapper. The latter is thereby caused to strike lightly against a cork disc on one of the aluminium springs, and shakes the coherer. The relay returns immediately to its initial position, and is ready to receive a new signal.

The speed of working depends on the mechanical properties of the apparatus. In the first place the circuit breaker of the induction coil has to with it. In this experiment a larger induction coil could not be used, as the interrupter would be too sluggish. The small induction coil suffices for such a short distance, but it would be necessary to modify the arrangements somewhat if a larger one were used. Difficulties begin already in the primary circuit of the induction coil through the rapid interruption of the strong current. At the receiving end also the tapper constitutes a sluggish electro-mechanical apparatus, and it is necessary that the moving parts of all the apparatus shall be completely at rest before a new signal is sent. Consequently, with the present arrangement it is not possible to send more than two letters per revolution with the Hughes instrument, and these two must not be too near together. To be sure, therefore, that the working is not too rapid, one letter per revolution is fixed as the limit, and this corresponds to the average speed of Morse signalling, so that the experiments point to no particular technical advantage.

Improved Connections for Morse Instruments.—The author also showed a method of improving the Morse signs received by making a simple modification of the usual connections, resembling one due to Delany. A shortening of the dots and dashes is thereby obtained so that one can operate almost as quickly as over an overhead line. The relay in circuit with the coherer does not work directly on the receiving Morse instrument, but a permanent current circuit is interposed. This is shown in Fig. 3. So long as

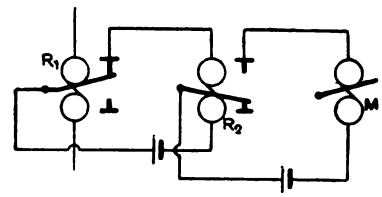

FIG. 3.

the armature of the first relay R_1 is not attracted, it closes a permanent current circuit in which is a relay R_2, the latter relay controlling the Morse instrument. If, owing to the quick action of the tapper, a dash is split up into a succession of dots, the tongue of the relay R_1, although it will not remain quietly against its contact, will only make short, quick movements. It will not move as far as the upper contact and restore the permanent-current circuit until the dash is ended and there is a pause in the succession of current impulses. In consequence, therefore, of the doubled inertia of the apparatus the dots will be shorter, and the dashes will be continuous and not too long.

* Abstract of a Paper read before the *Elektrotechnischer Verein*, February 22, 1898.

AN EXTENSION OF MAXWELL'S ELECTROMAGNETIC THEORY OF LIGHT TO INCLUDE DISPERSION, METALLIC REFLECTION AND ALLIED PHENOMENA.*

BY EDWIN EDSER, A.R.C.S.

A dielectric, like an electrolyte, is assumed to consist of molecules, each comprising, in the simplest case, two oppositely-charged atoms at a definite distance apart. In a homogeneous medium, when not subjected to electric strain, these molecules will be arranged in such a manner that any element of volume will possess no resultant electric moment. If a definite potential difference be maintained between any two parallel planes in the medium, the positively-charged atoms will move to points of lower, and the negatively-charged atoms to points of higher, potential. Thus two kinds of molecular strain are produced: firstly, a molecular rotation; and secondly, a separation in the molecule of the constituent atoms. Let P be the actual electromotive intensity at any point in the medium, and D be the electric displacement other than that produced by the atomic charges. Then

$$P(1+4\pi M)=4\pi D,$$

where M is a constant depending on the nature of the medium. The quantity $1+4\pi M$ represents the specific inductive capacity of the medium. The actual linear displacement of the atoms is shown to be small when compared with molecular magnitudes.

Maxwell's equation expressing that the line integral of the electromotive intensity round a closed circuit is equal to the rate of decrease of the magnetic induction through the circuit needs no modification when the propagation of disturbances through the above medium are considered. Maxwell's second equation is modified by adding to the total displacement current at any point the expression $\Sigma q v_x$, where q is the atomic charge, v_x is the velocity of that charge in the direction considered, and Σ denotes summation for unit volume.

* Abstract of a Paper read before the Royal Society.

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Subsidiary equations for the atomic vibrations (rotational and separational) are given, and the refractive index is finally determined in the form

$$\mu^2=\mu^2_\infty+\frac{c'\lambda_1^2}{\lambda^2-\lambda_1^2}+\frac{c''\lambda_2^2}{\lambda^2-\lambda_2^2},$$

which is the most general form of Ketteler's dispersion formula.

μ^2_∞ is found to be equal to the specific inductive capacity of the medium, as previously determined. For a medium which might be compressed without altering the period of vibration of the constituent molecules, Gladstone and Dale's law, in the modified form $\mu^2-1 \propto$ density, would follow. Double refraction, in case of a uniaxial crystal, is explained on the assumption that the molecules are arranged with their axes parallel to a certain direction. Electrical disturbances perpendicular to this direction will produce a molecular rotation, whilst those parallel to this direction will produce an inter-atomic separation. For infinitely quick vibrations the refractive index of the above medium will be equal to unity, a result possibly explaining the action of material bodies on Röntgen radiations.

The initial assumptions in the above investigation are similar to those made by Helmholtz in his papers on the "Electromagnetic Theory of Dispersion."* Some doubt has been expressed as to whether Helmholtz's developments are in consonance with Maxwell's theory.† In the present case the principle of Least Action is not used. The dispersion formula obtained differs from that of Helmholtz, but bears a general resemblance to that obtained by Rieff in his modification of Helmholtz's theory.‡ A more definite physical significance is, however, given to the various constants introduced.

ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Bedford (Municipal)	March 4	Notting Hill (Company)	March 11
Clerkenwell (Company)	March 18	Oxford (Company)	April 1
Dover (Company)	March 11	Richmond (Company)	March 4
Huddersfield (Municipal)	March 25	Scarborough (Company)	April 1
Kingston-upon-Thames (M'cip'l)	March 25	Wandsworth (Company)	March 18

We publish this week statements and analyses of the accounts for 1896 and 1897 of the municipal electric supply works at Hanley, and of the electric supply works of the Yorkshire House-to-House Electricity Company (Limited) at Leeds.

Hanley Municipal Electric Supply Works.

As an example of an average size of alternate-current electric supply undertaking the Hanley works are of interest, and the results obtained in the two years under consideration are in most respects fairly representative of average practice. A notable feature, however, is the unusually low capital expenditure per kilowatt on lands and buildings, and the moderate outlay upon machinery and other plant. In fact, the capital borrowed by the Corporation of Hanley for its electricity department has been put to good and economical use in practically every respect. There is a sum of £5,524 over-expended, but this is more than off-set by the further borrowing powers of £14,880 for 17 years.

There has been a considerable increase in the business done, both in the actual number of units sold and in the number of lamps connected. The sale of units has increased by 103,881 to 351,762, of which increase some 44,387 units are due to the extensions in public lighting. It is satisfactory to note that these considerable additions to business have occurred without any serious increase in the maximum demand, thus showing a better all-round load-factor. The total revenue has increased by £1,954 to £6,520, and there has been a slight increase in the revenue per unit sold. On the other hand, the total expenditure out of revenue has increased by £1,225, bringing this total up to a round £4,000. There has thus been an increase of £729 in the working profit for the year, which reached £2,520, or 5·26 per cent. of the mean capital expended.

This sum of £2,520 has been utilised by the payment of £1,421 in interest, and of £1,316 towards redemption of capital, there being a small temporary charge on the district rate account to effect a balance. No less than £2,586 has been allocated to the sinking fund since the commencement of the undertaking, and this sum has been repaid ; so that the works are to this extent free of all liabilities and the property of the ratepayers. Nothing has been specially allocated to meet depreciation of plant, &c., and it seems to be the view of the electricity department that "by keeping the plant up to a high state of efficiency . . . . it is unnecessary to provide any further reserve for depreciation than is required by the annual repayments on capital account." We distinctly deny that such repayments can be held to be a reserve against depreciation. Payment by instalments is no more in the nature of a provision against antiquation and other depreciating tendencies than is a lump sum down; and it would be deemed ridiculous to assert that because an article is paid for it is insured against depreciation. On the other hand, there is something to be said for the contention that municipal concerns which are not reaping large profits may advantageously put off the creation of a separate depreciation fund until a time when much smaller sums need be paid as interest on capital un-repaid.

Yorkshire House-to-House Electricity Company (Limited).

Leeds, as represented by the Yorkshire House-to-House Electricity Company (Limited), is certainly in the van of progress in the business of electric supply, and, though it will not stand actually at the top when the accounts of all the electricity undertakings for 1897 can be compared, it will probably be not far below that position of honour, and in regard to one or two individual items of cost it may possibly bear the palm. Certainly the enterprising chief engineer, Mr. Harold Dickinson, deserves great credit for the successful manner in which he has run the plant, and for the high economies he has been able to effect in many of the items of works and management costs; and this is all the more noteworthy in view of the fact that alternate current systems are usually below rather than above the average in the matter of economy. Attention may, perhaps, be specially directed to the 1·02d. for works costs, including only 0·25d. for fuel, both of which figures represent considerable reductions below the previous year's results. The low ratio of only 29·1 per cent. in the relation of total costs to gross revenue also indicates what may be done by a judicious encouragement of consumption combined with a close scrutiny of and restraint upon the items of expenditure.

The business of this undertaking has been increased during the past year by the addition of 9,754 lamps to the circuits, bringing up the lamp connections to 49,150, also by an increase of 131,871 units in the annual sales, bringing the total number of units sold to 833,280. To meet these and future increases in business the plant has been increased to 2,100-kilowatts capacity, and there has been a capital outlay during the year of some £55,632. The machinery-room and other departments of the new works adjoining the old power station are practically completed, and ample space now exists for future extensions of plant.

By an increase of £2,855 in the gross revenue, as against only £276 increment in expenditure, the working profit for the year has been raised from £10,475 to £13,054, this latter figure representing nearly 10 per cent. of the mean capital expended. It is of interest to note an actual *decrease* in the aggregate works costs, owing to a reduced expenditure on repairs. The working profit of £13,051 has been allocated as follows : £2,300 to the depreciation fund, which now stands at £6,600 ; £3,000 to the reserve fund, the amount to the credit of which is £5,000 ; and, after paying a small sum for interest on temporary loans, the balance, added to £393 brought forward from the last account, yields some £8,096 available for dividend, with which a 6 per cent. dividend has been paid on the Ordinary shares.

* *Wied. Ann.*, Vol. XLVIII., pp. 389-405, 723-725.
† O. Heaviside, *The Electrician*, Vol. XXXVII., Aug. 7, 1896.
‡ *Wied. Ann.*, Vol. LV., pp. 82-95.

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	HANLEY.	LEEDS.
Undertaking Worked by	Corporation of Hanley.	The Yorkshire House-to-House Electricity [Company (Ltd.)
Date of Commencement of Supply	1894.	1893.
System of Supply	Alternate-current transformer sub-stations.	Alternate-current transformers.
Chief Engineers	C. A. Cowell and C. J. Sutherland.	Harold Dickinson.

YEAR ENDED DECEMBER 31st.	HANLEY 1896.	HANLEY 1897.	LEEDS 1896.	LEEDS 1897.
QUANTITIES—				
Units generated	320,905	400,590	1,190,000[a]	not stated.
„ **SOLD (TOTAL)**	247,881	351,762	701,409	833,280
„ sold to consumers	195,889	255,383	701,409	833,280
„ sold for public lighting, &c.	51,992	96,379	nil	nil
„ used on works	4,443	5,032	not stated.	not stated.
UNITS SOLD PER 8 C.P. LAMP CAPACITY	12·4	17·6	18·3	13·9
Maximum supply demanded	325 kilowatts	376 kilowatts	—	—
Number of public lamps	30 arc, 14 glow.	64 arc, 23 glow.	—	—
Connections to mains in 8-c.p. lamps	16,000	22,000	39,396	49,150
CAPACITY OF PLANT IN 8-C.P. LAMPS	20,000	20,000	43,000	60,000
CAPACITY OF PLANT IN KILOWATTS	624	624	1,500	2,100

CAPITAL—	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£46,110	£73·9	£60,990	£97·7	£100,000	£66·7	£200,000	£95·2
Share	—	—	—	—	100,000	66·7	200,000	95·2
Loan (including Debenture charges)	46,110	73·9	60,990	97·7	nil	—	nil	—
RECEIVED (TOTAL)	46,110	73·9	46,110	73·9	94,620	63·1	131,992	62·9
Share	—	—	—	—	94,620	63·1	131,992	62·9
Loan (including Debenture charges)	46,110	73·9	46,110	73·9	nil	—	nil	—
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil	—	14,880	23·8	5,380	3·58	68,008	32·4
Share (unissued)	—	—	—	—	5,260	3·50	12,130	5·78
Share (uncalled)	—	—	—	—	120	0·080	55,878	26·6
Loan (including Debentures)	nil	—	14,880	23·8	nil	—	nil	—
REPAID (TOTAL)	1,270	20·3	2,586	41·4	—	—	—	—
RESERVE OR SINKING FUND	nil	—	nil	—	2.500	1·67	5,000	2·38
DEPRECIATION FUND	nil	—	nil	—	4,300	3·87	6,600	3·14
EXPENDED (TOTAL)	44.143	70·7	51,634	82·8	105,377	70·3	161,009	76·6
Lands and buildings	8,157	13·1	9,143	14·6	47,102	31·4	64,332	30·6
Plant	18,442	29·6	20,460	32·8	35,640	23·8	61,191	29·2
Mains	14,345	23·0	16,606	26·6	17,172	11·4	27,600	13·1
Miscellaneous	3,199[c]	5·12	5,425[c]	8·70	5,463[i]	3·64	7,886[j]	3·76
BALANCE OF CAPITAL ACCOUNT	+1,967	3·15	−5,524[b]	−8·85	−10,757[k]	−7·17	−29,017[k]	−13·8

REVENUE—	Total.	Per unit sold.	Total.	Per unit sold.	Total.	Per unit sold.	Total.	Per unit sold.
TOTAL	£4,566	4·43d.	£6,520	4·45d.	£15,551	5·32d.	£18,406	5·30d.
Revenue from supply	3,852	3·73d.	5,117	3·50d.	} 14,728	5·05d.	17,127	4·94d.
„ meters, &c.	106	0·103d.	150	0·102d.				
„ public lighting	510	0·494d.	1,175	0·801d.	—	—	—	—
„ sale of lamps, &c.	92	0·089d.	78	0·053d.	—	—	—	—
„ miscellaneous sources	6	0·006d.	—	—	823[g]	0·282d.	1,279[h]	0·368d.
EXPENDITURE OUT OF REVENUE—								
TOTAL COSTS	£2,775	2·69d.	£4,000	2·73d.	£5,076	1·74d.	£5,352	1·54d.
WORKS COSTS	2,230	2·16d.	3,108	2·12d.	3,639	1·25d.	3,544	1·02d.
Generation of electricity	*1,847*	*1·79d.*	*2,534*	*1·73d.*	—	—	—	—
Fuel (including cartage, &c.)	755	0·730d.	1,003	0·685d.	849	0·290d.	876	0·252d.
Oil, waste, water, stores	198	0·192d.	226	0·154d.	211	0·072d.	184	0·053d.
Wages at station	573	0·555d.	698	0·476d.	1,927[b]	0·660d.	2,041	0·589d.
Repairs and maintenance at station	321	0·310d.	607	0·414d.	652	0·223d.	444	0·128d.
Distribution of electricity	*209*	*0·202d.*	*277*	*0·189d.*				
Wages, &c.	13	0·013d.	42	0·029d.	} —[c]	—	—[c]	—
Repairs, renewals of mains, &c.	196	0·190d.	235	0·160d.				
Public lighting	*174*	*0·169d.*	*297*	*0·202d.*	—	—	—	—
Attendance	156	0·151d.	295	0·202d.	—	—	—	—
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WORKING PROFIT FOR YEAR	£1,791	4·69%	£2.520	5·26%	£10.475	11·5%	£13,054	9·80%
Sum carried to Depreciation Fund	nil	—	nil	—	3.000	3·30%	2,300	1·72%
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Net interest on loans (incl. Debenture charges)	1,684	4·40%	1,421	2·96%	515	0·57%	51	0·04%
BALANCE FROM LAST ACCOUNT	—	—	—	—	+518	0·57%	+393	0·30%
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THEORIES OF FERROMAGNETISM.

It is no explanation of ferromagnetism, Prof. J. A. Fleming told his hearers at the Royal Institution on Thursday last, to postulate in the individual atom or molecule the same conditions of magnetisation as are to be found in the larger mass. This *pronunciamento* strikes away the foundation from the majority of so-called theories of magnetism, for each and every one of these is either an open or a disguised attempt to "explain" ferromagnetic phenomena by referring them to a purely imaginary set of conditions in the separate atoms of the magnetic substance, the conditions differing in nothing from what is evident in an ordinary magnet. The most flagrant example is that antiquated hypothesis which deliberately and in the baldest fashion invested each molecule of iron with a permanent pair of magnetic poles, no more attempt being made to explain how the molecule acquired these poles than to account for the existence of the molecule itself. It is, of course, conceivable that in the primæval formation or creation of the molecule of iron this condition of polarity may have been fundamentally impressed upon it, independently of any other of its physical properties; but, until this independence receives reasonable evidence, students of physics may be forgiven their natural desire to fathom the connection between the magnetic properties of the iron molecule and its other physical and chemical attributes. Nor can it be said that the Ampère hypothesis carried the explanation of the magnetisation of iron into a much more logical position; for his supposition of an inherent and self-supporting magnetising current around each and every molecule merely repeated for each of these microcosmic masses what he was accustomed to find in the larger mass, and came very near to arguing in a vicious circle. Both the Ampère hypothesis, and the later idea that the magnetism of the molecule may be caused by currents induced during the approach of a magnet, postulate a condition in the atom or molecule of which there is no evidence, namely, perfect electrical conductivity. Only when the substance of the atom or of its immediate envelope is destitute of all trace of electrical resistance could a magne-

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tising current be maintained in it in the conditions commonly occurring when iron exhibits polarity, conditions which require no continued expenditure of energy for their maintenance. But, apart from the immense demand it makes upon the imagination, the hypothesis of a perfectly conducting molecule would appear to be discounted, if not actually negatived, by other properties of the molecule, such, for example, as its being in two opposite states of electrification in two of its parts at one and the same moment. On the other hand, though perfect electrical conductivity is unknown in the region of actual well-understood phenomena, the researches of Profs. Fleming and Dewar have shown that it forms an integral part of the physics of a definite but as yet unattained temperature, viz., the absolute zero of temperature. Only in the sense that this latter is physically unattainable can the existence of perfect conductivity be held to be also unattainable, unless we admit the possibility of a violent and unsuspected departure of Fleming and Dewar's conductivity curves, at temperatures lower than have yet been actually reached, from the law they have consistently exhibited thus far. If this contingency is inadmissible, there would seem to be no alternative but to admit that perfect conductivity is a condition not impossible in pure metals under conditions consistent with the known world of phenomena; and, if conceivable in metals in bulk at absolute zero of temperature, the conception may become less difficult as regards the single molecule.

Probably, however, the most rational and consistent hypothesis of ferromagnetism that has yet been advanced is the one put forward last year by Prof. Fleming, and enlarged upon last Thursday at the concluding lecture of his series on "Recent Researches in Magnetism and Diamagnetism" at the Royal Institution. Prof. Fleming attributes the anomalous ferromagnetic properties of iron, nickel, cobalt, and certain other elements, as contrasted with the rest of the elements, to the circumstances of the gyrations of the ferromagnetic molecules occurring around such axes as enable only one of the two kinds of electrification in the molecule to rotate around the axis, the other electrification being actually on the axis. Thus an effective displacement current is caused to circulate in the space occupied by the molecule, and is magnetically equivalent to an ordinary current flowing through the assumed perfectly conducting material of the molecule itself. We refer to this hypothesis as being consistent, because of its striking co-ordination with the accepted theories explanatory of other physical properties of the molecule. It is consistent with the kinetic theory of heat which attributes to the molecules of each kind of material a rotational energy bearing a fixed ratio to their total kinetic energy; and it harmonises with the modern hypotheses of electrolysis and ionic dissociation, in which the ions are assumed to bear electrical charges, and the atoms composing a molecule are supposed to be differently electrified. Viewed from this standpoint, ferromagnetism would appear to be an accident of molecular constitution, resulting from a happy combination of definite electrical distribution with definite atomic structure; and when regarded in this light the evidently anomalous nature of ferromagnetism, and its disappearance from the bodies that ordinarily exhibit it, when those bodies are subjected to conditions which are known to upset their molecular constitution, are capable of ready explanation. Heating ferromagnetic substances to a certain temperature is one means of depriving them of this property and of reducing them to the condition of mere paramagnetic bodies; and it may be supposed that the critical temperature at which this transition takes place involves a speed of molecular rotation at which instability arises and the molecule is constrained to rotate round a new axis, the new rotation involving no ferromagnetic condition. The combination of iron with small percentages of other elements also exerts a marked influence upon its magnetic properties, and it would appear probable that these elements form complex groups of atoms possessing little or no magnetisation of molecular spin. Carbon is one of the most effective of such elements, and it is a matter of chemical knowledge that this ingredient of commercial iron and steel forms molecules consisting of complex groups of iron and carbon atoms, the presence of which, on the hypothesis advanced by Prof. Fleming, explains the changes in magnetic permeability and reluctance of those substances when their percentage of carbon is varied.

A ferromagnetic theory, however, must go farther than simply to afford an intelligible explanation of how a molecule may exhibit ferromagnetisation. The magnetic properties of matter in general do not offer merely the bald alternatives of ferromagnetism and its negation; for there are the kindred properties of paramagnetism and diamagnetism to be accounted for and brought into harmony with the proposed theory; and it would be necessary not only to account for these properties in general terms, but also to show how their quantitative differences may be conceived to arise, before any such theory can be regarded as complete. This, however, would involve an explanation of the mechanism of magnetic induction; firstly, in relation to the ether, and secondly, in regard to the modifying influence on the ether produced by the presence of molecular matter. But though, therefore, a complete theory of the magnetic properties of ferromagnetic and other matter is probably a long way off as yet, light has been thrown by recent research upon the connection between ferromagnetism, paramagnetism, and diamagnetism. Thus, in Prof. Fleming's opinion, and we certainly agree with him, the discovery that the chemical combination of two diamagnetic elements results, in certain instances, in a paramagnetic compound, tends to show that while the property of paramagnetism is a function only of molecular constitution and rotation, the opposite condition of diamagnetism pertains to individual atoms. Should extended research establish a general law to this effect, an important step will have been made in the direction of elucidating this recondite subject. By another line of research, also, it is conceivable that progress in the same direction may be made; for if the ferromagnetic condition of iron is a function of its molecular electrification, it would appear probable that the disturbance of that electrification which accompanies electrolysis would produce a corresponding change in its magnetic properties. We are not aware, however, that this line of research has been pursued.

REVIEWS.

Physical and Electrical Engineering Laboratory Manuals. Vol. II. Practical Electricity and Magnetism. By John Henderson, B.Sc.Edin. (London: Longmans, Green and Co.) 1898.

As is the case with most manuals of this class, the work before us is more especially intended for the use of the students in the author's laboratory, but the very valuable list of references to the literature of the subject which is given at the end of each chapter, and the broad-minded spirit in which the book is written, raise it above the level of a mere class-book for students. The reader is advised to study Faraday's "Experimental Researches in Electricity" before engaging in experimental work, and to try to imbue himself with that great master's spirit. Then follow some practical notes on the conduct of electrical experiments and the recording of

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results, after which the subject of electrical resistance is introduced. The measurement of electrical resistance is dealt with first on account of its great importance, 120 pages being devoted to it. The apparatus required, and its arrangement for special cases, are fully described and illustrated. The student who follows this part should experience no difficulty in the measurement of the resistance of solid and liquid conductors, or in testing insulation resistance after he has carefully performed the experiments here described. There is a very brief account at the end of this chapter of some of the methods of measuring resistance in absolute units, which is introduced "not with the hope of the student making highly accurate determinations of the length of the mercury column which represents the practical unit of resistance, but simply to familiarise him with the methods of making such determinations, and also as an exercise in absolute measurement, albeit his results may not be correct to one or even ten parts in 10,000." Mr. Henderson is no believer in encouraging students to think that measurements which they may make in the course of their practical studies have any value as scientific determinations. Throughout the work mathematical deductions from the electrical theory are as far as possible avoided, the instruction being derived from the results of the student's own observations, the aim of the author being to teach the student to observe for himself rather than to cram his mind full of the deductions which have been made from the observations of others, while the references to the literature of the subject above mentioned enable the student to follow up the work that has been done in any particular line of research, and the theories which have been founded on it from time to time. The author has not attempted to give all possible methods for making the various measurements required in practical work but has made a careful selection of such methods, only the most suitable being mentioned; and this has enabled him to give fuller descriptions of the apparatus required and of the precautions to be observed, than is often the case in such manuals. Following the chapter on the measurement of resistance come those on the measurement of current, of electromotive force, of quantity of electricity, and of capacity; then a chapter on magnetism and one on electromagnetic waves, in which latter is a very clear account of the theory of the subject and a description of the experiments of Hertz and his successors in this line of research, Mr. Henderson rightly deeming that the education of an electrical student cannot be considered complete until he has familiarised himself with the methods for detecting the existence of electromagnetic waves, and has studied some of the simpler phenomena exhibited by them. The book is well illustrated and indexed, and concludes with an appendix containing tables of logarithms, &c., and of physical constants.

The Tutorial Chemistry. Part II., Metals. (The University Tutorial Series.) By G. H. Bailey, D.Sc.Lond., Ph.D.Heidelberg. Edited by William Briggs, M.A., F.C.S., F.R.A.S. (London: W. B. Clive.)

In this work of 287 pages the elements have been taken in the order suggested by the periodic system, and the characteristic properties of each family are summarised, the object being to bring out the relationships which exist between the different members of the same family, so as to represent (by a consideration of these summaries progressively) the whole of the chemical elements in a continuous series. The information given has been brought well up-to-date, but one cannot help feeling that unless due attention is paid to the exercises set for laboratory practice, the ordinary second year's student is likely to derive more harm than benefit from having so much food for thought supplied for his mental digestion in so condensed a form. Somehow or other the perusal of the book suggests the idea that if one is not going in for examination, one ought to be; one becomes so replete with knowledge in a terse form, handy for foiling the inconvenient questions of an examining inquisitor. The author apologises somewhat needlessly for the prominence in the book which he has given to chemical physics, for in view of the rapidly-increasing importance of this subject, and its effect on the chemical theory of the day, the student can scarcely be introduced to it too soon, and the chapters on solution and the nature of chemical reactions deal lucidly with these important topics, and will form a convenient introduction to the modern theories on these subjects, which he will have to deal with at greater length and in a more complex form later in his studies. It is true that they suffer from the same fault of compression which we have noticed in the case of the work as a whole, but we doubt whether treatment at greater length would have placed these highly complex theories in a clearer light before the student than has been done in the succinct account here given. The illustrations and curves are good, and the book is fairly well indexed; but its general usefulness would have been increased if references had been given to the authorities quoted.

La Teoria dei Raggi Roentgen. By Prof. Pillipo Re. (Palermo: Albert Reber.)

Prof. Röntgen announced his discovery at an opportune moment; in fact, just as it was becoming fashionable in science to recapitulate, condense and generally strive to arrange scientific facts. Matters relating to X-rays, therefore, are now fairly well grouped together and classified, although, so far, there has not appeared, outside periodical literature, any very extensive treatment of the subject from a purely theoretical point of view. Prof Re's little book therefore supplies a want. It is a tersely-written pamphlet of some 64 pages, in which the views advanced by various scientific teachers regarding the properties of X-rays are concisely drawn up, together with an account of the experiments which led to them.

Prof. Re devotes his first three chapters to the theories: (1) of propagation by longitudinal waves, (2) by molecular flux, (3) transverse waves of extreme shortness.

Regarding the first, the writer sums matters up by saying, "Thus the theory of propagation by longitudinal waves on the one hand explains the absence of polarisation, but on the other is insufficient to account for the absence of regular reflection and refraction."

With regard to number two, he points out that the theory of a molecular flux is incompatible with experiments made by Thomson, Righi, and others, demonstrating an apparent bending back of the rays behind objects they have passed.

In number three he discusses the difference of opinion as to the existence of diffractive properties in X-rays, adding that the problem must take the following terms: Either X-rays do or do not present the phenomena of diffraction—assuming that they do, then are they due to long or to short waves?

Prof. Re considers briefly "Electro-Dispersion," "New Rays" (Becquerel, Le Bon), and "Rays of Electric Force," finally advancing his own theory of the nature of X-rays, together with his explanation of their properties. He assumes that they are waves of infinite length: an assumption which he claims avoids all the difficulties encountered by other theories.

The pamphlet contains, as well, a couple of pages of diagrams illustrating the text.

Angewandte Elektrochemie. Vol. II. Anorganische Elektrochemie. First part, Elektrochemie der Metalloïde und der Alkalimetalle. Second part, Elektrochemie der Erdalkali-, Erd-und Schwermetalle. By Dr. Franz Peters. 1898. (A. Hartleben, Vienna, Budapest and Leipsig.)

The present volume on applied electro-chemistry, which appears in two parts, deals only with those electrochemical processes which have been carried out in laboratories, and on a large scale in electrochemical manufactories, and does not include electro-plating or electro-typing, or the recovery of those metals which are obtained by ordinary mining operations. The object of the author has been to place before the reader as comprehensive a view as possible of what has been attempted and accomplished in the field of electrochemical industry, so that he may be able to form a sound judgment on the value of any suggestion for a new process which may occur to him, or be submitted to him by others for his opinion, and with this end in view the author has collected and epitomised the literature and patents on the subject up to the middle of 1897. The work has been carefully done, and it does not appear that anything of importance has been omitted, while the list of patents, foreign and English, and the numerous references make the volumes distinctly useful

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as a handy index for those who are engaged in electro-chemical work.

The first part deals with the electro-chemistry of the metalloids and the alkali metals, and the second part with the heavy metals and the metals of the rare earths. The work throughout is arranged and classified in a systematic manner, while the index is full and complete. In view of the attention which is being paid at present to processes for the recovery of gold from tailings, it is a pity that the limitation which the author has imposed on himself prevents his dealing with this subject, but the analyst will find much that is suggestive in the summary of the methods which have been proposed for the electrical determination of the presence of gold and its estimation. The chapter on the production of soda and sodium compounds is, as one would expect, the longest in the book, comprising, as it does, 67 pages, and those who are interested in diaphragms for use in the electrolysis of salt solutions will find a very complete account of the various proposals for their construction which have been brought forward from time to time. Lithium, rubidium and cæsium are also treated of as well as potassium, ammonium and their compounds, and it is satisfactory to find that electro-chemists have long since passed the stage in which their ambition was limited to the electrolytic production of "bleach."

In the second part we find some accounts of Moissan's high temperature experiments with copper and other metals, and of the compounds of this and other elements which have been produced by electrical means, but probably the chapters which will most interest the reader as being most suggestive of a profitable field for electrochemical research are those which deal with the rare earth metals, to whose possibilities, it will be remembered, Prof. Dewar drew attention at the Royal Institution some two years ago.

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

(Continued from page 595.)

Part III.—Facts Concerning Carbons.

Modern electric-light carbons—that is, high-grade carbons—are made principally in Germany, and of late years the goods of these manufacturers have gained a pre-eminence that has taken the shine away from some of the pioneer firms who gained a worthy reputation in the early days, but who have continued the work "*per descendum*," and kept their old mill agoing as they did 10 years ago. France and Austria contribute a small percentage also of these carbons to the world, yet it is surprising to see how many German carbons find their way into the Austrian and Hungarian market, while at the same time they are preferred to the home make. It may be mentioned that Charlottenburg, near Berlin, and Nürnberg are the great centres of the high-grade carbon industry. In the United States, however, there are manufactured yearly nearly ten times the total products of all the European factories together, but the carbon is a low-grade one, and is coppered. To talk of a copper-covered carbon nowadays is sufficient to designate its inferior quality. Nevertheless, there are more than 150,000,000 of them made yearly, and all "solids," as in America they use only solids for both upper and lowers. However, the advantage of the cored carbon is beginning to be recognised, and where good lighting is desired many foreign carbons are employed. There are also carbon manufacturers in the United States who are striving to make a carbon that will compete with the foreign make, but up to the present there seems to be some difficulty which they have not yet overcome; nevertheless, their quality is not to be despised. No doubt the writer will be able to show them where the "bug" lies, and that they will soon be able to manufacture a carbon which will be on a par with any on the market.

There has always been an idea prevalent that the European manufacturers have the secret of making high-grade carbons, and it may be mentioned that many of these manufacturers have cherished this bogey. Just before the fall of the Roman Empire it was thought that China had the secret and monopoly alone of making silk, until two monks hid some of the silkworms in their bamboo staffs and brought them West, and established the silk industry in their own country. It is thus the writer's object to dispel these illusions, and show that high-grade carbons can be made in every civilised country. There are about $300,000 worth of foreign carbons that enter the United States yearly, although there is an *ad valorem* duty of 30 per cent. on them. This duty has caused the United States Custom House officials a great deal of annoyance, as some manufacturers under-rated the value of their goods in order to pay less duty. The United States officials are, however, sharpers, while at the same time just and fair. At the following invoice prices carbons are now allowed to enter the United States and pass without re-appraisement* :—

Diameter of carbon in mm.	Cored.	Solid.	Diameter of carbon in mm.	Cored.	Solid.
6	$3.81	$3.04	17	$15.24	$13.71
7	4.57	3.81	18	16.76	15.24
8	5.33	4.57	19	19.05	16.76
9	6.09	5.33	20	20.82	19.05
10	6.85	6.09	21	22.86	20.80
11	7.62	6.85	22	25.40	22.86
12	8.38	7.62	23	27.94	25.40
13	9.14	8.38	24	30.48	27.94
14	9.90	9.14	25	34.29	31.75
15	11.43	10.16	30	48.26	43.18
16	13.20	12.19			

The prices are per 1,000ft.

It will be seen that these invoice prices, which allow carbons to pass, are very liberal and just; in fact, they are the terms which only very large buyers of carbons here in Europe receive at present for a second-grade quality, although, no doubt, first-grade carbons enter the United States at these figures, which, however, cannot be obtained, as far as the writer knows, here in Europe. High-grade carbons cost about 10 to 20 per cent. more than the table shows.

There is also another question agitating the United States Custom Department at present, and that is: Are electric light carbons minerals, or composed of mineral substances? Now no person who understands the manufacture of electric light carbons, as made at present, can affirm they are not minerals, as the carbons are made of minerals in the true sense of the word. The object of some of the European manufacturers who affirm the opposite is simply to gain 10 per cent. of the duty, as carbons appraised not as minerals pay only 20 per cent. *ad valorem* duty. But who would take an oath and say that tar made from coal, gas retort carbon—a product of coal, petroleum coke made from a mineral oil, and lamp-black made from coal tar, coal-pitch, coal or mineral oils are not minerals? All these mineral substances are used in the manufacture of carbons. It has often been a surprise to the writer while he was connected with a well-known carbon firm that the industry—that is, the carbon manufacture—should be confined to that geographical position in which it is now situated. There are other positions on this earth situated as favourably, while there are some places far more advantageous. There is no reason why England should not make high-grade carbons; further, there is no reason why the United States, with its immense petroleum wells and natural gas springs, should not supply the greater part of the world with all grades of carbons. Russia and other petroleum countries have also an advantage in starting carbon factories and supplying their own market; in fact, the whole carbon business seems to fraternise with the coal-gas manufacturers and petroleum distillers. There is no reason for this; in fact, it would be an advantage to them if these concerns would make electric light carbons, &c., out of their waste products. With the tars, pitches and residue oils they can make the best of lamp-black for high-grade

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* Since the above was written, the writer has been informed that the duty on carbons has been raised.

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carbons, while the petroleum coke and gas retort carbon would make them carbons of the second grade, electrodes, &c.

Part IV.—The Modern Process of Manufacturing Carbons, Etc.

The raw material used in the manufacture of modern electric light carbons, electrodes, battery plates and carbon brushes are the following, together with their price per 100 kilogrammes (=220lb.):

	£	s.	d.		Fl.	Kr.		$	c.
Lampblack per 100 kilo.	1	6	7	...	16	00	...	6.40	
Gas retort carbon	0	8	4	...	5	00	...	2.00	
Petroleum coke	0	6	8	...	4	00	...	1.60	
Tar	0	6	8	...	4	00	...	1.60	
Waterglass	1	13	4	...	20	00	..	8.00	

The prices are taken f.o.b. Vienna, and are a little higher than the cost of raw material, the gulden being taken as equal to about 1s. 8d. and 40 cents U.S.

Electric light carbons of the best quality are made from lampblack mixed tar, which is the binding material. Carbons of second quality are made of lampblack, petroleum coke or gas retort carbon and tar, the proportions of which vary according to the maker and quality. Common carbons are made either of petroleum coke or gas retort carbon mixed with tar. Electrodes are composed of the same mixture as the common carbons. The same may be said of battery plates and carbon brushes with the exception that the latter mixture also contains some plumbago which imparts a sort of lubricating property to the brush. Formerly carbon brushes were made by Carré from the finest material and were in great demand, but to-day experience has proven that the common American carbon brush is preferred to those made formerly by Carré.

The tar that is taken in the above mixtures amounts to 25 per cent. to 33 per cent. of the total weight. It is self evident that when too much tar is taken the carbon mixture will be too soft and will not require much pressure to force it out of the press. If too little tar is taken it will not be enough to work the mass into the plastic condition which is desirable. A little experience will soon show what proportion to take, as the end to be attained is to get the carbon mixture into a plastic mass, which when compressed into cakes and then forced or squirted out of the press will require from 350 to 400 atmospheres constant hydraulic pressure.

It may be mentioned that in the above prices the price of the petroleum coke is taken so as to mean 100 kilos. of petroleum coke calcinated, as otherwise 100 kilos. when calcinated leave about 70 kilos., 30 per cent. of which consists of water and volatile matter, which disappears. The following table shows the proportions taken in making the carbon mixtures, and it will be seen that the amount of tar taken is rated at 20 per cent., although in practice it varies from 25 per cent. to 33 per cent. As later on estimates will be given showing the costs of production, the writer has taken 20 per cent. in order to have a better margin in calculations.

Carbon Mixtures.

Highest grade mixture consists of...	80 per cent. lampblack and 20 per cent. tar.
Second „ „ „ ...	50 per cent. lampblack, 30 per cent. gas retort carbon or petroleum coke and 20 per cent. tar.
Third „ „ „ ...	30 per cent. lampblack, 50 per cent. gas retort carbon or petroleum coke and 20 per cent. tar.
Common American mixture, also for battery plates and electrodes	80 per cent. gas retort carbon or petroleum coke and 20 per cent. tar.
Carbon brushes.....	65 to 70 per cent. petroleum coke, 10 to 15 per cent. plumbago and 20 per cent. tar.

We shall now begin to explain the process of manufacture, starting from the store house that contains our raw material, and go through each successive stage until we land our finished material in the shipping department.

Every respectable carbon factory is in communication with its various departments by means of push waggons that run on a narrow gauge rail, with turn-tables at junction points. By these means the material and carbons can be transported from one department to another with facility and saving of time. We will now push one of our waggons into the store-house where the raw material is kept, and bring in a load to be worked by the crushing mill.

Crushing Machine.—Fig. 1 shows a crushing mill as is generally used, and it will be seen that it has three pounders or crushers, which are alternately lifted and allowed to fall on to the raw material that is thrown in the receiver at the base. Before being thrown into the mill, the petroleum coke or gas retort carbon is thoroughly cleaned by hand by means of wire brushes, so as to take away any particles of sand, &c., that may have got mixed with it through handling or transportation. Petroleum coke is on an average clean, while the gas retort carbon, as it arrives in the factory from the gas-works, is not all serviceable for carbon production; it must generally be assorted, as some parts of a piece will be found to consist of a sort of a burnt porous material, while the other part of a hard solid material. Carbon manufactures take this hard part, which has either a black or grey lustre, and resembles graphite. In fact, many carbon makers call it gas graphite. These parts are usually knocked or chipped off by means of a hammer, while the other part which is not used for carbons is thrown into the boiler house for furnace consumption. The crushing or stamping mill breaks and

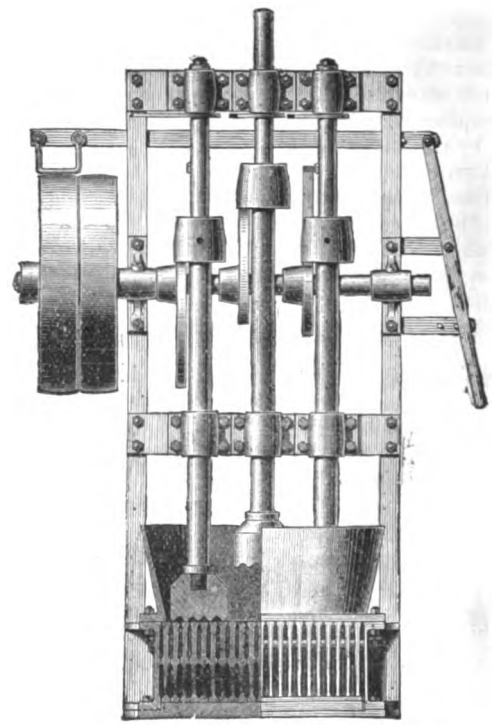

Fig. 1.—Braun's Crusher.

crushes the clean and assorted raw material into small pieces which pass through the steel grate, as can be seen in the illustration. This grate can be adjusted so as to allow pieces of any desired size to pass, and generally it is so set that the raw material is broken into pieces about the size of small gravel. There is no doubt that this kind of breaker, as shown in Fig. 1, is one of the most advantageous machines of its kind in the manufacture of carbon products, as it prepares the material to be ground in other machines, and saves lots of wear and tear in these machines. Yet it is almost impossible to believe that some carbon manufacturers are without this crusher, and the writer has seen a factory where they throw the raw material into a sort of centrifugal breaker or crusher, that of course breaks and crushes the raw material into a much finer state than the machine mentioned above does, but the wear and tear on these centrifugal machines is something terrible when they are required to do too much. As gas retort carbon and also the petroleum coke are very hard—in fact, some pieces will cut glass—it is plainly evident that when such a material is to be divided into a fine state, it must undergo several successive operations before it is reduced into powder. To throw large pieces into a machine and expect it to come out ground is out of the question. Apart from the wear and

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tear mentioned above, there is this one great objection to such hurrying processes—that the wear and tear does not only mean an expense of renewal, but the particles of metal that are worked off get into the carbon, which as every engineer knows is very detrimental to a good working lamp. The writer has seen carbon powder or flour, into which a horseshoe magnet was stirred, and when withdrawn was full of iron particles. Such a material will never make good electric light carbons, and the results will be that there is a continual complaining on the part of the customers that buy such goods. To obviate such difficulties the raw material should be broken gradually into smaller and smaller parts, and one must not expect a machine to pulverise it in one process.

(*To be continued.*)

CORRESPONDENCE

COMMUTATION OF CONTINUOUS CURRENT DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If there is any doubt about the simplicity or otherwise of Mr. Housman's "proof," there can be none about the fact that his views are not correct for any practical armature. His imaginary armature in free space, if a practical armature, must have a finite number of coils. Assume an even number, diametrically opposite brushes, and the width of brush tread equal to the width of a commutator sector; then, as pointed out in one of your notes, at some instant the current throughout the *entire length* of two coils or divisions of the winding must be at zero value, and not only will the armature field oscillate through a small angle, but it will also vary in strength between the values $\left(\frac{n-2}{2}\right)c_A$ and $\left(\frac{n}{2}\right)c_A$. One of the most important improvements in dynamos in the earlier days consisted in making this effect as small as possible by increasing the number of divisions in the armature winding. Of course the fact is that it is impossible that commutation should proceed uniformly in the sense required for Mr. Housman's theory in any practical armature, owing to the condition that, however uniform the commutation may be in one sense it must change in a whole section of the winding at a time, instead of the changing current passing through zero value continuously as the conductors pass through a stationary plane, which would be the case in an ideal armature.

Mr. Housman's remark that "the consideration of slotted-core armatures is, of course, more difficult" leads me to suppose that his theory was intended to apply only to the old-fashioned smooth-core type of dynamos. His captious reading of my remarks about the inductor may be ingenious, but the inductor causes what would otherwise be a stationary field to oscillate all the same.—Yours, &c., W. B. SAYERS.

Glasgow, March 28.

PARLIAMENTARY INTELLIGENCE.

THE TELEPHONE SERVICE.

In the House of Commons, on Friday, Mr. CALDWELL initiated a debate on the telephone service, and moved the following resolution:—

"That the continued refusal of the Post Office to grant licences to and allow municipal corporations and other responsible bodies to compete with the National Telephone Company is contrary to the Treasury Minute of May 23, 1892; is inconsistent with the letter and spirit of the agreement entered into with the telephone companies when the Post Office took over the trunk lines; and is calculated to prevent the establishment of a cheap, adequate and efficient telephone service in the United Kingdom, and to increase the difficulties and costliness of any arrangement for the assumption by the State of the whole telephone systems should that step ultimately be considered desirable."

In introducing the motion, Mr. Caldwell said that the question was one of national as well as local interest and importance. He traced the history of the telephone in this country, and reminded the House that the Post Office granted a licence to the United Telephone Company authorising them to erect and work telephone exchanges in London within a radius of five miles from a central point to be fixed by the Company, the royalty charged in all cases being 10 per cent. of the gross earnings. The United Telephone Company confined its own exchange operations to London, but it allowed its apparatus to be used in other parts of the country by subsidiary companies. These subsidiary companies were left to negotiate with the Post Office for a licence. The licences granted were all made to expire on Dec. 31, 1911. At the date named, therefore, all telephone licences would lapse, and the State would then be free to assume the sole right of working the telephones. Until 1884 telephone licences were restricted to towns and areas within a certain radius of towns. The Post Office offered to supply trunk lines connecting towns on condition that the parties using the same should pay the department direct. This offer was not accepted, but in a few cases, as between London and Brighton, trunk wires were provided for the use of the telephone companies at a fixed annual rent. In all about 23 licences were granted for telephone use in these restricted areas. In 1884 a new departure was made. Licences, instead of being limited to a restricted area, were made to apply to every part of the United Kingdom, and included the right to erect and work trunk lines. The new licences were granted to the original holders; but, while the policy of the Post Office was to increase the number of licences and to encourage competition, the policy of the telephone companies was to buy up competing companies at almost any price with the view of establishing a private monopoly. The amalgamation of the telephone companies then took place, and the probable effect did not escape the attention of the Postmaster-General. Mr. Fawcett said that he was pressed on all sides not to allow a private monopoly to grow up and to be vested in a private company, and the policy of Mr. Fawcett continued to be the policy of his successor. The Treasury Minute of May 23, 1892, restricted the granting of licences to responsible companies who had the consent of a municipal authority, and who were not so likely to apply for a licence merely in order to sell it to the National or other telephone company. But the interposition of the municipal authority in an application for a licence was a very limited safeguard, and would not, unless the licence was carefully restricted, prevent the National Telephone Company from afterwards buying it up. The only effectual safeguard seemed to be to give licences to such municipal authorities as were willing, with Parliamentary sanction if need be, to establish and work telephone exchanges in the public interest. In 1892 the Post Office found it to be necessary to revert to the original policy of restricting licences to the limited area to which the licence applied, and of keeping in the hands of the Post Office all the trunk lines connecting the towns. In asking that municipal authorities ought to be granted the licences in the public interest, it had to be borne in mind that the licence asked for was a licence to use what was the property of the State, which all parties seemed to think ought not to be in private hands, but ought to be worked in the public interest. He claimed the appearance of the amendment on the paper as an admission that the telephones ought to be worked in the interest of the public and not for private profit. The power to grant competitive licences was the only weapon which the Postmaster-General could use for the purpose of preventing the wholesale plunder of the public, who were compelled by business exigencies to use the telephone. In all other cases in which statutory privileges were granted to companies the dividends that could be earned or the rates that could be charged were limited or subject to control. But the telephone company might water its capital to any extent, could charge what rates it pleased, and could run up the market value of its shares to any extent, in the hope that in 1911 it might compel the Government to purchase the undertaking at as ruinous a cost to the taxpayer as the cost of purchasing the telegraphs. The only means of ensuring an efficient telephone service at a moderate tariff was by the use of the reserved power of granting competitive licences. In the hands of a municipality the service would be extended to the full extent, and small tradesmen and business men would get the benefit of it at a reasonable rate. In Glasgow the National Telephone Company seemed to think that it was to its interest to keep up the present high tariff of £10, and not to encourage additional subscriptions by making a reduction. The Corporation of Glasgow, however, were satisfied that an efficient service could be supplied at £5 a year, and that the present number of subscribers would be doubled if the price were reduced to that figure. Why should the Post Office refuse to a corporation like that of Glasgow a competitive licence, such as the Department formerly granted so frequently to private companies? The fact was that the Post Office officials objected to giving a licence to a municipal authority because their own operations in connection with the telephone had failed so conspicuously, and they did not view with satisfaction the probable success of others in the enterprise.

The motion was seconded by Mr. GRIFFITH BOSCAWEN, who said his quarrel was not so much with the National Company as with the Post Office, which allowed the monopoly to grow up. He pointed out that what people most desired was a local service. The monopoly was growing stronger every day, and the sooner it was put an end to the better. He thought it would be well if an Act were passed to enable all corporations to establish telephone services without having to come to Parliament for powers. At any rate, if the Government allowed competition to spring up in some form or another, their action would be most acceptable to the country.

Mr. FAITHFULL BEGG moved an amendment to leave out all after the first word in line 1 in order to add that

"the acquisition by the State of the whole telephone system of the country is the only solution of the difficulties which exist and are increasing under the present system of licences."

It had been said that one of the objections to the present telephone system, on public grounds, was that it was under no statutory obligation in regard to tariffs and charges such as undertakings of a similar nature were placed under by Parliament. That was owing to the fact that at the time licences were first granted there was little expectation that so great a development of telephonic enterprise would take place within a short period. The true solution of the question was that the State should acquire the whole telephone system of the country, combine it with the

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Postal Department, and develop it for the benefit of the community alone. As it was supposed by some that he was largely interested in telephone enterprise, and was, in fact, the mouthpiece of the National Telephone Company, he desired to say, as a matter of personal explanation, that, while he had been connected with the company for some years in its early stage, he had had nothing whatever to do for many years now with telephone enterprise. He therefore approached the consideration of this matter from a perfectly impartial standpoint. The hon. member for Tunbridge Wells had said that half the capital of the National Telephone Company was "water." But it was not all "water," for mixed with it were brains, enterprise, and patent rights. If licences were granted to corporations, what would happen was that one or two experiments would be made, based on calculations which were absolutely fallacious, with the only result that the ratepayers' money would be wasted. But whatever might be said in favour of granting licences to corporations, there was every objection to granting them to private individuals or private trading firms. Such a course would result only in the production of fresh shares for the public to gamble with and in waste and extravagance. Mr. Lamb, in giving evidence before the Select Committee of 1895, declared most emphatically that competing systems within one area must result in inconvenience to the public, expense, and want of efficiency. It was a curious fact that it cost more to carry on the telephone business wholesale than retail. The rates must rise with the number of subscribers. As to the municipalities, if the Post Office were not prepared to purchase, he did not believe that the Government would be able to resist the demands which would come from the municipalities for telephone licences. The question of cost need not be feared. Taking into account the rate at which the Government could borrow the money for purchase, the operation would show a profit long before the period when the licences would expire. There was a prevailing belief that at the expiration of the licences in 1911 the Government would be able simply to duplicate the existing system. But the system would by that time have expanded so much that he did not think the Government would be able to leave it on one side without an interruption which the public would not endure. In every fresh departure which the Government had made on this question they had been wrong. The policy of the Post-Office in the past had tended, not to the rapid development, but to the hampering and cramping of telephone communication. Owing to the blunders of the Department, the Government had had to buy back the trunk wires at a considerable profit to the companies, and had had to grant facilities to the companies which otherwise would have been retained. The result was that the National Telephone Company had to-day become an adjunct to the Post Office, while remaining unamenable to the House of Commons; and the more the Company was attacked the more it would protect itself against the evil day. Another great blunder would be committed if this new departure were entered upon, for there was no sound argument in favour of it. The Glasgow Corporation wished the Government to administer the whole of the telephone system, and the Corporation only wished to have a licence if the Government would not take that step. There could be no doubt at all that the Government was perfectly free to grant the licences if it chose. As to private competition with the National Company, Sheriff Jameson, in his recent report, pointed out, with reference to the cost and economy of construction, the Mutual Company, of Manchester, that "the evidence before him showed that that Company was being financed in such a way as would have inevitably led to bankruptcy upon the £5 rate, and was never really in a position to pay any dividend." Similarly in the case of the Dundee Company, the other case relied on in support of the motion before the House, the chairman of the company, according to the evidence, stated that if they had gone in at the £5. 10s. rate they would not have been able to pay anything at all. He hoped that under no circumstances would any licence be granted to any private company, because the results would be even more pernicious than granting licences to corporations. The confusion arising from having different systems in a town was terrible. Bad as he admitted the service in London to be, the confusion would be worse confounded if they had numerous systems growing up in the metropolis. State purchase, he was convinced, presented the true remedy.

Sir J. FERGUSSON said that he was interested in the National Telephone Company, but he did not in the least admit that he stood in a somewhat delicate position. It was true that he had been Postmaster-General and was now a Director of the National Company, but he reminded the House that he was the principal author of the Treasury Minute of 1892*, which had been referred to in the debate, securing to the Post Office the entire freedom of opening exchanges of its own or of granting new licences wherever it thought fit. The question lay beween the Post Office and Parliament, and he had no desire whatever to interfere.

Mr. HANBURY (Financial Secretary to the Treasury) said the motion before the House asked that certain municipalities should be allowed to enter into competition with existing licences of the Government in the same area. At first sight that might seem a rather strong suggestion, especially when it was borne in mind with regard to the telephone business generally that there were great difficulties with reference to competing companies in the same area. He thought, therefore, the first question which the House would ask was whether it was fair that they should allow competition to take place; and in the next place, if it was fair, whether the municipalities of the country were the best form of competition. In the early days of telephones, when little was known about them, the Postmaster-General of that day had to arrive at a decision as to the course that the Government should take with regard to the new system. Mr. Fawcett in those days decided that the telephone service should be carried on by the Government. If that had been done it might have been the best solution of the difficulty. However, the Treasury, rightly or wrongly, ruled otherwise. It imposed on the working of the telephones by the Post Office certain conditions which he admitted did make the competition and working by the Post Office very difficult. The result was that Mr. Fawcett, finding that the Post Office could not work the telephones efficiently as a Government monopoly, instead of granting local licences, which he had done up to about 1884, limiting the companies to definite areas, instituted a system of entirely free competition. He announced in August, 1884, that he would grant licences freely to every company that applied to him, and licences which would extend all over the country, so that any company would be at liberty to set up exchanges in any portion of the country. His idea was that, if the monopoly could not be in the hands of the Government, he would take steps as seemed to him best to prevent a monopoly falling into the hands of any private company. The result showed that Mr. Fawcett made a grave miscalculation. In the first place, he omitted to recollect that in those days one company, the United Telephone Company, had a great advantage because it owned patents, and it was not possible for companies generally to get patents except under the rules and regulations of the United Telephone Company; but the small companies were soon bought up, so that a series of companies came under the entire control of that company. Some of these companies did become somewhat strong competitors of the Mother Company, and in 1889 the United Telephone Company bought up the Lancashire and Cheshire Company and the National Company, and they were amalgamated in the National Telephone Company, which now worked the telephones. In 1891 the patents expired, and it then became possible for other companies to come into competition totally independent of the mother company. Two companies were started, the Mutual Company and the New Company. The New Company soon bought up the Mutual, and that brought the New Company and the National Company face to face. The Treasury Minute of 1892 was drawn up with the distinct recognition of competition as against monopoly. Very soon after the issue of the Treasury Minute a very vigorous flirtation took place between the two companies, and they were all but amalgamated before the agreement was formally signed. Therefore Mr. Fawcett's anticipations were entirely falsified, and the very means he took to promote free trade in competition resulted in an actual monopoly. Now that one company had swallowed up all the other companies they had a very remarkable state of things. They had not only a monopoly, but one which was not under strict control or under stringent regulations. Their railway, water, gas, and electric lighting companies were all placed by Parliament under very strict limitations with regard to their capital, dividends, rates, and, especially, preferences, and on all these points this telephone company was absolutely unfettered. He thought that that was a strange state of things. Without entering into any minute calculations as to the actual value of the plant of the company, while he believed its capital stood at a value of something like £6,000,000, the Post Office calculation was that the plant could be entirely replaced at a cost of very little over £2,000,000. Then there was a further point which had resulted from the want of competition. When he looked at the little competition there had been he could not blame the company for its defects. He was rather astonished that its service was as good as it was. He wanted to recognise that in a good many parts of the country they were giving a service about which there was no great complaint; but at the same time in several large and important towns, even in the metropolis itself, and in Glasgow and other Scotch towns, there had been complaint made of the inefficient service; and in the case of Glasgow the complaint had been proved to be true by the Government Commissioner, and with regard to London Mr. Forbes himself had admitted the charge to a great extent. It was most important that this country should not be behind other countries, and it was no doubt the fact that at the present moment the number of subscribers in London did not compare favourably with the number in Berlin and Paris and in some of the smaller Scandinavian towns. There was also the fact to be remembered that the service was now confined to the more populous parts of the country, that very little had been done in the country districts, and that even in the populous towns, after all, the service was rather one for the rich merchant classes than for the smaller tradesmen, who could not bear the heavy subscription in order to get the benefit of the service. He did not blame the Company for this. They had only taken advantage of the grave error committed by the Post Office in 1883. Now they had to accept the facts as they were, and to try to make the best of a bad bargain. The figures he had already given showed that they would make a very bad bargain if they purchased the Company at anything like the present market value. Although both in 1890 and 1897 it was possible for the Government to give notice to purchase by arbitration, two Governments in succession had decided not to exercise their option. It was not likely that they would put themselves into the hands of arbitrators, who were never very favourable to Governments and municipalities, and run the risk of having to pay such an enormous sum with probably 10 per cent. added. It had also been definitely decided that these licences would not be extended beyond the year 1911. The Select Committee which sat in 1892 said in their report that they were perfectly willing to leave everything else to the Government, but that they must make some strong recommendation that the licences should not extend beyond 1911. That being so, the Government had undoubtedly to face this difficulty. The National Telephone Company was in possession of the field at the present moment. It was extending very rapidly, and, he did not hesitate to say, becoming more formidable every year. If it was known that the licences would expire in 1911, and if the Government of that day did not agree to purchase, by notice or arbitration, the plant of the Company, its assets generally, it might be, its goodwill, and even the wayleaves the Government had conceded to it, it was possible that the company, seeing that there were only a few years to run, might take the opportunity of trying to put the Post Office and the Treasury in a difficulty—he did not say unfairly. The danger, therefore, to be guarded against was this. He could not suppose that anybody would buy by arbitration in 1911, and even if a bargain was come to in 1904, the Company

* See *The Electrician*, Vol. XXIX., p. 177.

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would still have control for seven years. But possibly the Company would not agree to a bargain, and unless the Government had started themselves very early, with an entirely new plant of their own, the Company would be unwilling to sell to them, and raise their rates, with the result that there would be such an outcry in the country that the Government might have to buy out the Company at its own price. This was one of those contingencies which the Post Office and Government must keep in view. This evil, however, might be avoided to a limited extent by competition. Of course it would be grossly unfair to do anything which in any degree trenched on the agreement with the Company. The Government were bound to stand by the agreement, but it was distinctly reserved in that agreement, and had been admitted—distinctly admitted—by the Chairman of the Company before the Select Committee, that not only were the Government entirely free to start in competition when they liked as against the Company, but neither in honour nor in faith were they bound to take any other course. They were, therefore, absolutely free to enter into competition. Then came the question, What was the best form of competition? He did not believe that competition by companies would be by any means the proper course. Companies became bought up, and the company that bought them up had to charge higher rates in order to cover the cost, and he could not believe that any company would be able during the short period the licences would run to realise a sufficient surplus of income to pay readily both interest and redemption of capital. Then as to competition by the Post Office. This had not been a success, so far. It was a perfect absurdity that the Company should have been allowed to invade the Post Office area; but that had been done, and the Post Office was committed to that arrangement, and had to make the best of it. He thought that the reason why the Post Office had not competed, even in its own exchanges, was partly the idea that it ought to work harmoniously with the Company. With regard to the greater portion of the area of the country, he admitted it was necessary to work in amicable relations with the Company. They must remember that those Treasury regulations, which were framed in 1882, and which caused Mr. Fawcett to throw the whole of this valuable service to open competition, were still in existence, but they now proposed to abolish them; they proposed to enable the Post Office to try and canvass for work in just the same way as any private company. He was afraid that even when they had done that there was a difficulty which militated against the success of the Post Office exchanges even more than the Treasury regulations. He had said already that the National Telephone Company had got certain unrestricted privileges which, so far as he knew, were enjoyed by no other monopoly. It had got the privilege of granting preferences to particular subscribers, and by means of giving free wires or reduced rates to large firms who would bring them a large amount of business, they did what the Post-Office exchanges naturally could not do, because they could not give preferences. It had thus been possible to drive the Post-Office altogether out of an exchange, or to make its business less profitable than it might be. Of course, this was a privilege which they could not take from them, and the Company probably would exercise that right of preferences in competition with the Post Office or anybody else who might be brought against them. If that was the case he did not think it quite fair that the Post Office should not on its side use its privileges; and if the Company was to compete, as he thought unfairly, in these exchanges with the Post Office, it must not in future expect from the Post Office a great number of privileges which the Post Office, outside its bargain and agreement, had hitherto given. They must insist on having a fair competition in the exchanges. A promise had been given over and over again by various Postmasters-General in that House, and he had repeated that promise only last Session, that if in any case where there was a dear or unreasonable service and no competition it would be the duty of the Post Office itself, if necessary, to enter the field and extend the exchange. There was the less objection to their doing so, because although the Post Office might be blamed for not having worked its exchanges as vigorously as it might have done, still in spite of all the difficulties—and the question of preferences was a serious one—the Post Office exchanges had paid the Post Office a very large interest on the money expended. Therefore from a financial point of view there was very little reason why the Post Office should not where necessary extend its exchanges, and if it did so of course it would be gradually preparing for the day when the whole of the telephone system would fall into its hands. Then they came to another class of competition which had hitherto not been dealt with. Until at any rate 1892 the municipalities were about the only bodies who could not well enter into telephonic competition with the Company, because of the general licences granted all over the country, including the right to work the trunk lines. The municipalities were the only bodies whose action must necessarily be confined to their own areas, and they were therefore shut out from competition. Now they had this motion submitted to the House that the municipalities should be allowed to enter into competition, and from some points of view there was a good deal to be said for the municipalities. The municipalities or local authorities were perfectly willing, as he understood, to undertake licences and to work them on condition that in 1911 they absolutely surrendered those licences to the Government. That was one argument undoubtedly in favour of the local authorities. Another argument was that they certainly would not be bought up as a company might be, and in addition they had wayleaves and would be able therefore to lay an efficient underground service. Municipalities argued also that, while they were willing to allow their streets to be taken up for their own exchanges, they did not wish those streets to be at the mercy of any private company. He thought there was a great deal of justice in that contention. Under the Treasury Minute of 1892 the municipalities had an absolute control over any new companies, and no new company could work within the area of any local authority unless it got the permission of that local authority. Therefore if they were not going to allow the municipalities to compete he did not quite see what chance of competition there was from other sources. On the other hand there were serious difficulties involving questions of policy which Parliament itself ought to decide. Even if they were to grant a licence to the Glasgow Corporation, for instance, although Glasgow had got a common fund, differing in that respect from the English corporations, it would not be able to exercise that licence, and there would be no use therefore in doing so. There were two questions of policy to be considered in granting licences to municipalities. Hitherto undoubtedly the telephone in England was more or less a luxury of the rich, although it was not confined to the richer classes in other countries. That was at any rate one question which the Select Committee which they proposed to appoint would have to decide—whether a telephone service was a matter of such general benefit to the community living within the area of a municipality or local authority as to justify the local authority in using public funds for the purpose of undertaking telephone work within the area. That was a question which a department ought not to decide, and which ought to be left to Parliament. There was this further peculiarity with regard to the telephone service, that there must be, even with regard to large municipalities, areas outside, which it would be for the public convenience to include in the area of the municipal exchange. He was bound to say that by some means or other certain areas had already been assigned to the National Telephone Company which even the largest municipality could not possibly embrace within its operations. The area of the exchange of London, he was told, had 750 square miles—an area a good deal larger than even the London County Council would possibly attempt to work. He should have thought with regard to a large body like that, thatif a license were granted to it it ought to be contented with its own area. What they proposed was to appoint a select committee of that House which should confine itself to these two legal points. Whether any change in the law should take place which would, by the removal of restrictions, make it possible for a municipality to engage in such an undertaking, and how far this extension of the telephone system in the hands of persons other than the Post Office was likely to damage their revenue. That was a subject which the Treasury had gone very carefully into with the Post Office, and undoubtedly a great deal of the danger of our telegraph revenue diminishing was removed when the Government bought the trunk wires. There was a feeling now at the Post Office, for which he thought there was some justification, that if a telephone service was properly worked in close communication with the Post Office, so far from damaging the telegraph service it might actually assist it. They were bound to treat the Company with fairness, they were bound also to consider the telegraph revenue. He did not think either of those considerations would suffer under the suggestions he had made. They had also, however, to consider that this was a new agency of communication which other countries had availed themselves of to a much greater extent than this country had.

Sir C. CAMERON said he regretted the right hon. gentleman was so strongly opposed to the granting of licences to companies, but he was sure the new policy announced by the right hon. gentleman would be greeted with satisfaction in the country.

The motion was then negatived without a division.

LEGAL INTELLIGENCE.

Corporation of the City of London v. City of London Electric Lighting Company (Limited).

THE CITY ELECTRICAL INSPECTOR'S EXPENSES.

At the Guildhall (London) on Tuesday, before Alderman Sir J. T. Ritchie, an application was made by the City Solicitor to ascertain the fees and reasonable expenses of the electrical inspector employed by the City (amount of claim, £1,142. 2s. 7d.), under Section 47 of the City of London Electric Lighting Orders Confirmation Act (1890). The City of London Electric Lighting Company (Limited) were treated as defendants, Mr. Rose-Innes represented the Corporation, and Mr. Roskill appeared for the Company. Mr. Rose-Innes pointed out that so far as the public was concerned it was essential that the electric light supplied should be kept up to a certain standard. The Order of 1892 provided that an electrical inspector should be created by the local authority, and that all fees and reasonable expenses, unless agreed upon, should be ascertained by a Court of Summary Jurisdiction, or, where appointed, the Board of Trade. What the Alderman had to decide was the amount to be paid by the Company to the Corporation for the inspection of meters. The electric inspector was to be an impartial person standing in a judicial position, and the point which arose for determination was, apart from the salary which the Corporation paid this gentleman, what were the fees and reasonable expenses in regard to the work which he had done. Mr. Roskill said he did not dispute the scale of fees settled by the Board of Trade. Mr. A. A. Voysey, electrical engineer to the Corporation, said that in respect of his employment as electrical inspector he received a salary from the Corporation He found it necessary to have a testing office, the rent of which, originally £195 a year, was afterwards reduced to £170. This was paid by the late Commissioners of Sewers. His duty was to test meters with a view of deciding disputes between the company and the consumer. Mr. Roskill contended that reasonable expenses meant those incurred by the inspector travelling to test meters, and so forth, but the Corporation could not claim any portion of the items now put forward. The Alderman said he had come to the conclusion that the items were not reasonable expenses within the meaning of the Act. He did not think that the Company were bound to provide offices and so on for inspectors. Mr. Frank Bailey, chief engineer to the City of London Company, having given evidence, Sir James Ritchie said if a higher Court held that the items mentioned could be included among reasonable expenses, in

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order to save the parties coming before him again, he would fix an amount. As the inspector had said that he gave about two-thirds of his time to testing, he would reduce the amount to £937. 14s. 8d. This was merely a formal matter to save the case being brought before him again should a higher Court decide against him. The summons was accordingly dismissed, a special case being stated for the higher Court.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Bibliography of X-Ray Literature and Research, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"Laboratory Notes and Forms."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade. *In the Press.*

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"The Electric Arc."—By Mrs. Ayrton. *In the Press.*

"Electrical Testing for Telegraph Engineers."—By J. Elton Young. *Ready shortly.*

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Armature Windings of Electric Machines."—By H. F. Parshal. and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *The New Edition is now ready.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. *Now ready.* Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"Signalling across Space without Wires by Electric Waves." Being a Description of the Work of Hertz and his Successors.—By Dr. O J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net 2s. 9d. post free.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—The Publisher of this well-known Blue-Book begs to announce that the Directory and Handbook for 1898 is *now ready.* Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary. The Directory is corrected up to Feb. 3, 1898, and contains about 150 additional pages over last year's book. Supply houses will find the book very reliable and complete for circularising.

Tenders Invited.—The Accrington Corporation invite tenders for supply and erection of (*c*) three sets of steam dynamos, feed water heater, feed pumps, steam, exhaust and water pipes, &c.; (*d*) a storage battery having a capacity of 750 ampere hours; (*e*) switch-boards, instruments, apparatus, cables, wires, &c., at the electricity station; (*f*) cables, wires, street boxes and connections. Further particulars appear in an advertisement elsewhere, and specifications, &c., may be obtained after the 4th inst. from the town clerk, Mr. A. H. Aitken. Plans and drawings may be obtained at the office of the town clerk, Town Hall, Accrington, or of the consulting electrical engineer (Mr. J. N. Shoolbred, C.E.), 47, Victoria-street, London, S.W. Tenders must be delivered to Mr. Aitken by Tuesday, the 19th inst.

——— The Belfast Harbour Commissioners require tenders for the supply of three belt-driven continuous-current series-wound dynamos, some further particulars of which will be found in an advertisement elsewhere. Copies of the specification can be obtained from the harbour engineer (Mr. G. F. L. Giles). Tenders must be sent in to the secretary (Mr. W. A. Currie), Harbour Office, Belfast, not later than Monday, April 18.

——— The Belfast Harbour Commissioners also require tenders for the supply and erection of three compound two-crank self-lubricating single-valve quick-revolution vertical engines, of which some particulars will be found in an advertisement on another page. Copies of specification of Mr. G. F. L. Giles, and tenders to Mr. W. A. Currie, secretary, by Monday, 18th inst.

——— Tenders are invited for the running and maintenance for a period of five years of an electrical installation at Esher. Some further particulars are given in an advertisement elsewhere.

——— The Wallasey Urban District Council require tenders for the erection and completion of extension to the engine and boiler house at the electricity supply station, Seaview-road, Liscard. Tenders to the clerk (Mr. H. W. Cook), Public Offices, Egremont, by 21st inst.

——— The Electric Lighting Committee of the Vestry of St. Mary, Newington (London), require tenders for the erection of an electricity supply station. Tenders to the clerk (Mr. L. J. Dunham), Vestry Hall, Walworth-road, S.E., by 18th inst.

——— The Shoreditch Vestry invite tenders for the supply and erection of arc lamps and accessories and also for electric cable for their electricity department. Tenders by noon on Tuesday, the 12th inst.

——— The Midlothian and Peebles Lunacy Board invite tenders for an electric lighting installation (including plant, wiring, fittings, &c.,) for Rosslynlee Asylum. Tenders to the Clerk, 19, Heriot-row, Edinburgh, by 23rd inst.

——— Tenders are invited up to 15th inst. by the Works Department of the Berne Municipal Council for the supply of between 27,000 and 35,000 metres of high-tension and from 60,000 to 70,000 metres of low-tension cable, together with distributing boxes, &c. Particulars from, and tenders to, la Direction des Travaux de la Ville, Berne, Switzerland,

——— The St. Pancras (London) Vestry require tenders for the extension of the Regent's Park electricity station building. Tenders to the Vestry Clerk, Vestry Hall, Pancras-road, N.W., by 19th inst.

——— The Cardiff Corporation requires tenders for fire alarm telephone boxes, indiarubber hose, &c., for their fire alarm system. Tenders to Town Clerk, Town Hall, Cardiff, by April 12.

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Tenders Accepted.—The tender of Mr. T. W. Thomas has been accepted by the Hammersmith (London) Vestry for the extension of the electricity supply station buildings, at £3,504. The tender of Messrs. W. T. Glover and Co. (Limited), has also been accepted for the supply of the necessary switches for 50 new arc lamps, at £5 each.

——— The Asylums Committee of the Middlesex County Council has accepted the tender of Veritys Limited for lighting the Recreation Hall and the stage therein by electricity for the sum of £289.

——— The Electric Lighting and Traction Committee of the St. Helens Town Council have accepted the tender of the British Insulated Wire Company for the supply of electric traction plant and equipment for the local tramways.

——— The Derby Town Council have accepted the following tenders for the Electricity Department:—Carbons: English Carbon Company, at £1. 6s. 6d. solid, and £3. 17s. cored per 1,000ft. Low-tension cables, including boxes: W. T. Henley's Company, half-mile at 7s. 7¾d. per yard, one mile at 3s. 3¾d. per yard. A 10-H.P. motor has been conditionally purchased at £35.

Tenders Received.—At the last meeting of the Hampstead (London) Vestry the tenders for the supply of the additional plant for the electricity supply station were opened, and referred to the Lighting Committee. There were 16 tenders submitted.

Plant for Sale.—An advertisement elsewhere gives particulars of an electric lighting plant which is for sale at Liverpool.

Appointments.—Mr. T. B. Goodyear, who has been with the Birmingham Tramways Company for the past ten and a-half years as assistant traffic manager and traffic manager, has been appointed general traffic superintendent to the British Electric Traction Company (Limited).

——— Mr. J. H. Cordeaux, technical officer, engineer-in-chief's department of the Post Office, has been appointed to be acting principal technical officer.

——— The Electric Lighting Committee of the Birkenhead Corporation have selected Mr. Bates, of London, for the position of borough electrical engineer, at a salary of £300 per annum.

Vacancies.—The Vestry of the Parish of Lambeth, London, require an assistant engineer. Some particulars of the duties are given in an advertisement elsewhere.

——— A resident engineer is required to supervise the construction of an electrical tramway. Some particulars are given in an advertisement on another page.

Business Notice.—Mr. L. Alwyn has taken into partnership the Hon. Rupert Craven, and the style of the firm is now Alwyn and Craven. All outstanding liabilities to date will be discharged by Mr. Alwyn.

Liquidation.—A meeting of the creditors of Latimer Clark, Muirhead and Co. (Limited) will be held at the offices of Messrs. Trinder, Capron and Co., 47, Cornhill, London, E.C., on May 2, to receive an account of the winding-up. Mr. James Worley, 27, Leadenhall-street, is liquidator.

Bankruptcy.—In the failure of Trehearne, Son and Crump, electrical engineers, 155, Fenchurch-street, E.C., debtors attended at the Bankruptcy Court on Tuesday and passed their public examination, accounts showing debts £1,102. 9s. 1d., assets £449. 13s. 2d. Failure ascribed to heavy expenses of establishing the business, losses on trading and bad debts.

The "Engineering Magazine."—The April issue of this magazine contains articles on "The Shifting Site of National Industrial Supremacy," by J. S. Jeans; "European Sea-Going Dredgers and Deep-Water Dredging," by E. L. Corthell; "Systems and Apparatus for Heating Buildings by Steam," by J. J. Blackmore; "Mining the Gold Ores of the Witwatersrand," by H. H. Webb and Pope Yeatman; "Tank Irrigation in Central India," by G. Palmer; "The Interpretation of Sanitary Water Analyses," by F. Davis; "An Effective System of Finding and Keeping Shop Costs," by H. Roland; "Notable Speed Trials of British Locomotives," by C. Rous-Marten; "The Steam Engine and the Dynamo—a Chapter in Evolution," by C. T. Child; and "The Gas Engine in American Practice," by G. Richmond. The usual Review of the World's Engineering Press is also given. Copies of the magazine may be had at the offices of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London.

Cassier's Magazine.—The contents of the April issue of this Magazine include "The Liverpool Overhead Railway and Docks," by S. B. Cottrell; "Trade Unions and Political Economy," by Francis G. Burton; "Suggestions for Improvement in Power Plants," by A. Bement; "Inventions for a Living," by G. E. Walsh; "Across the Chilkoot Pass by Wire Cable," by W. Hewitt; "Crushing and Pulverising Machines," by J. Douglas; "Car Ferrying on American Lakes," by A. S. Chapman; and "The United States Ironclad 'Monitor,'" by F. M. Bennet.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 30 to April 5, with the ports of destination:—

Australasia—Adelaide, £334; Melbourne, £935 (including £800 telegraph material); Sydney, £347. *Austria*—Trieste, £400 (telegraph material). *Brazil*—Rio Janeiro, £63. *Ceylon*—Colombo, £120. *Egypt*—Alexandria, £16. *France*—Boulogne, £84. *Gibraltar*, £199. *Holland*—Amsterdam, £175; Flushing, £36. *India*—Bombay, £333; Calcutta, £343. *Italy*—Genoa, £500. *Japan*—Yokohama, £225. *Madeira*, £40. *Natal*, £1,110 (telegraph material). *Norway*—Christiania, £40. *Portugal*—Lisbon, £10. *Russia*—Odessa, £90 (telegraph material); Reval, £315. *South Africa*—Cape Town, £139; Delagoa Bay, £112; Durban, £388; East London, £51; Port Elizabeth, £670. *Spain*—Barcelona, £41; Malaga, £196. *Sweden*—Stockholm, £100. *West Indies*—Trinidad, £16. Total £7,428, against £37,766 in the corresponding week last year (March 31 to April 6).

Hardtmuth Carbons.—We learn that the stockholders of the Hardtmuth Company, of Ratibor, Austria, have decided to close their carbon factory for six months. It is stated that nearly four million marks have been expended without the production of a good or satisfactory carbon being effected, and that this has exhausted the patience of the stockholders, who have decided to employ a new manager in the place of Messrs. M. and F. Hardtmuth. Such would appear to be the present condition of the well-known Hardtmuth carbon firm, which in the early days of electric lighting manufactured a product which was considered an excellent one. The result of the experiments at the Ratibor works must be disappointing to the Allgemeine Elektricitäts Gesellschaft of Berlin and Herr Jacob Lanbau who, we understand, financed the Hardtmuths in their extended range of experiments, and we learn that the factory, which although a new one was equipped with the old type of plant, is to be entirely reorganised and put on a par with modern works making high-grade carbons.

Fire Prevention.—The latest publication of the British Fire Prevention Committee contains a Paper by Mr. Hugh Bonner, chief officer of the New York Fire Department, showing the arrangements made for dealing with conflagrations by the New York local authorities. The illustrations include views of the interior of the main fire telegraph office at headquarters and the fire-alarm boxes used for street alarms.

Catalogue.—The United Ordnance and Engineering Company, with which is incorporated the business of Messrs. Easton, Anderson and Goolden (Limited), are well-known manufacturers of electrical engineering plant and machinery. This Company have recently issued an illustrated catalogue of multipolar continuous current dynamos and motors, suitable for electric lighting, transmission of power and other purposes. These machines are of the "Fynn" type, and were designed by Mr. V. A. Fynn; they have already been fully described and illustrated on several occasions in our columns. The catalogue is illustrated by a number of photo-process views of the interior of the Company's workshops at Erith, as also by drawings of the principal details of plant manufactured at these works. Further particulars of this plant are given in a number of conveniently arranged tables.

Instrument Catalogue.—Messrs. John Davis and Son, of All Saints' Works, Derby, and London, forward their 1898 catalogue of engineering and mathematical instruments, &c.

Balmoral.—It is stated that the Queen has decided that Balmoral Castle shall be lighted electrically, water-power to be derived from the Gelder at a point between one and two miles from Balmoral. The work connected with the turbine installation is already in hand.

Bedford.—The Town Council have approved the Electric Light Committee's recommendation to reduce the charge for electric current to 4½d. per unit net as from 1st July. The Council have also authorised the committee to purchase six new transformers for street lighting purposes, at an estimated cost of £300, and to obtain tenders for extending the engine-room at the electricity supply station.

Belfast.—The Electric and Law Committees have been authorised to submit to the Belfast Tramways Company fresh terms upon which the Corporation would be willing to sanction the introduction of electric traction. It is surprising that this progressive and prosperous city has not already availed itself of the advantages of electric tramways. As it is, Belfast has to follow the lead of Dublin and Cork.

Berlin.—The agreement between the Berlin Municipal Authority and the Berlin Electricity Works, whereby the latter's concession is prolonged until the year 1915, has been confirmed.

Bradford.—The deputation recently appointed to visit the Continent for the purpose of inquiring into the electric lighting and traction systems employed in the principal Continental cities

presented their report at last Thursday's meeting of the Gas and Electricity Committee. Visits were paid to Brussels, Hamburg, Berlin, Dresden and Leipzig, and after describing the various electricity supply and tramway undertakings in these cities the report concludes as follows :—

"After taking into consideration all the deputation have seen, they are satisfied that the arrangements which have already been made at the electricity works at Valley-road for running the Bolton-road and Great Horton tramways are as complete as anything which the deputation have seen on the Continent. The generating stations there, however, are very much larger and finer than anything to be seen in this country, and there can be no question but that, instead of making undue haste in the matter of electric traction or lighting, we are in each of these instances considerably behind the development which has already taken place in each of the towns which we visited."

The Gas and Electricity Committee have decided to reduce the price of electric current for lighting by a halfpenny per unit, and have also adopted a sliding scale for current for motors, making prices range from 2½d. to 1d. per unit.

Blackpool.—At Tuesday's meeting of the Town Council, Mr. J. Brodie, Chairman of the Electric Lighting and Tramways Committee, submitted the report of the deputation which recently visited several continental cities for the purpose of obtaining information as to the most suitable form of electric traction for the borough. The deputation unanimously recommended the adoption of the overhead trolley system.

Bray.—There is a proposal before the Township Commissioners which, if adopted, will at once bring that sapient body into notoriety. The finances of the town are not, it appears, in a very flourishing condition, and, in order to effect an economy and reduce rates, the peculiar (may we say the Hibernian ?) suggestion has been made to make wholesale reductions in the salaries of the permanent officials, including the electrical engineer, whose salary is to be reduced to £100 per annum. The matter is to be discussed at the next meeting, but in the meantime it would be interesting to know the views of the permanent officials on the position of affairs.

Brighton.—The report of the Lighting Committee presented at yesterday's meeting of the Town Council contained a recommendation in favour of reducing the price of electric current, as from the 30th June next, from 1½d. to 1d. per unit after the first hour's average daily use. The report states that Mr. Wright has accepted the position of consulting electrical manager to the British Thomson Houston Company, the terms of his arrangement enabling him to give at least half his time to the Corporation. The accounts of the department show that borrowing powers to the extent of £234,581 have been obtained, and of this sum £198,155 has been raised, leaving an uncalled balance of £36,426. Owing to the premiums at which the loans were issued, the actual liability incurred is only £188,543. 13s. 5d. The gross revenue during 1897 was £32,722. 17s. 10d., of which £18,512. 4s. 6d. was expended on maintenance and £14,210. 13s. 4d. carried forward. Leaving £110. 13s. 4d. of this as provision for bad debts, and adding £5,000, balance from 1896, the Corporation had in hand £19,100, of which £2,000 was applied in aid of the district rate, £3,000 transferred to reserve fund, £5,688. 5s. 6d. paid as interest, £5,547. 9s. 1d. put to sinking fund, and £2,864. 5s. 5d. carried forward. The assets are valued at £229,522. 4s. 5d., leaving £19,496. 16s. 10d. above liabilities, which include a reserve fund of £5,901. 13s. 11d., and a suspense account of £350. Private consumers purchased 1,505,867 units last year, and the public lamps consumed 486,634 units ; 111,693 units were used in the works; and 335,977 units represents the extra quantity generated but not accounted for.

Bristol.—The City Council were engaged for several hours on Friday in discussing a report from the Sanitary Committee as to the negotiations with the Bristol Tramways and Carriage Company. The Council were recommended to oppose the Company's Bills for the introduction of electric traction, as the Committee had failed to come to an agreement. The various speakers, while admitting the advantages of electric traction, thought the Company might be fairly asked to make further concessions. Eventually the Committee were instructed to renew the negotiations with a view to coming to some arrangement.

The latest return of the electricity department states that on the 25th ult. there were 614 customers, representing an equivalent of 38,302 8-c.p. lamps connected to the mains, an increase of 200 customers and over 10,000 lamps on the year. The extension of the public lighting has not yet been carried out, but is in progress, and before the summer is over it is expected that the number of public arc lamps will be increased three-fold. Various extensions of the mains for private lighting have been or will be made within the next two months. The number of sub-stations has been increased from 31 to 39. The extensions at the generating station in Temple-back have been almost completed. Five new boilers have been put in, together with a new elevator, conveyor and mechanical stokers and electric motors for driving these, and the sundry pumps are now being placed in position. One new steam alternator has been fixed and brought into use, and two others will be put in during the summer. These three machines alone are capable of supplying current to over 40,000 lamps at one time. In addition to the alternators, other steam dynamos have been and are being put in for public lighting and the supply of power. The trading profits for the year exceeded 8 per cent. of the capital expenditure, although a considerable amount of this capital has been expended on buildings and plant which have not yet come into operation. The following table, prepared by the city electrical engineer (Mr. H. Faraday Proctor) shows the progress of the department :—

Year of working.	Customers connected.	Lamps computed.	Net profits.	Trading profits.	% to capital expended. per ann.
1st, ended Dec., 1894...	240	14,530	Loss	£456	½%
2nd, ended Dec., 1895...	439	24,046	Loss	4,020	4%
3rd, ended Dec., 1896...	593	30,299	£487	7,590	7%
4th, ended Mar., 1898...	749	49,719	3,290	11,397	8%

Can there be a Greater Man than Edison ?—It is stated in *Electricity*, of New York, that a former employé of the Edison Electric Light Company has been placed in a lunatic asylum by the officials of Warren Township. The man is 26 years old, and has applied himself to the study of electricity so steadily that it affected his mind, and he became possessed of the hallucination that he was greater than Edison, and could make improvements on the latter's inventions. If there are no further grounds for assuming the man's insanity, the officials of Warren Township should themselves be relegated to the lunatic asylum in place of the unfortunate employé.

Cork.—According to the *Daily Nation* good progress is being made with the electric tramway and lighting scheme. Current will be available for lighting before the end of May, and the whole of the tramway lines will be in operation by July 1st. The charge for current for private lighting will 4½d. per unit for the first two hours' maximum demand, and 1½d. per unit afterwards. A local "free" wiring company has been formed and undertakes the wiring and fitting of premises in consideration of obtaining 1d. extra per unit for all current consumed. The chief engineer of the undertaking is Mr. H. F. Parshall, while Mr. Arthur Wright has special charge of the lighting arrangements. Mr. R. D. Walsh is the engineer for the tramway construction, and Mr. Merz and Mr. Beverley Griffin are the resident engineers for the electric works and tramway construction respectively.

Derby.—The Town Council have adopted the following revised scale of charging for electric current for motive power purposes :—3d. per unit for the first 18 hours per week ; 2d. per unit for the next 18 hours ; and 1d. per unit for all electricity consumed beyond that time.

The Derby Corporation are the latest recruits to that rapidly-increasing body of local authorities who own local tramway systems. As a preliminary the Derby Corporation have engaged a firm to value the undertaking of the local tramway company. The introduction of electric traction will follow the purchase.

Dewsbury.—At the Town Council meeting on Tuesday the Electricity Committee recommended the doubling of the existing trunk mains at a cost of £5,000, an extension of the mains to a part of the borough not yet served at a cost of £2,500, and also the purchase of an additional engine and dynamo at a cost of £2,450, including the cost of the extension of the electricity station building. It was announced that the borough electrical engineer (Mr. J. B. Mitchell) had resigned in order to take a similar position at Southend, and the extension scheme was postponed pending the appointment of his successor.

Edinburgh.—At Tuesday's meeting of the Town Council it was decided to reduce the charge for electric current, from May 15, to 3½d. per unit. The charges for current for public lighting and motive power are to be reconsidered.

Exhibitions.—On the occasion of the celebration of the fourth centenary of the discovery of the maritime route to the East Indies an exhibition of agricultural machinery, &c., will be held at Lisbon on May 17, 18, 19, and 20. Exhibits of English manufacturers will be allotted space free of charge, and will be admitted free of duty. Particular attention should be given to electrical machinery and plant, more especially electric motors. Applications for space to the Director-Secretario da Real Associaçao Central da Agricultura Portugueza, Lisbon.

Official catalogues of the exhibits at the Birmingham Electrical and General Trades Exhibition are now ready.

There is to be an exhibition devoted mainly to mining and other local industries, at Auckland, New Zealand. Efforts will be made to secure a specially fine machinery exhibit. The Agent-General in London will, we understand, furnish further particulars.

Festiniog.—Before deciding upon a proposal by a local firm of electrical engineers to establish an electricity supply station in this town the District Council have instructed their clerk to ascertain the probable cost of establishing a system of supply.

Electricity in the Manchester Suburbs.—In virtue of agreements with the District Councils of Withington and Moss Side the

Electricity Committee have decided to apply to the Local Government Board for sanction to borrow £150,000 for extending the city electric light system to these districts. The actual cost of carrying out the extensions is put at £138,000. The Committee's proposals were approved at the meeting of the Council on Wednesday.

Electric Traction in West London.—The London United Tramway Bill for the extension of their system, and for the introduction of electric traction, is being opposed by the Kew Observatory authorities.

Havre.—The Chamber of Commerce of this French town is making steady progress in providing the most modern material for the loading and discharging of cargo. Electric cranes have recently been erected on the Bassin Vauban. A new line of electric tramways is in course of construction from Havre to Harfleur and Mont Villiers. The electric tramways of the city carried last year 1,500,000 more passengers than in the previous year, the total being for 1897 11,131,363.

Inverness.—By the casting vote of the Provost, the Town Council on Monday decided not to give facilities to a company to establish electricity supply works in the town.

Kidderminster and Stourport Electric Tramway.—It is stated that the contractors will have finished the works in hand in about a fortnight.

Kilmallock (Limerick).—Mr. J. J. O'Sullivan, J.P., has arranged with the Markets Committee for the public lighting of this town, and is putting down a plant for private consumers. The mains extend in four circuits of about a quarter of a mile each, and current will be delivered to customers at 200 volts. Hitherto the town has depended upon oil as its illuminant; but now the premises of nearly all the residents are wired for the electric light, the greater number having not more than three lamps at a fixed contract price per annum for current, which has, we learn, given satisfaction to the consumer, and should prove remunerative to Mr. O'Sullivan. The electric lighting of these small towns opens up a large and promising field for the electrical industry, and success at Kilmallock will undoubtedly lead to extensions in many districts in Ireland where similar conditions prevail. The engine for this installation is being supplied by Messrs. J. and R. Lees, of Glasgow, and the dynamo, switchboard, wires, and general fittings by the Edison and Swan Company.

Kimberley (South Africa).—The Municipal Council propose to borrow £25,000 for electric lighting purposes. The De Beers Directors have offered to lend the money at 4 per cent. per annum for 10 years.

Leeds.—A Local Government Board inquiry was held at Leeds on Thursday by Mr. E. P. Hurd into the application for a Provisional Order (1) to empower the Corporation to create irredeemable stock bearing a dividend at a rate not exceeding 5 per cent. per annum, in order to issue or transfer the same as provided in Clause 59 of the Leeds Provisional Order (1891); and (2) to confer on the Corporation such borrowing powers, and power to create and issue redeemable stock as may be necessary or advisable for and in connection with the purchase of the undertaking of the Yorkshire House-to-House Electricity Company (Limited). The application was supported by the town clerk (Mr. John Harrison), and Mr. Cyril Dodd, Q.C., represented the Company. The Town Clerk said, that in 1891 the Company obtained an Order to supply electricity within the then borough of Leeds, and that Order was obtained largely by the aid of the municipal authority. After referring to Mr. Justice North's recent decision in the Sheffield case, he said that the Leeds Corporation had accepted the suggestion that irredeemable stock was the quality required to meet the conditions of the contract relating to themselves, and they therefore asked the Local Government Board for an Order to enable them to issue this description of stock. Mr. Harrison dealt with the financial position of the Company. On the question of sinking fund charges Mr. Harrison explained that the amount expended by the Company on capital account to Dec. 31 last (less depreciation) was £154,409. This would mean, according to the value of 5 per cent. security to-day, £308,818 to be paid to the Company, or double their capital expenditure. The profit for the year ended Dec. 31 last, after transferring £2,300 to the depreciation fund, was £10,703. Interest at 5 per cent. on £154,409 represented £7,720, leaving £2,983 for sinking fund purposes. Assuming the market rate of interest to be 2½ per cent., the amount required to be provided for at the end of 60 years would be £308,818, in order to produce 5 per cent. per annum on the capital value, or purchase money, and the amount to be set aside annually to produce £308,818 at the end of 60 years would be £2,271. The Lord Mayor (Alderman C. F. Tetley) and the city accountant (Mr. W. Derry) gave evidence in favour of the application, after which Mr. Dodd stated that the Company were willing to come to a fair and honourable agreement with the Corporation. They did not desire to oppose the application; they were only anxious that the Local Government Board should have the whole of the facts before them.

Light Railway Schemes.—Application is to be made to the Light Railway Commissioners to authorise the construction of a light railway, to be known as the St. Just, Land's End and Great Western Junction (Light) Railway. Power will be reserved to use electricity or other motive power, and it is propsed to adopt the standard gauge.

The Light Railway Commissioners (Lord Jersey and Col. Boughey) have held an inquiry into the application of the British Electric Traction Company to construct additional tramways in Tynemouth and the adjoining districts of Whitley and Monkseaton. Mr. Sydney Morse, who appeared for the applicants, said that the new line would have a gauge of 3ft., and the engineer's estimate was £11,356. There would also be two extension lines. There were no difficulties in construction. The Town Clerk of Tynemouth contended that the Commissioners had no jurisdiction, as the application came within the scope of the 1870 Tramways Act. The inquiry was adjourned.

At Beaumaris, on Friday, the Light Railway Commissioners (Lord Jersey and Col. Boughey) held an inquiry into the application to construct a light (electric) railway between Beaumaris and Llanfair. Mr. E. F. Vesey Knox, who appeared for the promoters, said that it was proposed to make a connection with the L. and N. W. Railway at Llanfair. The proposal had the support of all the local governing bodies in the district affected, as well as of the County Council of Anglesey. A petition was presented in favour of the scheme from all the tradesmen in Beaumaris except one. Mr. H. Justus Eck considered that the proposed railway could be worked safely and economically. Cadnant had been chosen as a suitable place for the generating station, and it was contemplated to run a half-hourly service of trains. The wires would be carried on the bracket arm system. The cost of rolling stock would be about £5,750. Mr. Myers Beswick, the engineer of the proposed line, said the actual cost of the whole railway would be between £52,000 and £53,000, but the Company proposed to raise a capital of £73,000 in order to provide a sufficient margin for further development and equipment. Some opposition was offered by two or three property owners in the district. The inquiry was adjourned.

Lincoln.—At the meeting of the City Council on Tuesday the Electricity Works Committee presented a report in which they recommended that (1) the price of supply be 6d. per unit for first hour's average maximum demand and 2½d. per unit afterwards; (2) that a contract be entered into with the National Electric Free Wiring Company to "free" wire those consumers who wish to take advantage of this method of wiring their premises. The electricity works are in a forward state, and supply is to be given on Oct. 1.

Liverpool.—The Electricity Supply Works Committee held its first sitting on Friday, when Sir Arthur Forwood was elected chairman and Mr. Chas. Petrie vice-chairman.

London County Council.—At Tuesday's meeting it was resolved to loan the Islington Vestry £13,660 for electric lighting purposes.

On the reception of the Highways Committee's report Mr. Beachcroft asked whether in view of the expressed intention of the Government to appoint a Select Committee to inquire into the question whether municipalities should be given power of working the telephone system, the Committee was prepared to consider the question of the obstacles placed in the way of the National Telephone Company laying underground wires in London, and whether a report would be submitted on the subject. Mr. Benn, Chairman of the Committee, replied that with regard to the present decision of the Government, that would, of course, be considered by the Highways Committee. He did not know that it would affect the position of the Council, because, supposing the Government decided that it was desirable to grant licences to municipalities, they had yet to establish a case for London, and that proposal would involve the inquiry which was sought by the Council.

Lyndhurst.—A scheme for the erection of electricity supply works in this district is before the Local Authority.

Nottingham.—At the monthly meeting of the City Council on Monday the Tramways Committee's report, referred to in our last issue, was presented, and after discussion was unanimously agreed to.

Paris.—The scheme for the construction of a metropolitan railway in this city has at last assumed practical form. The French Chamber and the Municipal Council have come to an understanding on the matter, and the works are to be undertaken as soon as possible, with the view of the first line being ready for the Exhibition of 1900. The lines will be constructed on the standard gauge, and electricity will be adopted as the motive power. A municipal loan of 165,000,000fr. has been sanctioned for the construction of the railway.

Peking.—A Berlin telegram states that this city is to be provided with an electric tramway, and that Messrs. Siemens and Halske have secured the contract for carrying out this project.

Peterborough.—The Town Council have a second time been refused authority by the Local Government Board to borrow

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£20,000 for electric lighting purposes. A deputation of the Council waited upon the President of the Local Government Board on Monday, in order to urge him to reconsider the matter. The deputation contend that the decision has been come to owing to a misconception of the financial position of the town by the Board's inspector.

Private Bill Legislation.—The Metropolitan Railway Bill has now passed the Committee stage of the House of Commons. In giving the Committee's decision the Chairman (Mr. S. Hoare) said that the opposition of the Great Western Railway Company was interesting from the fact that, with the exception of the Metropolitan District Railway last year, this was the first old-established railway which had come to Parliament for powers to introduce electric traction on their system. On the proposal that the Company should have that power there seemed to have been a general consensus of opinion in agreement with the report of the departmental committee of the Board of Trade, that it was a desirable thing that the Metropolitan Company should have the power to work their line electrically. The Committee had gone very fully into the question of the rights of the Great Western Company, and it appeared to them that the clause which had been submitted by the Metropolitan Company would meet the requirements of the Great Western. They found the preamble proved, subject to the addition of that clause.

Ryde.—A Board of Trade inquiry was held last week at Ryde into the application of the Ryde Electric Light and Power Company (Limited) for a Provisional Order for the district. The application is being opposed by the Town Council. Mr. Damant, who appeared for the Company, explained that the object of the application was to obtain power from the Board of Trade to dispense with the sanction of the local authority, which had been refused. Evidence was given to show that the Ryde Town Council had persistently refused sanction to the proposals of similar companies, but had never themselves attempted to carry out the work. Mr. Rickard, for the Council, did not deny the advisability of the electric light, but his clients were experimenting with a view of ascertaining the best light. The Council wished to keep the power in their own hands so that they would be able in future to have the control of the lighting of the borough. The inquiry lasted six hours, and a vote of thanks to Major P. Cardew terminated the proceedings.

St. Helens.—The Electric Lighting and Traction Committee recommend the Town Council to equip the tramways on the overhead trolley system, and to apply to the Board of Trade for their consent, and also for sanction to borrow £25,000, the estimated cost of the electrical equipment.

Salford.—The Highways Committee have appointed a sub-committee to prepare a report upon the probable cost of taking over and working the local tramways, and of equipping them electrically.

South Africa.—A Committee of the Queenstown Municipality is considering the particulars of an electric lighting scheme, which has been submitted by Mr. E. T. Stuart Menteath.

The *British and South African Export Gazette* announces that a scheme for the electric lighting of the public buildings, shops and private dwellings at Kimberley is proposed.

The East London Town Council contemplate putting down an electric lighting and traction plant at an estimated cost of £25,000.

Stretford.—The District Council have decided to purchase the local tramways on the expiry of the present lease in July, and to promote a Bill to empower them to work and use the lines and to introduce electric traction.

Swansea.—Mr. E. Manville has now presented his report on the electric lighting question, and a special meeting of the Council will be held for the purpose of considering it. The initial capital outlay involved by an electric lighting scheme is put at about £36,000, the probable revenue at £5,117, and net profit at £1,052.

Wallasey.—Mr. W. A. Ducat will hold a Local Government Board inquiry at the Public Offices, Egremont, on Thursday next, into the application of the District Council to borrow £20,785 for electric light extension purposes.

Wednesbury.—The Town Council has passed a formal resolution in favour of applying for a Provisional Order.

BOOKS RECEIVED.

"The Law Relating to Electric Lighting." By John Shiress Will, Q.C. (London: Butterworth and Co.) Price 15s.

"Practical Radiography." By A. W. Isenthal and H. Snowden Ward. Second edition. (London: The Photogram, Limited.) Price 2s. 6d.

"*Proceedings* of the Royal Society." No. 388, Vol. LXII. Price 6d. No. 389, Vol. LXIII. Price 1s. 6d. (London: Harrison and Sons.)

COMPANIES' MEETINGS AND REPORTS.

Oldham, Ashton and Hyde Electric Tramway (Limited).

The statutory meeting of this Company was held yesterday (Wednesday) at Donington House, Norfolk-street, Strand, London. The Chair was taken by Mr. Emile Garcke.

The SECRETARY (Mr. H. S. Hodgson) read the notice calling the meeting.

The CHAIRMAN said: Gentlemen, as you are aware, this meeting has been called to comply with the Companies Act, which provides that a meeting shall be held within four months from the date of the registration of the Company. The Company was registered on December 18th last, and a prospectus was issued in the month of January. The whole of the capital offered for subscription, consisting of 4,000 Five per Cent. Cumulative Preference shares and 4,000 Ordinary shares of £10 each, was subscribed for and allotted. We lost no time in making application for a quotation on the Manchester Stock Exchange, and we are informed that, subject to our compliance with a small formality, the quotation has been granted. It affords the Directors pleasure to have the opportunity of stating what progress has been made with the work, and I am glad to be able to say that the advance has been satisfactory. Out of the 8 miles of tramways 2½ miles are already constructed, and other portions are in course of being constructed, and we understand that there is every probability of the work being completed in the course of July. The contract for the electrical portion of the work is being carried out by the British Houston-Thomson Company, and we are informed that satisfactory preparations are also being made with the view to that work being carried ont expeditiously. There seems to be very little doubt that we shall be well ahead with our work, and we only hope that there will be no delay on the part of the Ashton Corporation in the completion of their part of the work, so that we may have the tramway in full working order in the course of the early autumn. As you are aware, the Ashton Corporation have made an agreement with this Company whereby they supply the electrical energy. I do not know if any gentleman wishes to ask any question or to obtain any information not in his possession which it is in our power to give, but there is no resolution to put before the meeting, and no other business to transact. That therefore concludes the business of the general meeting.

Mr. Alderman THOMAS HEGINBOTHAM, J.P., said he had great pleasure in saying, as the representative of the Ashton Corporation, that the Corporation were doing all they possibly could to get the engines at work. He was afraid, however, that the power would be a little behind time—that they would be ready before the Corporation was quite ready with their power.

A vote of thanks to the chairman terminated the proceedings.

Indo-European Telegraph Company (Limited).

The Directors' report for 1897 announces that the Company's revenue from all sources for 1897 amounted to £130,347. 3s. 5d., compared with £123,539. 17s. 11d. for 1896, an increase of £6.807. 5s. 6d. The expenses were: on commercial and general account £36.765. 11s. 5d., on maintenance account (expenses and charges) £32.613. 2s., total £69,378. 13s. 5d., against £68,105. 10s. for 1896, an increase of £1,273. 3s. 5d. Deducting these expenses, taking credit for £7,704. 3s. 2d. brought over from 1896, and debiting income tax, there remains the sum of £66,573. 4s. 1d. From this amount £15,000 has been placed to reserve, and that sum, together with £10,625, amount of interim dividend, have to be deducted, leaving a balance of £40,948. 4s. 1d.

The Directors now propose the declaration of a dividend for the six months ended Dec. 31 of 17s. 6d. per share, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year, carrying forward £9,073. 4s. 1d. The balance carried forward is rather larger than usual; there are, however, several items involving an increase of expenditure that will have to be provided for in the year 1898.

The lines of the Company continue to work satisfactorily, and the introduction of the Wheatstone automatic apparatus has proved successful; the system is being extended.

Mr. T. W. Andrews has joined the Board.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—This Company was registered on April 1, with a nominal capital of £6.000, in £1 shares (of which 5.000 are Deferred), to carry on the business of an electric light, heat and motive power company, and of electricians, electrical, mechanical and general engineers, suppliers of electricity and manufacturers of and dealers in electrical apparatus. The first subscribers (with one share each) are: R. S. Rose, R. F. Wykeham Martin (electrical engineer), P. H. Drake, A. Scott, D. Hays (electrical engineer), S. N. Powell, and O. S. Phillpotts.

NEW ELECTRICITY SUPPLY SYNDICATE (LIMITED).—This Company was registered on April 2, with a capital of £40,000, in £1 shares, to enter into an agreement with Messrs. A. T. Salisbury-Jones, G. L. Bidwell, and F. W. Salisbury-Jones, and to promote, construct, equip, maintain and manage electrical works and appliances connected with electric lighting.

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The first seven subscribers (each with 100 shares) are: Lord Lurgan, F. B. Jameson, J. Hone, J. Chambré, T. B. C. Harrison, Hon. G. E. H. Trevor, and A. A. Baumann. The first Directors are: Lord Lurgan and Mr. Arthur A. Baumann.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct. 14, 1897). Price of silver 26d. per oz. (April 6). Consols (2¾ per cent.) 110 15/16—111 1/16 for money, 111—111¼ for account; 2½ per cent. 104½—105 (April 6). Stock Exchange Settling Days: Consols, May 5; Stocks and Shares Continuation Days, April 13 and 27; Ticket Days, April 14 and 28; Pay Days, April 15 and 29; Mining Share Carry-over Days, April 12 and 26.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company, after placing £6,000 to the credit of the renewal fund, have declared an interim dividend for the quarter ended March 31 of 15s. per cent. on the Ordinary stock and £1. 10s. per cent. on the Preferred stock, less income tax, payable on 30th inst.

ANGLO-ARGENTINE TRAMWAYS COMPANY.—At the ordinary general meeting of this Company on Monday, the Chairman (Lord R. H. Browne) said that the directors had come to the conclusion that favourable results might be obtained by using electric traction on certain parts of the system. An offer had been made by a body of financiers to find the necessary capital for the conversion of the system, but he was unable at present to enter into details. The syndicate offered to guarantee 4 per cent. on the shares, pending the obtaining of the municipal concession to run the cars by electricity. As soon as the electrical equipment had been completed, the shares would be converted into Five per Cent. Preference.

BIRKDALE AND SOUTHPORT TRAMWAYS COMPANY.—The Directors of this Company have entered into an agreement for the sale of their undertaking to a London syndicate, one probable result of the sale being the introduction of electric traction.

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD COMPANY (LIMITED).—The annual meeting of this Company was recently held at Brighton. The Directors' report stated that the car continued to run satisfactorily, but it was deemed advisable to gain experience by the working of the present car before building another. The Directors had arranged to take the necessary current from the Corporation mains, and this would result in increasing the speed of the car and in obtaining greater power at less cost than at present.

CHADBURN'S (SHIP) TELEGRAPH COMPANY (LIMITED).—Letters of allotment and regret in the recent issue by this Company have been posted.

EASTBOURNE ELECTRIC LIGHTING COMPANY (LIMITED).—The ordinary general meeting of this Company was held at Eastbourne on Monday, the Chairman (Mr. George Boulton) presiding. In moving the adoption of the report (which was given in our issue of the 25th ult.), he congratulated the shareholders on its satisfactory character, and said that the new shares which they asked permission to issue were not preferential as to interest and not as to capital, so that in the case of the winding-up of the Company there would be no preference in payment of the principal. The report and accounts were adopted.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—A list will be found in an advertisement elsewhere of 451 Five per Cent. Australian Government Subsidy Debentures of £100 each in this Company, which were on Monday last drawn for payment at par by Messrs. Barclay and Co., 54, Lombard-street, London, E.C., on 1st July next.

ELECTRICAL STREET CAR MANUFACTURING SYNDICATE (LIMITED).—The statutory meeting of this syndicate was held on Friday at Wolverhampton. The Chairman (Major Flood Page) stated that there was no business to discuss, but he would take the opportunity of making a statement on the Company's prospects. He thought that the speed and success with which those new works and offices had been erected and equipped indicated great energy and skill on the part of those of his colleagues who had directed the work. The amount of money subscribed in cash was a little over £7,000. They only required a good accumulator and good business management. The fact that Mr. Parker was engaged in the undertaking gave it an element of certainty; for chance was, he was sure, placed out of the question by that gentleman's association with the Company. All over the world Mr. Parker was known in connection with electrical engineering, and they could congratulate themselves that, at any rate, so far as electrical engineering was concerned, the undertaking would be a success. He thought that their prospects were excellent. In four or five years there would hardly be a horse-drawn omnibus in the country. The London omnibus companies had incomes amounting to over a million, and that represented the business which the syndicate was waiting for. He thought that the younger shareholders present would live to see the day when that business would attain vast proportions, comparable, even, to that of the London and North-Western Railway Company.

ELEKTRICITATSGESELLSCHAFT FELIX SINGER & CO. A.-G. (BERLIN).—A dividend at the rate of 12½ per cent. for the past year has been declared by this Company.

EVERED AND CO. (LIMITED).—Mr. R. B. Evered presided at the annual meeting of this Company on Thursday last. The Directors' report stated that, after providing for debenture interest, amounting to £2,417, the accounts showed a net profit of £25,147, making, with £7,288 brought forward, £32,453 to be dealt with. An interim dividend at the rate of 7½ per cent. per annum to June 30, 1897, had been paid (absorbing £6,403), and the Directors proposed to pay a dividend at the rate of 7½ per cent. per annum for the remaining six months (which would absorb £6,403); to pay a bonus of 2½ per cent. for the year (taking £4,269); to write £7,017 off various items; to place to an equalisation of dividends account, £2,000; and to carry forward £6,362. There had been an increased amount of business done, which was deemed very satisfactory. Further provision for increased trade had been made in the way of additional buildings at both works. The report was adopted. It was announced that Mr. A. H. Griffiths had resigned his position as Managing Director at Birmingham, and that Mr. R. B. Evered had undertaken the sole manager directorship, with the assistance in Birmingham of Mr. R. G. Evered and in London of Mr. G. J. Evered.

FISH OIL AND GUANO COMPANY (LIMITED).—At a meeting on Tuesday of the shareholders of this Company, presided over by Lord Lurgan, the chairman went very fully into the value of the Company's property in "Volenite," invented by Mr. Lamplough, and which the chairman claimed was equal to gutta-percha and superior to vulcanite, and especially suitable for a large variety of electrical engineering purposes. The Company claim that they have succeeded in making commercial pliable Volenite as well as the hardened material. Several shareholders referred in sanguine terms to the early success of the Company in its manufacture of this substance.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY (LIMITED).—The Directors of this Company, subject to final audit, recommend the payment of a further dividend of 8d. per share, free of income tax, making, with the interim dividend paid in October last, 5 per cent. for the year to Dec. 31.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—The amount of electricity sold by this Company for the quarter ended March 25th is returned at 1,016,642 units, estimated to produce £21,180, against 907,919 units for the corresponding quarter of last year, which produced a net revenue of £19,898. A further reduction in the scale of charges made by the Company came into force on the 1st January, 1898.

SIEMENS AND HALSKE AKTIENGESELLSCHAFT (BERLIN).—The capital of this Company has been increased by 5,000,000 marks (£250,000).

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has ordered the $603,000 additional Five per Cent. Thirty-year Consolidated Mortgage Gold Coupon Bonds of 1926 (Nos. 7,001 to 7,603) of the Milwaukee Electric Railway and Light Company to be quoted in the Official List. The Committee has also been asked to appoint a special settling day in and to grant a quotation to the further issue of 9,157 shares (Nos. 55,842 to 65,000) of £5 each (£2 paid) and also (second application) to allow 12,500 Ordinary shares (Nos. 43,342 to 55,841) of the South London Electric Supply Corporation to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended April 1 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,895.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half-month ended March 31 is £2,309, against £3,151 in the corresponding period of 1897. The November receipts (estimated at £4,154) realised £4,158.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	AGGREGATE. Amount.	AGGREGATE. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Apl. 2	3,508	+321	...	...	...
Bristol Trams & Carriage	„ 1	2,340	+315	13	30,619	+ 4,383
City & South London Ry.	„ 3	1,050	+ 24	14	14,942	+ 124
Dover Tramways	2	117	...	30	3,327	...
Dublin United (Southern)	„ 1	359	- 9	13	5,152	- 362
Liverpool Overhead Rly.	„ 3	1,313	- 10	14	18,756	+ 726
Sheffield Tramways	„ 3	895	+ 13	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price March 30.		Price Tuesday, April 5.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 2.	
			ELECTRIC RAILWAYS AND TRAMWAYS.					£ s. d.		Highest	Lowest
£19,126	£10	3/0	Central London Ordinary	10¼	11	10¼	10⅜	2 15 10	June and December	10⅜	10⅛
143,106	1/9⅜		Do. (6s paid)	6½	6⅝	6½	6⅝	2 13 4	„ „	6⅝	6⅝
£630,000	Stock	1¾%	City and South London Railway Con. Ordy.	66	68	67	69	2 14 4	January and July	69	68
8,419	£10	5%	Do. 5% Perpetual Preference	15	16	15	6	3 2 6	„ „	..	..
£135,701	Stock	4%	Do. 4% Perpetual Debenture	138	140	138	1·0	2 17 2	May and November	138	..
540,000	Stock	3%	Waterloo and City Ordinary	135	138	135	138	2 3 6	June and December	137	..
37,500	10	3⅛%	Liverpool Overhead Railway Ordinary	10⅜	10⅝	10 1/16	10 3/16	3 0 2	February & August	-	-
10,000	10	5%	Do. 5% Preference	15⅝	16⅛	15⅝	16⅛	3 1 6	„ „	-	-
125 000	Stock	4%	Do. 4% Debenture	109	111	109	111	3 9 0	January and July	-	-

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 30.		Price Tuesday, April 5.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending April 2. Highest	Lowest
			TELEGRAPHS.								
£923,960	Stock	19/6	Anglo-American	59	62	61	64	4 13 9	Feb., May, Aug., Nov.	60½	58
£3,038,020	Stock	39/0	Do. Preferred	110	111	111½	112½	5 6 8	" "	112	108½
£3,038,020	Stock	5/0	Do. Deferred	12½	13	12⅝	13⅛	— —	—	13¼	12⅝
£137,400	£100	4%	*African Direct Telegraph (Red)	100	104	100	104	3 16 11	January and July	..	..
£25,000	10	..	Amazon Telegraph	7	8	7	8	.. ..	—	..	..
130,000	10	3/0	Brazilian Submarine xd	16½	17½	16½	17	4 2 4	Mar., June, Oct., Dec.	16⅞	16½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	112	116	4 6 2	June and December	..	..
10,000,000	$100	$1⅜	Commercial Cable Capital Stock xd	185	190	185	190	4 4 3	Jan., Apr., July, Oct.	—	—
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock xd	104	106	104	106	3 15 6	" "	106½	105
16,000	10	6/0	Cuba Submarine	6½	7½	6½	7½	9 6 8	February and August	..	—
6,000	10	10%	Do. Preference 10 per Cent.	14½	15½	14½	15½	6 9 0	" "	—	—
12,931	5	2/0	Direct Spanish (fully paid) xd	4	5	4	5	4 8 11	April and October	—	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference xd	10	11	10	11	4 12 10	" "	..	—
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	—	—
60,710	£20	3/0	Direct United States Cable, 1877	10⅝	11¼	10⅝	11¼	5 15 7	Jan., Apr., July, Oct.	11¼	10¹⁵⁄₁₆
£120,000	100	..	Direct West India Cable 4½% Reg. Deb. (red)	99	102	99	102	.. ..	..	100½	..
400,000	£10	2/6	Eastern	17⅜	18¼	17⅜	18¼	3 11 3	Jan., Apr., July, Oct.	18⅝	17⅜
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18½	19½	18½	19½	3 1 6	" "	—	—
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	128	131	128	131	3 2 0	May and November	130	..
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	—	..
250,000	10	2/6	Eastern Extension	18¾	19¼	18⅝	19¼	3 13 8	Jan., Apr., July, Oct.	18¹⁵⁄₁₆	18⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	128	131	128	131	3 1 8	February & August	..	—
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	99	103	100	103	4 17 3	January and July	—	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99	103	99	103	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 16 2	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	107%	110%	107%	110%	3 13 9	May and November	—	—
180,227	10	1/9	Globe Telegraph and Trust	11¾	12¼	11¾	12¼	3 17 7	Jan., Apr., July, Oct.	..	—
180,042	10	6%	Do. 6 per Cent. Preference	17½	18	17½	18	3 6 8	" "	..	—
150,000	10	5/0	Great Northern of Copenhagen	29⅛	30½	29½	30½	3 5 7	January, April, July	29¾	—
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	100	103	100	103	4 17 1	March & September	..	—
97,000	100	..	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	95	100	95	100	..	June and December	..	—
17,000	25	12/6	Indo-European	52	55	52	55	4 10 11	May and November	..	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	106	109	106	109	5 10 11	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105	108	105	108	3 13 5	June and December	..	—
11,839	8	4/0	Reuter's	8	9	8	9	4 8 11	April and October	8	—
3,381	£100 Cert.	6%	Submarine Cables Trust	140	145	140	145	4 4 3	" "	..	—
15,609	10	6/0	West African Telegraph	3½	4½	3½	4½	.. ..	..	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	5 8 5	March & September	—	—
30,000	10	..	West Coast of America	½	¾	½	¾	.. ..	..	..	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	108	105	108	3 14 9	June and December	105	—
88,321	10	1/0	West India and Panama	½	¾	½	¾	— —	May and November	..	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7⅜	8	7⅜	8	7 10 0	"	7⅜	7⅜
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 2	January and July	108	106
64,256	15	3/0	Western and Brazilian	12	13½	12	12⅝	2 8 0	May and November	12⅝	11⅝
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7⅜	8¼	7⅜	8¼	3 12 9	" "	..	..
33,129	7½	1/6	Do. Deferred Ordinary	4½	5	4½	5	.. ..	" "	4⅝	4¹⁵⁄₁₆
£382,230	..	4%	Do. 4 per Cent. Debenture Stock	106	109	106	109	3 13 9	June and December	107	—
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	..	—
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chill Telephone (fully paid)	3	3½	3	3½	5 14 4	August	—	—
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	2 1/16	2 3/16	.. ..	July	..	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	..	—
484,597	5	3/0	National	6	6½	5½	6	5 0 0	February & August	6⅝	5⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	—	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	15	17	15	17	3 10 7	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	5½	6	5½	6	4 3 4	" "	5⅛	5⅛
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	102	107	100	105	3 7 2	June and December	104	..
171,504	1	0/4	Oriental	3/8	¼	3/8	¼	6 13 4	April and October	..	—
58,000	5	5/0	United River Plate	4	4½	4	4½	5 11 1	July	—	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105	108	105	108	4 13 6	June and December	107½	—
			ELECTRICITY SUPPLY COMPANIES.								
£200,000	5	4½%	Birmingham Electric Supply (fully paid)	10⅛	10⅜	10⅜		—	March	..	..
50,000	£10	20/0	City of London Electric Lighting (fully paid)	25½	26½	25	27	3 14 1	February & August	27⅛	25⅝
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17½	18½	17½	18½	3 4 10	January and July	17⅝	17½
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	..	—
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	13½	14½	13½	14½	2 8 6	February & August	13⅝	—
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	..	—
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	—	— —	January and July	—	—
£26,000	5	3/6	Chelsea Electricity Supply Ordinary xd	10½	10⅝	10½	10⅝	3 9 9	March	10⅝	10⅝
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	115	117	115	117	3 17 5	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	14⅜	15¼	14⅜	15½	.. ..	..	15½	14⅝
20,000	£10	6%	Do. 6% Cumulative Preference xd	15½	16	15½	16	3 15 0	March & September	..	..
10,000	£5	4/0	House-to-House Electric Lighting Supply Ord. xd	10⅜	11½	10½	11½	1 14 9	..	11½	11½
10,000	£5	3/6	Do. 7 per Cent. Preference xd	11½	12	11⅝	12	2 18 4	March & September	11⅞	11⅝
111,000	£5	..	London Electric Supply Ordinary	3½	4¼	3⅝	4¼	..	—	..	..
48,050	£5	..	Do. Preference	6½	7	6½	7	..	—	..	—
49,900	10	7/0	Metropolitan Electric Supply Ordinary xd	20	21	20	21	2 17 2	April and October	21	20½
12,500	10	6/0	Do. issued at 2 prem. (fully paid) xd	20	21	20	21	2 17 2	" "	..	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	—	—
6,452	16	12/0	Notting Hill Electric Ordinary	19½	20½	20	21	2 17 2	March	20⅝	—
275,000	1		Rand Electric	1 7/8	1 9/8	1 7/8	1 9/8			—	—
£125,000	Stock	5%	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90	96	90	95	5 6 6	..	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares xd	145	147	143	146	5 10 4	..	—	—
154,000	100	4½%	* Do. 4½% 1st Mort. Debs. xd	105	107	103	105	4 5 9	April and October	..	—
31,980	5	11/0	St. James and Pall Mall Electric Ordinary	18	19	18	19	3 16 4	February & August	18⅝	18½
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	—	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	107	110	107	110	3 13 1	June and December	..	..
67,900	5	8/0	Westminster Electric Supply (fully paid)	17	18	17	18	3 6 8	March & September	17⅝	17
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	5%	Brush Electrical Engineering	1¾	2	1¾	2	—	—	1¾	..
90,000	2	1/2⅞	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0		2¼	..
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110	114	110	114	3 18 11	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 3 2	June and December	—	—
10,000	£10	..	British Aluminium Ordinary	—	—	—	—	— —	—	—	—
20,000	10	..	Do 7% Cumulative Preference	..	..	..	..	.. ..	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	9	10	9	10	5 0 0	June and December	—	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	110	113	110	113	4 0 0	" "	..	—
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1	1½	1	1½			—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1⅞	2¼	1⅞	2⅛			..	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	86	90	86	91	5 12 4	January and July	..	..
99,261	5	1/6	Edison and Swan United ("A" Shares) (£3 paid)	2½	2⅝	2½	2¾	6 0 3	February & August	2⅝	2½
17,139	5	2/6	Do. (£5 paid)	4½	5	4	5	5 10 0	" "	..	—
£200,000	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.)	103	105	103	105	3 16 2	June and December	—	—
110,000	£2	1/1½	Electric Construction Co. (Limited)	2⅜	2⅝	2⅜	2⅝	3 13 1	February & August	2 1/16	—
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3⅜	3⅝	3½	3⅝	4 3 4	August	..	..
91,196	1	10/0	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝			..	—
12,500	10	18/0	Henley's Telegraph Works Ordinary	22	23	22	23	5 4 4	February & August	..	..
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	19⅝	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 3	" "	112	—
50,000	£10	15/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21	22	4 10 11	" "	21⅞	21½
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	..	..
87,350	15	24/0	Telegraph Construction and Maintenance	35	38	35	38	4 12 4	March and July	36¾	35
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July	..	..
£22,500	£5	3/6	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	..	..
£22,500	£5	3/0	Do. 6% Cumulative Preference	7	⅞	7	7½	4 0 0	" "	7½	..
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	107	109	107	109	3 19 0	May and November	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

IN respect of the pending inquiry into the law of electric generating stations by a Joint Committee of the Houses of Parliament, the Electrical and Allied Trades Section of the London Chamber of Commerce recently held a meeting to discuss the situation presented by the creation of this Committee. After considerable discussion resolutions were passed supporting "the principle of the reference to the Joint Committee," and advocating "that the various municipalities and companies interested in electric lighting be asked to support the principles contained in the reference to the Joint Committee." It was also resolved to appoint a Committee of the Chamber of Commerce to take such action as may be deemed advisable. Our readers have already been informed that the next sitting of the Joint Committee is fixed for the 21st inst., when Sir COURTENAY BOYLE will give evidence. The main propositions referred to the Joint Committee relate: (1) to the granting of power for acquiring land compulsorily for generating stations; (2) to restrictions as to nuisance; (3) to the granting of power to break up streets connecting a station with the area of supply; and (4) to projects for electrical supply on such an extensive scale as to involve areas controlled by several local authorities. This last named matter concerns such schemes as that of the Midland Electric Corporation for Power Distribution (Limited), and upon the recommendations of the Joint Committee in respect of this section of its inquiry will largely depend the future possibilities of an important, but hitherto undeveloped, class of electrical undertaking, affecting in a degree impossible to estimate at present the industrial welfare of the extensive manufacturing districts of this country.

A propos of schemes for the distribution of electric power over extensive industrial areas, it is interesting to note that there is a project now under consideration for the erection of a large central power station at the Hänichen coalfields, near Dresden, from which station it is proposed to supply the entire kingdom of Saxony with current for factory and tramway purposes as well as for illumination. No less than 168 towns and villages are comprised within the scheme.

THERMODYNAMICS, like many other theoretical aspects of physical science, have too often been a butt for the jeers of rule-of-thumb "practical" men, but it is the unkindest cut of all when these men claim that an economy in steam generation is possible, which—so they allege—thermodynamics deny. At the meeting of the Institution of Naval Architects recently held in London, Mr. MACFARLANE GRAY, whose contributions to thermodynamics have been of immense value to applied science, pointed out that a considerable economy of heat may be effected in steam raising by the simple process of heating boiler feed-water by live steam from the same boiler as that into which it is fed. This apparently paradoxical result is well-known in steam practice, and, indeed, has been made use of for many years past. As our contemporary the *Engineer* justly observes, it was first discovered by Mr. KIRKALDY, and is the basic principle of the widely used feed-heater bearing his name; though it is only fair to say that the discovery of this principle by Mr. KIRKALDY was accidental and quite unlooked-for.

ABUNDANT testimony that this principle is no myth is afforded by practical results obtained with live-steam feed-heaters, yet it has often been erroneously asserted that an economy of heat in this manner is theoretically impossible. Mr. MACFARLANE GRAY hazards the opinion that the improvement in economy may arise from the increased mobility of the water when raised to a higher temperature, this producing better circulation in the boiler; and our contemporary adds that the greater adhesion of hot water to the plates, as compared with cold, may improve the effective value of the heating surface. Both these explanations are of a practical rather than of an abstract scientific nature, and, while they may operate to a considerable extent in practice, they do not go to the root of the matter. In our opinion a considerable part of the improvement in economy arises from a reduction in the thermodynamically wasteful sudden drop in

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temperature between the furnace and the water in the boiler. To be thermodynamically perfect the passage of heat through the boiler plates should take place absolutely without any fall in temperature, a condition impossible of realisation; and perfection is approximated to precisely in proportion as the water is brought nearer to the temperature of the furnace. The turning of a small amount of live steam into the boiler feed-water, while it results in no direct loss or gain in the total quantity of heat, has this useful result, that it increases the thermodynamic availability of that heat —*i.e.*, it raises the efficiency.

The Vienna correspondent of *The Times* states that a new application of Röntgen rays for curative purposes has been successfully made by Dr. Schiff, and was described by him at a recent meeting of the Imperial and Royal Medical Society, at Vienna. It is alleged that a series of experiments conducted by Dr. Schiff have proved that these rays can be used for the cure of disease in a manner capable of perfect control by means of a more or less intense application for a longer or shorter period, producing reaction in the exact degree required. In this way it has been possible to remove hair from parts of the body where it constituted a disfigurement without causing the slightest inflammation, while, on the other hand, to treat lupus with uniform success by means of an artificial inflammation, the intensity of which Dr. Schiff was able to increase or reduce at will. The results secured by the new method, both in the removal of superfluous hair and the treatment of lupus, were demonstrated, it is said, in the persons of some of Dr. Schiff's patients. The promptness with which exposure to these rays has nearly always removed hair from parts of the body where it does *not* constitute a disfigurement supports the assertion so far as mere depilation goes; but the *sequelæ* have so frequently included dangerous cutaneous inflammation, that we are loth to believe the process has any practical value. As regards the application of the rays for the cure of lupus, or kindred forms of skin disease, these same *sequelæ* have hitherto rendered unavailable any curative action the rays may possess. Not until the evidence in favour of the safe application of Röntgen rays to curative purposes has been greatly strengthened by accumulation from many sources will the medical faculty be justified in adopting it in regular practice.

Following a national custom, American electrical associations are persistently advocating standardisation. The standardisation of lamp-holders, which has effected itself automatically in this country, is regarded as being necessary on the other side of the Atlantic; but the movement for its adoption appears to have met with as little success as that for the standardisation of fuses or of electrical apparatus generally. The Chicago Electrical Association has made a new move in issuing a list of some 50 or 60 "standard conventional diagrams" for various apparatus, &c., from a battery to a motor generator, and from a jointed wire to a differential relay; and, judging by the favourable comments from the American electrical press, the effort seems to have met with considerable favour in that country. While not so fantastic as the diagrams and symbols issued by a German society a short time ago, some of these are also unnecessarily elaborate. A great many have already been "standardised" by long continued use, but it would be a pity if the others proposed were adopted. For instance, why should a new symbol for an inductive resistance or for a storage battery be introduced, or why should we revert to the now obsolete shaded earth or "ground" in place of the conventional arrow-head? There is no difficulty in understanding those symbols, already referred to, which have become generally recognised; and, where other apparatus is shown in a diagram, we have seldom found it hard to trace the draughtsman's meaning, for it must be remembered that he has, in addition to conventional symbols, numerous different types of reference-letters at his disposal.

The Murder of Mr. Graves.—A Reuter's telegram says that it is announced from Hintorzola, on the Rabu River, that one of the murderers of Mr. Graves has been captured and that another has been killed.

Erratum.—In Mr. Jehl's article on "Carbons for Electric Lighting and Other Purposes," p. 797, col. 2, line 17, *for* "sharpers" *read* "sharper." Mr. Jehl, we are sure, had no intention to libel United States officials.

Memorial to Werner von Siemens.—The Hanover Electrical Society has resolved, on the occasion of their "foundation festival," next month, to erect a memorial tablet to Werner von Siemens, in his birthplace, Lenthe, near Hanover.

Cable Interruptions.—

	Date of Interruption.
Bissao—Bolama	April 12, 1898
Sierra Leone—Accra	April 9, 1898
Latakia—Cyprus	Feb. 10, 1898
Saïgon—Hong Kong	Feb. 28, 1898
Cayenne—Pinheiro	Mar. 24, 1898
Capetown - Mossamedes	April 14, 1898

Appointment.—The Council of University College, London, have appointed Mr. H. L. Callendar, M.A., F.R.S., late Fellow of Trinity College, Cambridge, and now Professor of Physics in the McGill University, Montreal, to the Quain Chair of Physics in University College, about to be vacated by Prof. Carey Foster.

Patent Expiring.—Herr Richard Grätzel's patent, No. 6,414 of 1884, for "Improvements in Apparatus for the Extraction of Metals from their Haloïd Compounds by means of Electrolysis," will expire to-morrow. The patent refers to a method of insulating the negative electrode from the metallic melting and decomposing vessel.

Annual Meeting of the Verband Deutscher Elektrotechniker.—The annual meeting of the Verband will be held at Frankfort-on-Maine this year, from the 8th to 11th June. Members wishing to read papers are requested to communicate their intention as soon as possible, and to state whether their papers will be illustrated by experiments.

Temperature Coefficients of Meters.—In the *Electrical World* of New York, of March 26th, Prof. W. L. Hooper gives an account of some tests made to verify whether Thomson meters have actually such a high temperature coefficient as that given by Mr. G. W. D. Ricks in his recent B. A. Paper. The four meters tested were selected by Prof. Hooper's representative from the General Electric Company's stock-room, and were forwarded by express on the same day. The meters were all tested between 0°C. and 44°C., and the temperature coefficients varied from −0·00030 to −0·00060, the average coefficient being −0·00048, as compared with Mr. Ricks' −0·0032. Prof. Hooper surmises that the instrument tested by Mr. Ricks must have had a german-silver resistance in series with the armature, instead of one of copper.

Portable Galvanometer for use with Potentiometer and similar Tests.—The Weston Electrical Instrument Company of America have recently placed upon the market a new form of testing galvanometer, made up in exactly the same form as the Weston type of ammeters and voltmeters. In this instrument the moving coil is exceptionally light, and is wound with about 800 ohms resistance. A light pointer is provided,

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and the sensibility of the instrument is such that one volt applied to the terminals through an external resistance of 250,000 ohms gives a deflection on the scale of about one millimetre. The instrument is very handy and portable for resistance measurements and potentiometer work. Messrs. Elliott Brothers (acting as agents for the Weston Company) are stocking these instruments in this country.

A New Type of Mercury Break.—At a recent meeting of the Société Internationale des Electriciens (*see* the *Bulletin* of the Society, March, 1898), M. Janet presented a paper, in which he described a new form of mercury break applicable to switches and cut-outs. The principle is as follows:—A vessel of insulating material is divided by a partition which only reaches a small distance from the bottom. Each of the compartments is partially filled with mercury, the level of which can be raised above the level of the partition by the insertion of plungers. On the removal of the plungers the mercury falls back into the two compartments, the arc being effectually broken as the liquid metal falls below the level of the partition. A number of switches and cut-outs utilising this principle were described, some of which were designed for high pressures.

The Legalisation of Electrical Units in Germany.—We read in the *Elektrotechnische Zeitschrift* that it has taken more than two years to draft the Bill which is to be submitted to the Reichstag for the legalisation of certain electrical units (see *The Electrician* of March 25th). The Bill was drafted by a committee of representatives of the Physikalisch-Technische Reichsanstalt, representatives of the town of Berlin, and nine experts named by the Verband Deutscher Elektrotechniker. Further, a preliminary draft was submitted to the Council of the Verband last year for their opinion, and certain modifications were suggested. Two of these suggestions have not been accepted: the first, that the watt should be included in the list of the units to be legalised in the first clause of the Bill, and the other, that the name for the unit of current should be "ampère" and not "amper."

The Channel Bridge.—Those who have seen the seashore railway between Brighton and Rottingdean will have a lively appreciation of the proposal of the Channel Bridge Company, of Paris, to erect a somewhat similar railway between England and France. The new method proposed for crossing the Channel consists in a railway bridge submerged to a depth of 15 metres below low-water mark, there travelling upon this bridge an immense platform upon wheels or rollers emerging from the surface of the water, the propulsion being electrical. Upon this moving platform trains crossing the channel would be secured, very much as the trains are fastened on the ferry boats between New York and New Jersey. It is claimed that this project, while furnishing a connecting link between British and Continental railway systems, would not interfere with the navigation of the Channel, and, further, would not destroy Great Britain's "splendid isolation."

Fire in a Telephone Exchange.—A serious fire is reported to have taken place in the Zürich Telephone Exchange. The fire was caused by the breakage of a telephone wire after the recent heavy snowfall, the wire falling across the trolley line of the tramway. The first announcement of the accident in the exchange was by a jet of flame shooting out of a spring-jack as the operator was making a connection. The same occurred almost simultaneously at different parts of the switchboard, and in an instant the whole wooden board was on fire, and the operators had barely time to escape. Only one girl was injured, she receiving a shock which threw her to the ground. Although the fire was extinguished in two hours, the whole exchange, which occupies the fourth floor of a building belonging to the Federation, was completely burnt out. Several accidents have recently occurred in Switzerland through telephone wires falling upon traction conductors. In Geneva and in Basle two men were killed from this cause; also near Gersau, on the Vierwaldstätter See, a wood was set on fire by a contact between telephone and trolley wires, and two men who were assisting in extinguishing it received fatal shocks.

The Banquet to M. Gramme.—The banquet to M. Z. Gramme to celebrate his receiving the decoration of Commander of the Ordre Léopold, was held at the Hôtel Métropole, Brussels, on the 27th ult. The Senator, M. Montefiore-Lévi, presided, and among the guests, who numbered 130, were Prince Roland Bonaparte, the Minister M. Nyssens, representing the Belgian Government, the Burgomaster and Aldermen of Brussels, M. Mascart, president of the Organisation Committee, M. A. d'Arsonval, president of the Société Internationale des Electriciens, and M. Hippolyte Fontaine, manager of the Gramme Company. M. Mascart, in an eloquent speech, traced the career of M. Gramme, from his commencement as a simple workman in the tiny Belgian village of Jehay-Bodégnée down to the present day, and presented the great Belgian electrician, in the name of the electricians of the whole world, with a fine gold medal engraved by Chaplain. After the banquet the guests were received by the Town Council in the Hôtel de Ville. Profs. Ayrton and Silvanus Thompson, who had been appointed delegates by the Institution of Electrical Engineers, were unable to reach Brussels on account of the storm, and the illuminated address of congratulation, of which they were to have been the bearers, had to be sent by post. Numerous congratulatory telegrams were received, including two from Lord Kelvin and Mr. W. H. Preece.

New Projected Tramway in Rome.—Our Parisian contemporary, *l'Industrie Electrique* hears that Messrs. Tosi and Medina are proposing to build an electric tramway between Rome and Genzano with a branch in the direction of Roca di Papa. The line will be of normal gauge with Phœnix rails on oak sleepers placed at distances of about 3ft. apart. The steepest gradient will not exceed 9 per cent., and the sharpest curve 92ft. radius. The length of the line will be about 26 miles, divided into three nearly equal sections forming a Y. The generating station is to be at Capanne di Marino at the centre of the Y, and will comprise five Dowson gas engines each of 120 H.P. driving continuous-current dynamos. One of these three sets constitutes a reserve. The station will also supply light to the streets and villas of Castelli Romani. The adoption of gas engines is primarily due to the lack of water. Overhead distribution at 1,200 volts is used with the rails as return. Motor cars are to be used with one or two trailers as required. The speed will vary from 9½ to 18½ miles an hour, and each motor car will carry two 35 H.P. motors.

Gas and Electric Lighting Works Accounts.—Our esteemed contemporary, the *Journal of Gas Lighting*, complains in the following terms of the slur which has been cast on gas company finance by certain critics; and in another page it objects to Mr. Hammond's recent suggestion that gas companies would not care to have to make the full disclosure of their accounts enforced on electric supply concerns by the Board of Trade:—

> In the course of an editorial discussion as to the qualities and prospects of the new 200-volt indandescent electric lamps, which are admitted to be imperfect things in themselves, but calculated to conduce to the perfectibility of central electric lighting stations on the continuous-current system, our usually fair contemporary *Engineering* has indulged in an uncalled-for slur upon gas company finance. It was necessary to argue that electricity distribution at high voltage is good for the consumer in the long run; and in pursuance of this contention it was stated that "in electric lighting every economy is to the advantage of the consumer, for under the system of account-keeping insisted on by the Government every detail of working is revealed, and it is not possible for officials to have the pleasant times which often prevail in gas works." There is a very unwholesome suggestion here which is altogether extraneous to the argument. If the words mean anything, which is doubtful, they must mean nothing else than that the statutory account-keeping of gas undertakings is more lax than that which is imposed on electric lighting undertakings. Where is the justification for this statement? Is not the form of accounts legalised by the Electric Lighting Acts modelled upon earlier gas legislation? So far from the statutory accounts of electric lighting undertakings being exhaustive, our electrical contemporaries who make a point of analysing such accounts have had to complain that the form in which they are published does not give a full statement of the affairs of those undertakings which for any reason do not court publicity. We protest against the insinuation that conductors of gas works have "pleasant times" in the sense of being able to present accounts more favourably "cooked" than is possible in the case of electric lighting undertakings. If gas-making has a financial advantage over electric lighting, this is not the way of it.

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Obituaries.—We regret to announce the sudden death of Mr. Nelson W. Perry, a well-known American technical journalist and electrical engineer. It appears that Mr. Perry had been making some experiments involving the use of a solution of bichromate of potash, and during the night of March 27th last he arose to procure a drink of water, and accidentally drank the solution of bichromate. On discovering the terrible mistake he sent at once for a medical man, but all efforts to prevent a fatal consequence of the poison draught proved futile, and Mr. Perry expired during the night. Mr. Perry was a graduate of Harvard University and of the School of Mines of Columbia College. He was in the mining business for several years, and about 1880 became specially interested in electrical development, with which profession he was associated at the time of his death. He was editor of *Electricity* of New York for several years, and in 1883 was the editorial representative of the *Electrical World* at the Chicago Exposition. He was the author of several Papers read before scientific bodies, and of a book on "Electric Railway Motors." Mr. Perry was 45 years of age, and a widow and three sons survive him.——With great regret we have also to record the death, after a prolonged illness, of Mr. William Thomas Newitt. Mr. Newitt died at Putney, on Good Friday, while on leave from his duties at Madras. He had been intimately connected with the Associated Telegraph Companies since 1868, and was formerly in the service of the Electric and International Company. He joined the Anglo-Mediterranean Telegraph Company in 1868, and on the establishment of the Trans-Indian Companies he was appointed to Hong Kong. After filling various positions in the Eastern Extension Company's service he became general superintendent at Madras, which post he held up to the time of his decease. In Mr. Newitt's death the Eastern Extension Company have lost a hard-working and zealous officer. Mr. Newitt was 49 years of age in January last.

A Monocyclic Power Distribution Plant.—An interesting description of a successful monocyclic plant is given in *The Electrical Engineer* of New York. The station is that of Middletown, Ohio, and it supplies both direct and alternating current, the electrical plant at present consisting of two General Electric 12-pole 150 kilowatt monocyclic generators of 1,040 volts pressure, two 1½ kilowatt exciters, three 50 light Thomson-Houston series arc dynamos, and one G.E. 100 H.P. 500-volt continuous-current generator. The 500-volt machine is used exclusively to furnish direct current to several small motor plants throughout the town; the arc machines operate 112 street arc lamps. The motor load on the station already far exceeds the lighting load, and runs up close to the limit of the capacity of the monocyclic machines. The factory of the Miami Cycle Company, a little over a mile away from the station, takes considerably over 200 H.P. The current is received in the factory in six 40 H.P., one 20 H.P., and two 10 H.P. transformers, reducing the pressure to 115 volts. The motor circuits run from the 40 H.P. transformers, the lighting circuits from the three of smaller capacity, and all the current is measured in a recording wattmeter, connected on the primary circuit. The motor equipment consists in all of 10 G.E. induction motors—three of 20 H.P. in the machine shop, driving 88 machines; one of 10 H.P. in the drill and pattern room, driving 29 machines; another of 10 H.P. driving the machinery in the frame department; three of 30 H.P. in the polishing room, two for the polishers and one for the 48in. exhaust fan; one of 5 H.P. driving two plating dynamos in the plating room, and another of similar capacity operating a number of small machines in the assembling room, as well as a three-ton elevator. The incandescent lights in the factory number 750, of which, during the rush season, almost all are lighted. In addition to the cycle factory the station furnishes power to a tobacco factory, in which two departments are already equipped, each with a G.E. 30 H.P. induction motor. The incandescent lights in the town already wired number 3,800; of these 750 are in the cycle factory, 100 are in the tobacco factory, 650 are in the Opera-house, and 2,300 in other parts of the town. These lamps burn with absolutely no interference from change in the motor load; in fact, the entire motor load may be thrown on or off without in the least affecting the burning of the lamps, the presence of the motor load being usually only determined by reference to the ammeter. The monocyclic machines operate with almost perfect regulation, requiring little or no attention to maintain the constant potential at all times.

An Electric Coal-mining Plant.—The following particulars are taken from an abstract in the *Engineering News* of New York of a report by Messrs. Buck and Belsey, students at Sibley College, Cornell University, on tests made by them on coal-mining plant:—The plant consists of two 100 H.P. return tubular boilers, a 125 H.P. McEwen automatic engine, a 75 kilowatt "independent" generator, an 80 H.P hauling locomotive, a 25 H.P. motor on a "larry," a 15 H.P. chain breast coal-cutting machine, a 3 H.P. enclosed motor and rotary pump, and a 2 H.P. emery grinder and motor. The report referred to above is very full, and includes tests on the boilers and engines, as well as the motor combinations. The coal-cutting machine, made by the Link Belt Company, is geared so that it may feed fast or slow for cutting in soft or hard coal as the case may be. In the test it was geared slow. When the end of a cut is made the feed is reversed and a new set of gears thrown into operation causing the machine to recede out of the cut in about one-fifth of the time it takes to go in. The motor is a bi-polar shunt-wound machine of 15 H.P., armature speed 1,820, and pressure 260 volts. The tests showed that in medium hard coal, to make a cut 4·5in. high, 3·5ft. wide to a depth of 6ft. in 4¼min. required an average of 10·4 E.H.P., while to withdraw out of the cut in one minute required 7·08 E.H.P. Tests of the locomotive gave as the ratio of the dynamometric horse-power to the electrical horse-power at the motor terminals from 42 per cent. to 65 per cent. at a speed of from four to six miles per hour, the maximum draw-bar pull recorded being 5,700lb. The locomotive is a 10-ton 80-H.P. one, and has a single-reduction motor, the axis of the armature lying in the direction of the track; both pairs of driving wheels are geared to it by bevel gears. A shop test of this locomotive, under which 86·7 E.H.P. was delivered to the machine and a speed of 8·56 miles per hour obtained, gave as the total losses 21 H.P., or 24 per cent., of which the gear loss was 5·5 H.P., or 6·4 per cent.; the rolling friction 5·7 H.P., or 6·6 per cent.; and the electrical loss 9·7 H.P., or 11·2 per cent. The measured draw-bar pull was 2,700lb. The average power taken by the rotary pump was 2·04 E.H.P., and the horse-power represented by the work done on the water (including the water friction in the delivery pipes, but not that due to the slip of 30 per cent. in the pump) was 0·5, representing an useful efficiency of 25 per cent.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, April 18th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:40 p.m. Sixth General Meeting in the Lecture Hall of the Sunderland Literary Society, Fawcett-street, Sunderland. Paper to be read: "Cylinder Ratios," by James Andrews.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture I.: "Sources of Commercial India-rubber," by Dr. D. Morris.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Palatine Hotel, Hunt's Bank, Manchester. Paper to be read: "Commercial Forms of Electrical Resistances used for Lighting and Power Purposes," by Ll. B. Atkinson.

TUESDAY, April 19th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be discussed: "The Electricity Supply of London," by A. H. Preece.

THURSDAY, April 21st.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Continuation of Discussion on Mr. Hammond's Paper: "Cost of Generation and Distribution of Electrical Energy."

FRIDAY, April 22nd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Paper to be read: "On a Method of Viewing Newton's Rings," by the Rev. T. C. Porter.

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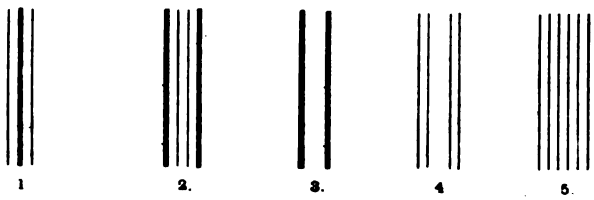
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Details of the Zeeman Effect.—With the aid of an excellent Rowland concave grating mounted in the physical laboratory of the Royal University of Ireland, T. Preston has obtained some capital photographs of the Zeeman phenomenon, which, together with simultaneous eye observations, bring out the complex character of the doublings and triplings of the spectrum lines in a strong magnetic field. The author photographed the spark from an induction coil with terminals of cadmium and zinc, and thus obtained the cadmium and zinc lines simultaneously on the same plate. Viewed along the lines of force the lines all appear doubled, and the photographs show the two constituents clearly separated. When the source is viewed across the lines of force, the lines 4,678 of cadmium and 4,680 of zinc are both converted into triplets, whereas the line 4,722 of zinc and the blue cadmium line 4,800 show as a species of quartets in which most of the light is concentrated in the side lines. Finally, the line 4,811 of zinc shows as a kind of hazy doublet. Other modifications are also observed. They are shown in the diagram. No. 1 is the normal triplet. No. 2 is the weak-middled "quartet," in which nearly all the light is concentrated in the side lines. No. 3 is a doublet in which the centre line has completely disappeared. No. 4 is the double doublet, consisting of two pairs of fine lines. This is produced by the "reversal" of the two lines in No. 3. Finally, No. 5 is a "sextet" of equally spaced fine lines, due to the reversal of each member of the triplet. These five types represent all



the modifications seen across the lines of force; only the simpler ones have been successfully photographed. That the complex modifications are due to reversals may be seen in the case of sodium, where the lines may be watched during successive reversals. The author also obtained the re-solution of some iron lines into triplets, and others into doublets, and observed a distinct broadening of the air lines. He points out that the number of groups of similarly affected lines would determine the number of different kinds of ions in the atom or molecule.

[Preston, *Phil. Mag.*, April, 1898.]

Laws of the Zeeman Effect.—A. A. Michelson, who has for some time studied the Zeeman phenomenon with the aid of his interferometer, lays down some laws which he has verified by observations on a dozen or more lines. According to him, all spectral lines are tripled in a magnetic field. The separation is proportional to the strength of the field. The middle line is itself a symmetrical triplet, the distance between the components being one-fourth of that of the outer lines. The relative intensity of the components varies for different substances and for different lines of the same substance, and accordingly the group may appear as a single line, a doublet, or a triplet. When viewed across the lines of force, through a Nicoll having its plane of polarisation normal to the field, the triplets appear as three distinct types. The first type is Preston's No. 1, the second is Preston's No. 3, with thin lines outside and down the middle, the third is a triplet of nearly equal constituents, with smaller maxima adjoining the central line. The first type is shown by the yellow mercury line and the red lines of cadmium and zinc. The second type is seen in the violet mercury line, the blue lines of cadmium and zinc, and the yellow sodium lines. The third type is exhibited in the green lines of mercury, cadmium and zinc. These relations require further investigation.

[Michelson, *Phil. Mag.*, April, 1898].

Frequency of Alternating Currents.—A novel method of determining the frequency of an alternating current is proposed by C. Kinsley. The apparatus consists of a telephone and an air column of adjustable length, contained in a tube of drawn brass provided with a closely-fitting piston. The telephone receiver is inserted in the alternate-current circuit, and the tube is placed in front of it at a distance of about half the diameter of the tube. The telephone not only gives a note corresponding to the frequency of the alternating current, but also to a number of "harmonics," and for all these notes there will be a reinforcement of sound when the air column attains a certain length. But in any case the frequency of the fundamental is the greatest common divisor of the frequencies of successive harmonics, so that it is easy to discriminate between them. Before arriving at the final result corrections have to be made for temperature and for the diameter of the tube (add 0·41 d to the length). For these corrections tables are given. The author finds drawn brass tubes 4cm. in diameter most durable and convenient. He also finds that the natural period of the diaphragm in every telephone on the market is too high to affect in any sensible way the harmonics due to the alternating current.

[Kinsley, *Phil. Mag.*, April, 1898.]

A New Thermopile.—That the old thermopile has been replaced by the bolometer, the radiometer and the micro-radiometer is ascribed by H. Rubens to its great thermal capacity, which makes its reactions slow and uncertain. The obvious remedy lies in making the elements of thin wires. Since bismuth and antimony do not admit of fine wire-drawing, Rubens suggests the employment of constantane-iron couples, which have only half the E.M.F. of the other combination, but otherwise answer all the requirements. The couples are mounted on an ebonite frame contained in a brass cylinder with slits on both sides and provided with a conical receiving tube. The wires are 0·1mm. thick, and run in a close zig-zag with the odd joints down the centre line and the even joints at the sides, out of the way of the radiation. The wires are soldered to brass pins by means of silver. The thermopile contains 20 joints 1mm. apart, and forms an excellent receiver for spectrum lines. It has an E.M.F. of 0·00106 volts per degree centigrade, and an internal resistance of 3·5 ohms. With a sensitive galvanometer, differences of temperature of one-millionth of a degree may be discovered. It has a far better zero stability than the bolometer, since no perceptible heating of the apparatus walls takes place.

[Rubens, *Zschr. f. Instrumk.*, March, 1898.]

Protection Against Vertical Vibrations.—In cases where apparatus such as liquid mirrors, &c., have to be protected against vertical disturbances, W. H. Julius recommends their suspension by three springs, as much alike as possible. This has the effect of considerably reducing the effect of small impulses. Suppose the points of suspension are suddenly raised about $\frac{1}{20}$cm., and the springs are stretched 10cm. by the load. That means that the springs are further stretched by about $\frac{1}{200}$ of the original extension, and the impulse imparted to the suspended apparatus is only $\frac{1}{2000}$ of its weight. If the disturbance touched it directly the impulse would be at least equal to its weight.

[Julius, *Zschr. f. Instrumk.*, March, 1898.]

The New Generator at Niagara Falls.—On Friday, March 18th, the Niagara Falls Power Company tested the fourth 5,000 H.P. Westinghouse generator placed in their station. The test was a success in every way. This machine brings the capacity of the station up to 20,000 E.H.P., and is the first of the new dynamos to be installed and operated. Additional dynamos of the same design, make and size will be installed in the power house until the total capacity reaches 50,000 H.P.

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A CONTINUOUS RECORDING VOLTMETER.

The accompanying illustration (Fig. 1) shows a form of continuous recording voltmeter which has been devised by Mr. John H. Barker, the electrical engineer to the Cambridge Electric Supply Company, and has been in use for some time in the electric supply station at Cambridge.

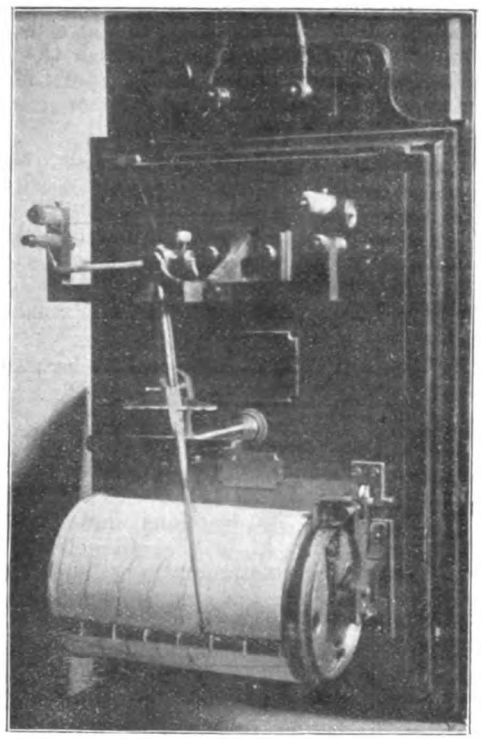

FIG. 1.—Barker's Continuous Recording Voltmeter.

The use of recording voltmeters, as at present made, necessitates for every instrument the filing of 365 charts every year, as well as daily attention and changing of the same. A continuous strip obviates the daily attention, but rather increases the trouble of detaching and keeping the records. To obviate the difficulty, Mr. Barker devised and adapted the instruments already in use to run on the same chart for a week, the principle of moving the drum along its spindle most naturally suggesting itself, and was, as a matter of fact, included in the application for patent. To have adopted this method would have rendered the horizontal length of the instrument too great, and would not admit of the ready adaptation of existing instruments to the continuous movement. By an arrangement of cams, the general principle of which is clearly shown in Fig. 1, the desired end has been attained. A sample of the work done by one of these modified instruments in regular use is reproduced in Fig. 2.

ON MAGNETIC SHIELDING.—V.

BY PROF. H. DU BOIS.

(*Continued from page 654.*)

Permeability Tests.

§ 35. Several samples of transformer sheet were tested by the methods discussed in §§ 17 and 29. The initial value of μ was calculated from the measured shielding ratio by the formula (9*) or (11*). The results are given in the following table :—

—	Centimetres.				—		Ergs per c.cm.	Remarks.
No.	b	d	r	$2\pi R$	g	μ	u	
1	30	0·270	2·285	...	10·8	199	870	6 turns } Same cylinders as described in §30; retabulated for comparison.
2	30	0·180	4·080	...	4·2	160		4 „
3	30	0·225	6·175	...	4·0	177		5 „
7	12	0·045	...	16·3	2·45	170		1 „ ; simple lap joint.
4	7	0·045	...	15·4	1·92	102	1,050	1 „ ; scraped butt joint.
5	8	0·045	...	13·9	2·11	111		1 „ ; simple lap joint.
5A	8	0·045	...	13·9	1·99	100		1 „ ; bevelled joint.
6	12	0·090	...	16·9	2·79	109		2 „ } No. 6 was annealed for
6A	12	0·090	...	16·9	2·89	117		2 „ } 4 days; then marked 6A
8	10	0·039	...	13·0	3·17	234	600	1 „ ; simple lap joint, grain parallel to axis.
9	10	0·039	...	13·0	3·14	231		1 „ ; simple lap joint, grain perpendicular to axis.
10	10	0·039	...	13·0	2·63	176	1,180	1 „ ; simple lap joint.

Cylinders bracketed together in the table were taken from one and the same piece. After testing they were cut up into a bundle of strips fitting Prof. Ewing's hysteresis tester, and tested with the result given under u, in ergs per cubic centimetre (for $\mathbf{B} = 4{,}000$). The results appear to be as consistent as could be expected; with the small cylinders q never happens to very different from the value 2, the value Maxwell would assign to it (see § 17). A comparison of Nos. 4, 5 and 5a shows that the nature of the joint is almost indifferent, so long as it is not too badly made, and an influence of the azimuth of the joint relatively to the impressed field could not be detected. It is of course easiest and answers well to wrap the sheets on a brass tube in one turn and let the ends overlap for about half a centimetre, after roughly removing the black oxide. The joint should be compressed by some simple clamp holding the whole combination together. The

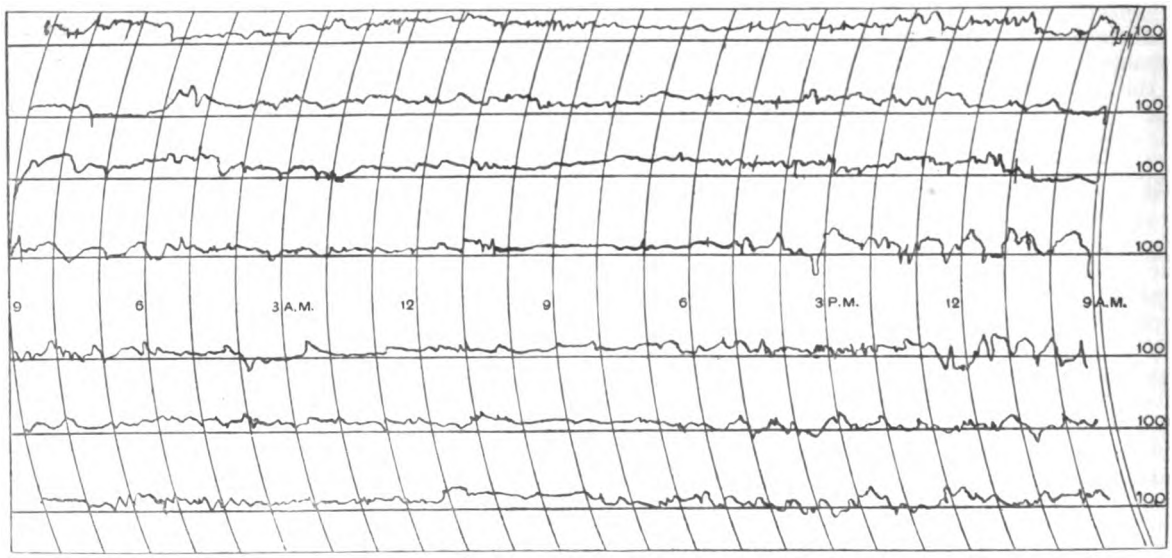

FIG. 2.—Chart of Voltage from end of Feeder for Week ended April 5, 1898, as Recorded by Barker's Hot-Wire Recording Voltmeter.

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cylinders were, with one exception, all wrapped up as they had been rolled in the mill, *i.e.*, the grain was at right angles to the axis, but the tests on No. 8 tend to show that this hardly makes any difference. Some tests were made with cylinders of smaller diameter (3cm.). Too small a diameter is, however, not advisable, as the iron is too much strained by the sharp curvature, and this affects μ.

§ 36. The experience gained from these tests led to the construction of a "shield permeameter," illustrated in Fig. 10, which proved convenient for rapid every-day work, and could also be used as a magneto-meter and tangent galvanometer. The brass tube carrying the shield has an outer diameter of 4·88cm; this makes $r = 2{\cdot}44$cm. With sheets of average thickness ($d = 0{\cdot}03$ to $0{\cdot}05$cm.) the formula (11*) of § 17 is so far simplified as to give

$$\mu - 2 = 10\,\frac{g-1}{2d}.$$

The height of the shield is made 8·0cm., the length 16·0cm., allowing for 0·5cm. overlapping. The specific gravity of iron

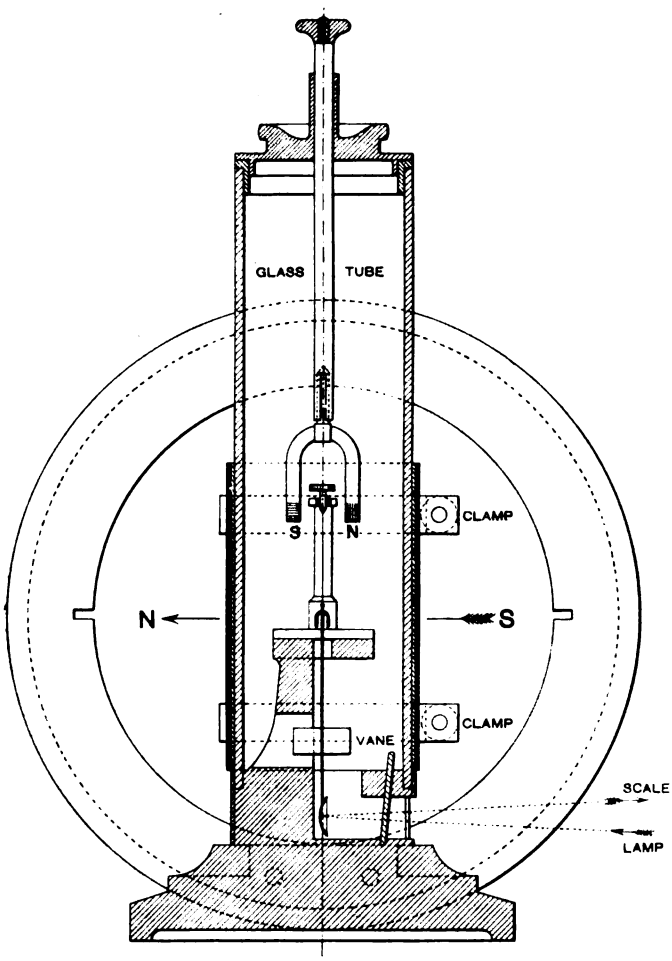

FIG. 10.—Shield-Permeameter. Half actual size.

being 7·80, we have by chance $16{\cdot}0 \times 8{\cdot}0 \times 7{\cdot}80 = 1{,}000$; hence the weight of the sheet in kilogrammes, at once gives its thickness, d, in centimetres.* The directing magnet $\overline{ns}$ is shown, adjustable in height and azimuth. The deflecting field may be that of magnets placed east or west (behind or in front of the plane of Fig. 10) as described in § 29; but it is more convenient to use two symmetrical parallel coils, as in the Gaugain-Helmholtz galvanometer. The mean radius and distance of mean planes of the two coils was made 8·1cm., the number of turns on each was 9. Then the deflecting field—normal to plane of paper—simply comes out equal to the amperes in the coils, and hence the range of constant permeability corresponds to about a deci-ampere. The field of the two coils is approximately uniform within the extent of the shield.*

It remains to be seen whether such a permeameter may be used beyond the initial stage; if a stronger field than, say 0·1, be applied, the shielding ratio increases and a certain higher mean value for the permeability may be calculated by assuming the formula still to hold. The difficulty is to properly assign the corresponding mean value of the true magnetising force, which is less than the impressed, and greater than the shielded field, though probably nearer the latter.

In the above table the test-pieces 8 and 9 show the highest initial permeability and least hysteresis, and are certainly the best. It would, no doubt, be possible to improve the initial permeability if metallurgists were to turn their attention to this particular magnetic quality, about which but little is known at present.† Dr. D. K. Morris has lately investigated it, especially in its relation to temperature. By very carefully annealing transformer sheet at 1,150°C., he has been able to improve the initial permeability at ordinary temperatures in one case from 178 up to 450! But the most startling result is that at 750°C., just below the critical temperature of iron, the permeability shows enormously large initial values, the highest observed being 12,660 (susceptibility 1,000). Hence, the shielding of the cylinders in the above table ought to increase almost hundredfold at a low red heat, so as to afford practically perfect protection. In exceptional cases this remarkable property might, perhaps, be turned to account. Ordinary annealing, beyond that which the commercial material has already undergone, does not much improve it, as may be seen from a comparison of Nos. 6 and 6A in the table.

Applications of Shielding.

§ 37. The preceding theoretical and experimental discussion demonstrates the special adaptability of the general principle of shielding with alternating layers of very high and very low relative permeability. Bi-lamellar sheaths will afford sufficient protection in almost all practical cases. If three sheaths are adopted it will probably be best to make their relative thickness about equal, and not more than, say, 10 per cent. of mean radius, and to make the relative clear width of the two air-spaces, roughly speaking, some 30 per cent. of their mean radius. The exact conditions of maximum efficiency in each particular case, with or without regard to economy in weight, sufficiently follow from the above investigation. For the detailed mathematical discussion of spherical multi-lamellars, Prof. Rücker's Paper may be referred to (*see* § 18).

The geometrical question of design being thus settled, the choice of the material has still to be discussed. With regard to the advisability of symmetry in all azimuths, of homogeneity and of moderate cost, welded sheaths of wrought-iron present serious disadvantages (*see* § 28). The most advantageous combination has to be sought of the following qualities in order of importance:—high initial permeability, low retentivity, homogeneity, high electric resistivity, small magnetic time-lag, and cheapness. A sufficiently fierce struggle against disturbance might lead to the evolution and survival of a material specially excelling in these properties. As yet, transformer sheet, iron wire, or some kind of modern non-porous casting will be best to use, according to the particular circumstances to be dealt with; it would lead too far to discuss all the *pros* and *cons* of each material, the more so as little is known about some of the qualities referred to. If one of the sheaths shows a higher permeability through being subject to a field beyond the initial range, its thickness ought to be increased at the expense of the other less permeable shells (Rücker, *loc. cit.* p. 128).

§ 38. We have as yet exclusively dealt with shielding against *constant* impressed forces. But in practice, disturbances often vary more or less rapidly. Experience with solid iron-clad galvanometers, perfectly compensated for shielding against

* It is well to subtract from 5 to 7 per cent. of the weight, as an allowance for the black coating of oxide; on removing this with carborundum, no difference was found in permeability or hysteresis.

* *See* Maxwell, "Electricity and Magnetism," Vol. II, §713, and plate xix. The coefficient G_1 is given with sufficient approximation by

$$G_1 = \frac{16\pi \times 2 \times 9}{10 \times 5\sqrt{5} \times 8{\cdot}1} = 1.$$

† *See* Holborn, *Berichte Akadem.*, Berlin, February, 1897, p. 95; and D. K. Morris, *Dissert., University of Zürich*, 1897. Also *Phil. Mag.* (5), Vol. XLIV., p. 213 (1897).

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constant impressed forces, seems to show an occasional inadequacy in the case of disturbances varying at a quick rate; the spot then shows a small "kick," though soon reverting to its steady position. This can only be due to time-lag or eddy-currents in the shield, or to both; hence some importance was attached to the fourth and fifth quality in the above enumeration. If eddy-currents should prove the principal cause, the material must of course be subdivided. This is the case with coiled wire, and to a certain extent with wrapped sheet. Theoretically, cylindrical shields should then be built up like armatures—*i.e.*, of flat annular stampings; but this would be more costly than wrapping. In "differential shielding" of astatic systems suspended in the axis of cylindrical sheaths (§ 4) the dotted curve of Fig. 9 may be referred to; the magnetic moment of each of the two partial systems should be proportional to the value of g at the place it occupies in order to ensure perfect astatic compensation.

A number of examples of internal shielding were mentioned in § 4. An interesting adaptation of external shielding was described by the Astronomer Royal a few years ago; a 2-kilowatt dynamo in the Greenwich Magnetic Observatory was shielded with a triple sheath of thin iron plate.*

Dynamical Shielding.

§ 39. Let part of an electromagnetic system placed in an external field be subjected to a resultant force tending to produce translational motion in any direction. If now that part be shielded in any way, the impressed field being thereby reduced in the ratio $1/g$, the resultant force is *diminished* in the same ratio. The amount by which it is reduced—*i.e.*, $1-\frac{1}{g}$ times the total value, now acts on the shield in the same direction, whatever be its shape and in whatever way it be applied. If, on the other hand, the iron be so arranged as to shield other regions of space, while in the region occupied by the electromagnetic system the field is strengthened, we have $g<1$, and the resultant force is also *increased*. But the expression $1-\frac{1}{g}$ now becomes negative, and the corresponding part of the resultant force therefore acts on the iron in the opposite direction. This theorem may be proved by the principle of the conservation of energy as applied to a suitable cycle of operations carried out with the electromagnetic system and shield. The fraction of the resultant force thus *transferred* to the shield is, by the above, equal to

$$1-\frac{1}{g}=\frac{g-1}{g}=\frac{(g-1)}{(g-1)+1} \quad . \quad . \quad . \quad . \quad (20)$$

For spherical and cylindrical shields this fraction may be easily calculated by substituting the various expressions given for $(g-1)$; if its value be somewhat considerable, nearly the whole of the resultant force is seen to act on the shield instead of on the enclosed system. The general phenomenon may therefore be appropriately described as "dynamical shielding."

§ 40. In order to carry out direct qualitative and quantitative tests, an oil-damped aluminium frame was fixed to an octofilar suspension about 300cm. long, having one degree of freedom, and thus allowing translational motion in one direction only. To this frame the smaller cylindrical shields described in § 35 could be fixed.

If one end of a round magnet be axially introduced into the vertically-suspended shield we have a slightly unstable magnetic equilibrium, the shield showing a tendency to move off so as to come in contact with the magnet. This is easily overcome by loading the octofilar suspension until sufficient gravitational stability is reached. The sensibility to transverse force is adjusted in the same way. One millimetre of motion of the frame corresponded to a force of between 50 and 200 dynes. If now a uniform field be impressed parallel to the direction of freedom of the shield, the latter at once moves off in the direction of the magnetic force, or in the opposite direction, according to whether the north or south end of the magnet is introduced. A few measurements showed rough agreement with what could be expected from the amount of "free magnetism" shielded off by the cylinder, this quantity being rather difficult to evaluate. More accurate results will be given in the next article relating to "Current Shielding."

The above case is illustrated in Fig. 11; the concentric position of the shield is marked clearly enough; between it and the central pole the lines of force are *almost* exactly radial. With infinitely perfect internal shielding they would

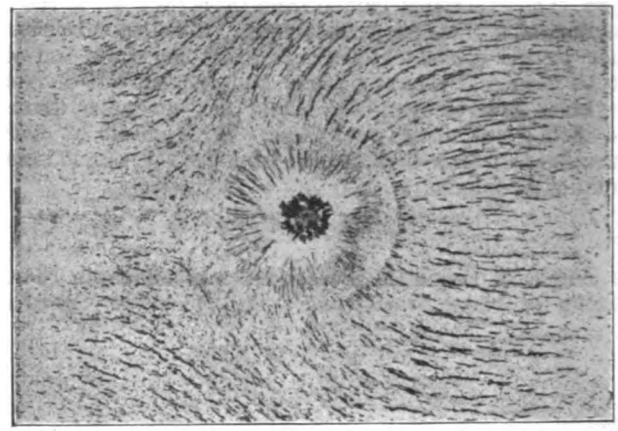

Fig. 11.—Shielded North Pole in Uniform Field.
⟶ H_e.

be so absolutely, corresponding to the case of § 25—linear central source, with no external shielding. Then there would be no resulting stress between the source and the surrounding shield. If the "strength" of the source be denoted by m, the original stress between it and the "bearings" (earth, steel magnet, coil, or otherwise) of the impressed field H_e is equal to mH_e. As the stress cannot, according to modern conceptions, act at a distance *through* the shield it is bound now to act entirely *between* the shield and field-bearings. If there remain any small stress between the shield and source, as in Fig. 11, this is then equal to $mH_e g$; and the resulting force on the shield, is $mH_e(1-1/g)$, as by equation (20). In the diagram the dis-

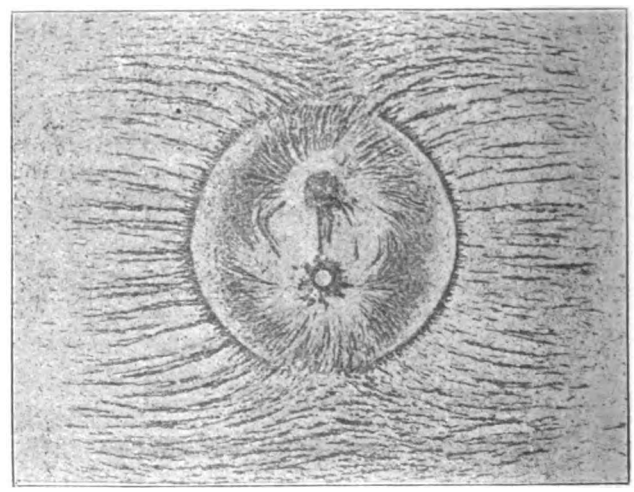

Fig. 12.—Shielded Linear Source and Sink in Uniform Field.
(● North Pole; O South Pole; ⟶ H_e.)

tribution of the external field evidently tends to push and pull the shield from left to right by the well-known "elastic string" property of the lines of force—or, to express it in a more scientific way, by the Maxwellian stress, compounded of hydrostatic pressure and longitudinal tension, and integrated over the outer boundary.

§ 41. If the shielded system consist of sources and sinks of equal aggregate strength (*e.g.*, complete magnets or closed currents as in § 26) there is no tendency to pure translational motion, a uniform impressed field only exerting a torque. To illustrate this let the shielded linear source and sink of Fig. 8, be placed in a uniform field, directed from left to right, as in Fig. 12. The distribution and lines-of-force diagram in the

* For details *see* W. H. M. Christie, *The Electrician*, Vol. XXXI., p. 446.

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unshielded state is well known and corresponds to a clockwise torque on the system equal to $\mathbf{M}_i\mathbf{H}_e$, if $\mathbf{M}_i$ denote its magnetic moment. When shielded this torque is reduced to $1/g$ of the above value. Now suppose the enclosed system to be rigidly fixed with respect to the "bearings" of the impressed field (a suitable electro-magnet was used in the experiments which the diagram reproduces). The shield, on the other hand, is to be free to rotate round its axis by suspension to a torsionless unifilar or by a suitable floating device.

In the actual experiment the shield showed a small *counter-clockwise* rotation when the field was applied; however, this can only be due to the shield's opposite intrinsic polarity, owing to retentiveness. It is a phenomenon of the same order as the drag exerted by a rotating magnet on an iron disc, due to hysteresis (eddy currents being supposed absent). If, however, the shield is absolutely "soft" the distribution cannot depend upon its azimuth, everything being symmetrical all round; in this ideal case therefore the *resulting* torque on it must be zero; for if it were finite it would set the shield into perpetual rotation and heat the liquid floating it. Equal and opposed twisting stresses must therefore arise between the soft cylinder and the enclosed system on the one hand, and the field-bearings on the other hand. The resulting torque on the shield thus vanishes. If, however, the cylinder and its contents be rigidly connected, the compound system will naturally be subject to a torque $\mathbf{M}_i\mathbf{H}_e/g$, and tend to rotate relatively to the impressed field.

§ 42. A qualitative illustration of this is given by a careful inspection of Fig. 12, though naturally the latter is not so easy to interpret as the preceding diagrams. A better insight is obtained by plotting the problem for a thicker shield in red and blue to denote sources and sinks. The dynamical proof of the equality of the external and internal shielding ratios mentioned in § 26 may now be given as follows. Let the bearings of the impressed field be again supposed to be a source and sink at sufficient equal distances from the centre. Denote its magnetic moment by $\mathbf{M}_e$, and the magnetic force at either the outer source or sink due to the central system (this being placed as in Fig. 12, *i.e.*, in Gauss's second position) by $\mathbf{H}_i$. Then the counter-clockwise torque exerted by the central system on the bearings of the impressed field will evidently be equal to $\mathbf{M}_e\mathbf{H}_i$ without shielding. By elementary dynamical principles this must be equal and opposed to the torque $\mathbf{M}_i\mathbf{H}_e$ of the preceding paragraph; hence the equation

$$\mathbf{M}_i\mathbf{H}_e = \mathbf{M}_e\mathbf{H}_i \quad . \quad . \quad . \quad . \quad . \quad (21)$$

is at once reduced to an identity by substituting the proper values for $\mathbf{H}_i$ and $\mathbf{H}_e$. If now the shield be put in place the two torques reduce to

$$\frac{\mathbf{M}_i\mathbf{H}_e}{g}, \text{ and } \frac{\mathbf{M}_e\mathbf{H}_i}{k}, \quad . \quad . \quad . \quad . \quad (22)$$

k again denoting the external shielding ratio of § 26. But equality must still subsist between the two terms of (22), otherwise in the experiments of § 41 the table would be set turning on a frictionless laboratory floor. From (21) and (22) we at once obtain the necessary condition $g = k$, as in (19). This proof is only valid if the outer and enclosed sources and sinks are surrounded by a medium of equal permeability, the same assumption having been made above.

(To be concluded.)

THE COST OF GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY.*

BY ROBERT HAMMOND.

(Concluded from page 790).

SUMMARY.

So far I have, with one exception, considered the question of costs from a past, rather than a future, point of view; but I feel that I should not be doing justice to my subject if I did not devote some space to the consideration of the range of ultimate costs of production and distribution. I have already, under a number of headings, set out what are the most important factors affecting the costs of production and distribution, and I now purpose considering the probable influence of these factors on the further reduction of same.

(a) Output.

In Diagrams I. (*a*) and I. (*b*) I have plotted out the relation of works cost per unit and units sold in the principal works in the kingdom, and I have already drawn attention to the falling costs that accompany increasing outputs.

It will be seen that I have in the tables analysed the fall in all the items that make up the cost of the unit sold. In addition, in order to shed the fullest light on the relation between costs per unit and increasing outputs, I have plotted a series of curves of

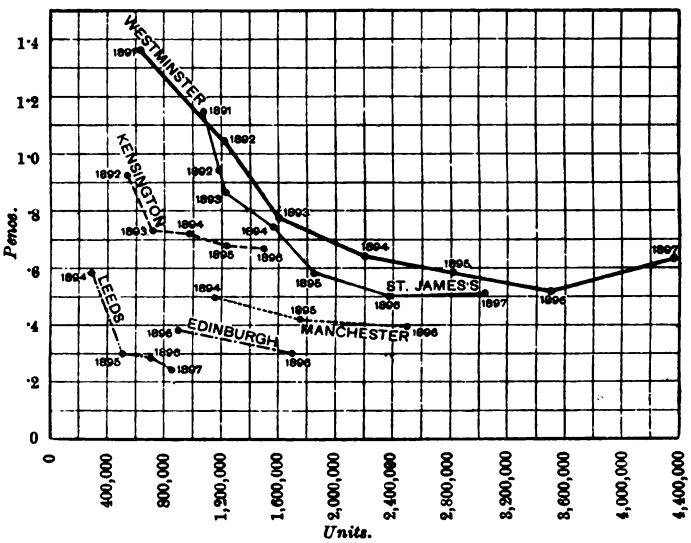

DIAGRAM V. (*a*).—Curves showing relation between Costs per Unit of Coal and other Fuel and Units Sold.

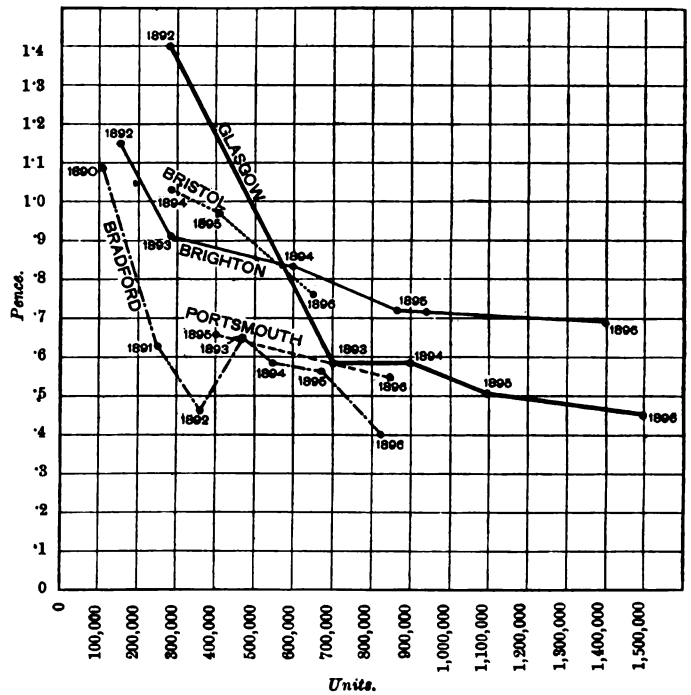

DIAGRAM V. (*b*).—Curves showing relation between Costs per Unit of Coal and other Fuel and Units Sold.

the items—*i.e.*, coals, oil, waste, water and stores, wages, repairs and maintenance—which make up the cost of production and generation in the places referred to on Diagrams I. (*a*) and I. (*b*). *See* Diagrams V. to VIII. I also show the curves of the total costs (Diagram XI.), and to complete the series I give the rent, rates, taxes and management (Diagrams IX. and X.). I have adhered to the same scale as that of the *Works Costs*, except in case of the oil, waste, water and stores, where I have plotted the ordinates to a much larger scale, for the sake of clearly displaying this comparatively small item.

These subsidiary curves set forth some most interesting features, which I will not, however, dwell upon at the moment, as the real

* Abstract of a Paper read before the Institution of Electrical Engineers, March 24, 1898.

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Table showing the Fall in Costs which accompanies Increase in Units Sold.—Per Diagrams I. (a) and I. (b).

Name of works.	Year	Increase over pr'vious year.	Per unit sold. Decrease in coal cost.	Decrease in oil, waste, and stores.	Decrease in wages.	Decrease in repairs and maintenance.	Decrease in works cost.	Decrease in rent, rates and taxes.	Decrease in management expenses.	Decrease in total costs.
			d.	d.	d.	d.	d.	d.	d.	d.
Edinburgh.	1896	833,222	0·07	0·03	0·10	0·09	0·29	0·06	0·19	0·54
Kensington	1893	188,965	0·18	Nil	0·07	0·04	0·29	0·11	Nil	0·40
,,	1894	253,489	0·02	0·05	0·03	0·27	0·37	0·03	0·19	0·59
,,	1895	250,937	0·04	0·01	0·06	0·18	0·29	+0·03	0·03	0·29
,,	1896	285,995	0·01	0·02	0·23	+0·01	0·25	+0·13	+0·21	+0·09
Leeds	1895	222,516	0·28	0·02	0·38	0·03	0·71	0·17	0·18	1·06
,, ...	1896	176,780	0·01	0·09	0·43	+0·03	0·50	+0·05	+0·13	0·32
,, ...	1897	131·871	0·04	0·02	0·03	0·09	0·18	Nil	0·05	0·23
Manchester	1895	597,862	0·08	0·08	0·17	+0·06	0·27	+0·03	0·13	0·37
,,	1896	760,344	0·02	0·04	0·12	0·10	0·28	0·02	0·05	0·35
Westm'ster	1892	590,371	0·33	0·13	0·12	+0·18	0·40	0·20	0·48	1·08
,,	1893	486,744	0·26	0·06	0·50	+0·16	0·66	0·09	0·06	0·81
,,	1894	468,683	0·13	0·06	0·13	0 21	0·53	0·13	0·08	0·74
,,	1895	657,098	0·07	0·02	0·13	0·01	0·23	0·05	0·10	0·38
,,	1896	672,658	0·05	0 02	0·28	0·02	0·27	+0·03	+0·02	0·22
Bradford...	1891	131,454	0·46	0·08	0·80	+0·03	1·31	0·40	0·07	1·64
,, ...	1892	126,050	0·17	0·01	+·18	0·15	0·15	0·05	0·17	0·37
,, ...	1893	115,203	+·20	Nil	0·06	0·17	0·03	0·04	+0·07	Nil
,, ...	1894	74,019	0·03	+0·10	0·35	+0·20	0·13	0·02	+0·12	0·03
,, ..	1895	119,066	0·02	Nil	0·18	0·34	0·54	+0·07	+0·17	0·30
,, ..	1896	139,924	0·16	0·05	0·10	0·14	0·45	+0·04	0·02	0·43
Brighton...	1893	130,785	0·23	0·05	0·08	+0·20	0·16	0·11	0·53	0·80
,, ...	1894	296,806	0·08	+0·06	0·62	+0·10	0·54	+0·04	0·16	0·66
,, ...	1895	283,793	0·11	0·08	+·08	Nil	0·11	+0·08	+0·09	+0·06
,, ...	1896	521,327	0·03	0·05	0·12	0·06	0·26	+0·12	0·18	0·32
Bristol.....	1895	114,778	0·33	0·06	0·26	0·05	0·70	0·32	0·22	1·24
,, ...	1896	242,457	0·21	0·01	0·21	+0·10	0·33	0·24	0·12	0·69
Glasgow ...	1893	414,536	0·81	0·24	0·63	+0·58	1·10	0·05	0·08	1·23
,, ...	1894	199,039	Nil	0·02	0·06	0·25	0·33	+0·19	0·12	0·26
,, ...	1895	189,672	0·08	0·03	0·15	0·36	0·62	0·03	+0·07	0·58
,, ...	1896	406,883	0·06	Nil	0·13	0·11	0·30	0·07	0·15	0·52
Portsm'uth	1896	433,274	0·11	0·01	0·18	+0·10	0·20	0·02	0·13	0·35

+ = increase ; - is omitted.

question is, to what extent increasing outputs will be accompanied by reduction in costs per units sold. It will be seen on reference to Diagram I. (*a*) (works costs) that in the cases of both the St. James' and Westminster works the downward tendency of costs per unit has been checked on outputs respectively of 3,028,242 units and 4,355,781. I may add that the recently-published accounts of the Charing Cross and Strand Company show the same check in reduction of costs. In each case I have made careful inquiries, and I am convinced that the non-reduction of costs is due to exceptional circumstances. In the case of the Westminster Company an important rearrangement of the steam-raising plant has been made during the past year, and it is patent that while carrying on works in the midst of alteration economical production must in many directions be sacrificed. The net result of my investigation is that I feel safe in assuming that the St. James', the Westminster, and the Charing Cross Companies will in the current year all show lower costs than those for 1897, and that in the case of the other London companies whose outputs have not yet reached the amounts of these concerns the downward tendency of costs of production will continue.

(b) Load-Factor.

Practically the whole of the costs set out in this paper are on the basis of the supply of electrical energy for lighting. I have already pointed out that an increase in the load-factor would have a marked influence on costs. The paramount business of the electrical engineer at the present moment is to discover "by-uses" for his plant. In provincial towns and cities, if not in the metropolis, the supply of electrical enery for tramway traction would afford a splendid day-load ; and works that succeeded in reducing their costs on a lighting load to, say, 1·50 per unit (total costs) would probably have the costs reduced to 0·75 by the addition of one million units delivered to the tramway feeders between the hours of 6 a.m. and 10 p.m. Some works engineers, in settling the price to be asked for electrical energy for tramway traction have killed the business by demanding figures based upon the cost per unit for lighting. It must always be borne in mind, in reference to lighting, that under the obligations of the Provisional Order "supply" has to be available constantly over the whole of the 24 hours, which involves the upkeep of a 24-hours' staff for a full-load return of two to three hours. A considerable increase in the load-factor would hardly have any effect on the standing charges, and would by no means increase the coal bill in proportion to the increased output. Works engineers would therefore always be pretty safe if they demanded for a "day load" supply a price that covered their "lighting" works costs. They would get their profit out of the all-round reduction per unit which the day load would cause.

(c) Reliability of Plant.

My further remarks under this head may be brief. Obviously, the weeding out of unreliable plant, and its replacement by solid high-class apparatus, will result in decrease of costs of production.

(d) Engineer Factor.

The gradual improvement of status in the position of electricity works engineers is most encouraging, as it indicates the growing appreciation of the value of excellent management. It is true that

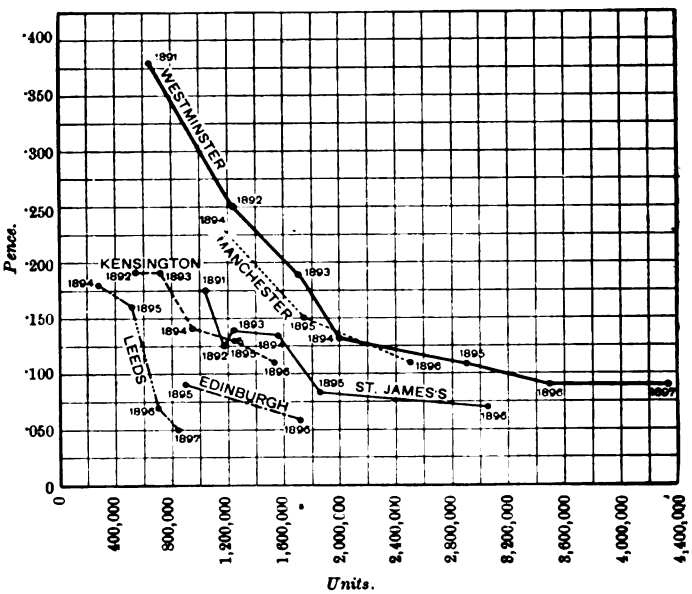

DIAGRAM VI. (*a*).—Curves showing Relation between Costs per Unit of Oil, Waste, Water and Stores, and Units Sold.

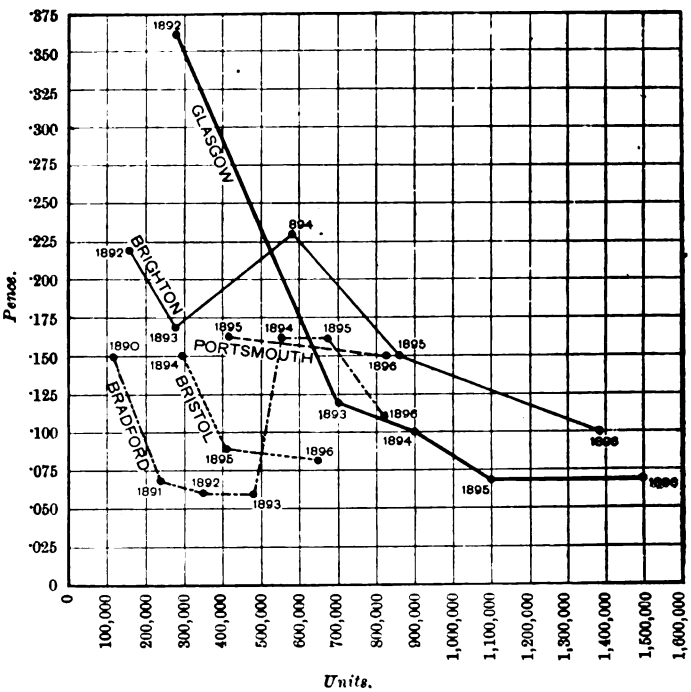

DIAGRAM VI. (*b*).—Curves showing Relation between Costs per Unit of Oil, Waste, Water and Stores, and Units Sold.

the higher salaries paid for greater efficiency will enhance "management" costs per unit ; but this will be much more than counterbalanced by the lower works costs.

(e) Efficiency of Generating Plant.
(f) Efficiency of Distribution.
(g) All-round Efficiency.

Mr. Crompton, in his 1894 "ideal costs," made a forecast, on an output of 5,000,090 units, of a consumption of 2·5lb. per unit sold of Welsh coal of a calorific value of 14,500 B.T.U. per pound ;

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yet we find that no London works has yet succeeded in getting below 6·41b. per unit sold. I must confess that in works operating against the low load-factor presented by a lighting load, even in well-designed works, where the plant is so sub-divided that whatever the load, it is working at its maximum efficiency, there appears from the data before me little chance of the great reduction in the coal bill forecasted by Mr. Crompton. The Westminster works had a consumption of coal in June last of 6·621b. per unit sold; whereas in December, with a much heavier output, the coal only fell to 6·26. The Charing Cross and Strand Company,

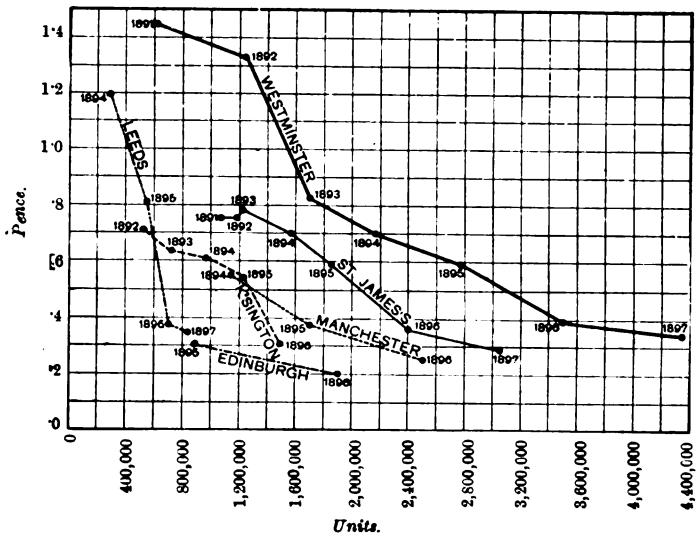

DIAGRAM VII. (*a*).—Curves showing Relation between Wages per Unit and Units Sold.

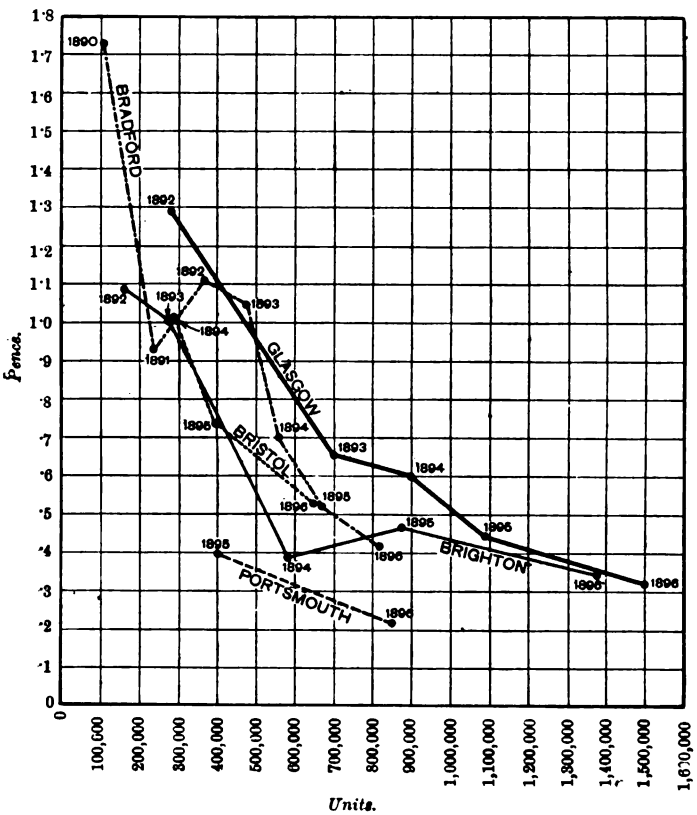

DIAGRAM VII. (*b*).—Curves showing Relation between Wages per Unit and Units Sold.

blessed all the year round with a magnificent evening load, showed a consumption of 8·691b. of coal in June, as compared with 8·76 in December. In alternating works the relation between the June coal and December coal is, of course, much higher, as they have to contend with the fixed factor presented by the magnetising current. There is one direction, however, in which coal economy will in the future be secured, viz., the provision of much larger and more economical plants than those already in use. As long as the day load is limited, smaller engines working at their full output and at their best economy will be required for use during the day, leaving the heavy night load to be coped with by the larger and more economical plant. The principle of an increase in the size of plant has been recognised at Manchester, where 1,500-kilowatt dynamos have been ordered; at the City of London works, where there is a 1,500-kilowatt plant at work; at Deptford, with its three 1,000-kilowatt and one 1,500-kilowatt plants; at Leeds, with its 600-kilowatt plant in course of manufacture.

H.—*Depreciation.*

Before closing my Paper I think it well to devote a few paragraphs to the question of depreciation. No provision is made by the Board of Trade in the "No. III.—Revenue Account" for a debit for depreciation; and wisely so, for that account purports to set forth those sums which have actually been disbursed, whereas "depreciation" is a sum determined upon by the undertakers themselves, and set aside in the form of sinking fund or reserve fund. Accordingly, provision is made for the transfer of the balance of revenue account to "No. IV.—Net Revenue Account," and in this account will be noticed the two items of sinking fund and reserve fund. With regard to the former, the Local Government Board, in the case of the undertakings of local authorities,

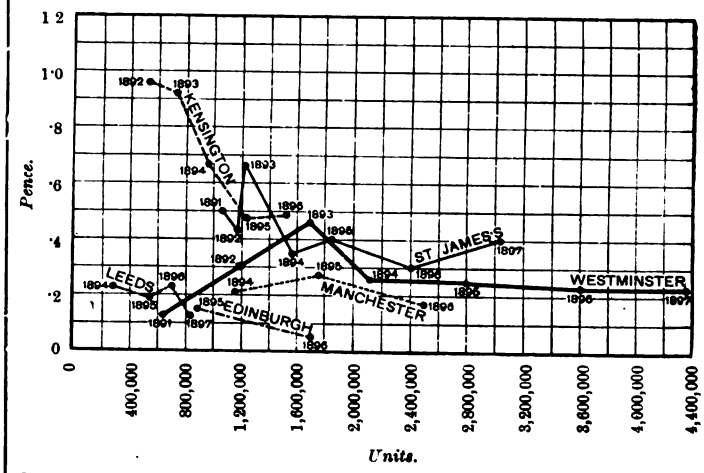

DIAGRAM VIII. (*a*).—Curves showing Relation between Repairs and Maintenance per Unit and Units Sold.

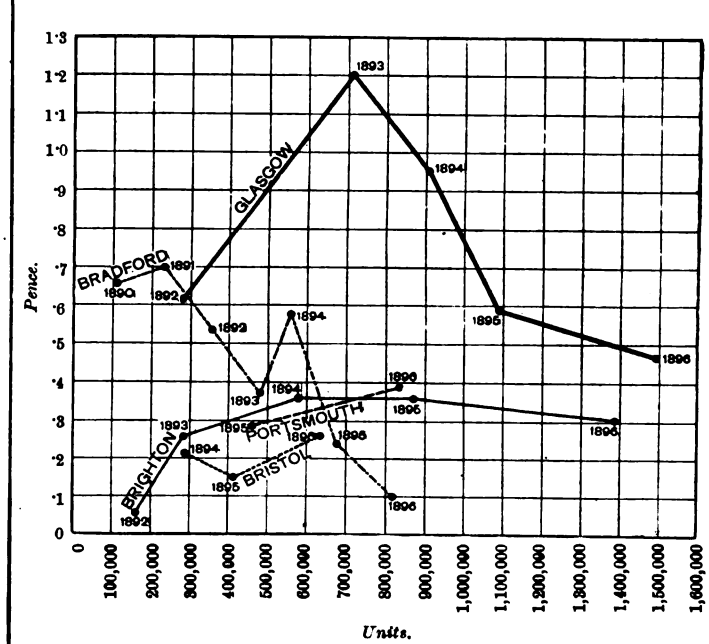

DIAGRAM VIII. (*b*).—Curves showing Relation between Repairs and Maintenance per Unit and Units Sold.

usually fixes 25 years as the limit of time over which the loan to cover the capital expenditure may be repaid; thus imposing an obligation to extinguish the whole cost of the plant by the end of the period named, and necessitating the setting aside annually of almost 3 per cent. upon the amount of the capital expenditure —and in most cases this is considered a sufficiently important contribution towards depreciation. In others, however, a further sum is set aside annually to a reserve fund, which is sanctioned by clause 5, section 52, of the Model Provisional Order. Under that section it is permissible for a local authority to create

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a reserve or depreciation fund in addition to setting aside a certain amount annually to the sinking fund for the amortisation of capital. It will be noted, however, that this reserve fund is limited to 10 per cent. of the capital expenditure. The question arises whether there is any need for a local authority to set aside a sum for depreciation beyond that which is obligatory upon them in the form of sinking fund. It is pointed out on the one hand that it is impossible to run electricity supply works efficiently without maintaining them at a high state of efficiency, which maintenance entails the expenditure of an annual sum out of revenue. On the other hand, as I pointed out at the discussion on Mr. Crompton's Paper

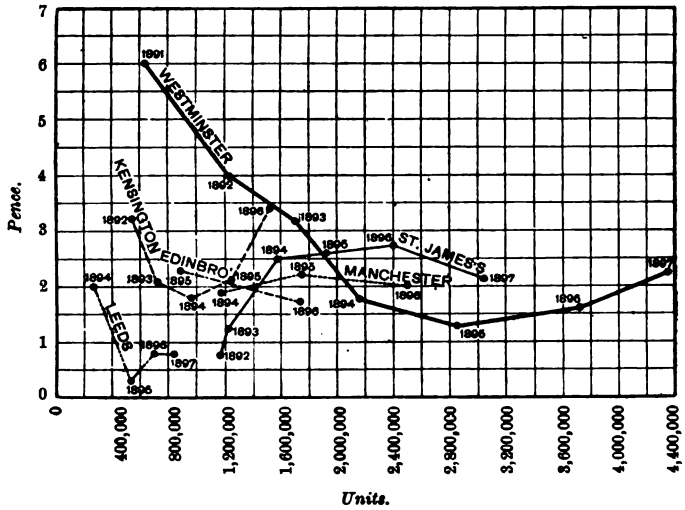

DIAGRAM IX. (*a*).—Curves showing Relation between Rent, Rates and Taxes per Unit and Units Sold.

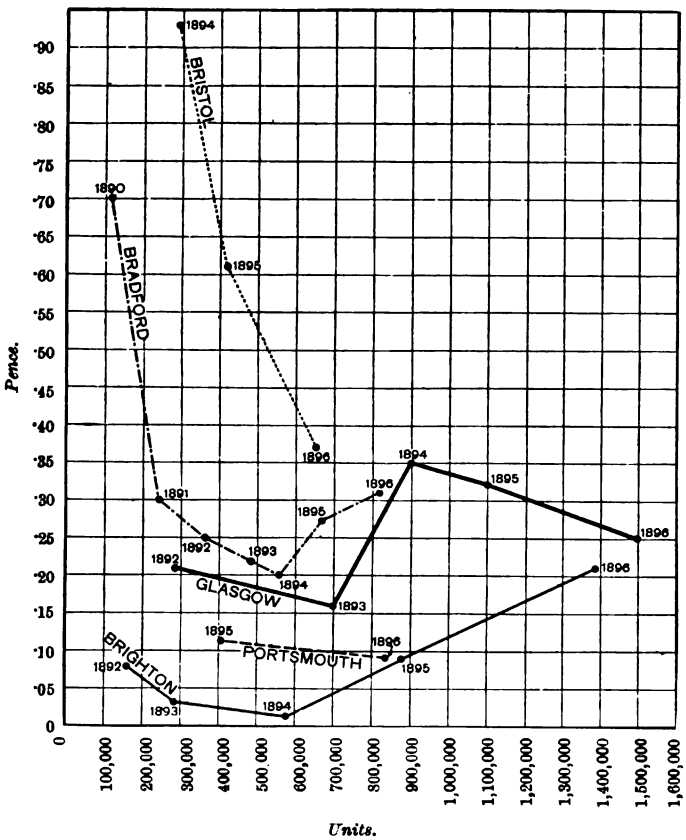

DIAGRAM IX. (*b*).—Curves showing Relation between Rents, Rates and Taxes per Unit and Units Sold.

in 1894, plant tends to become antiquated, and if the sinking fund were deemed sufficient to cover depreciation it might be urged that a further sum should be put aside to cover *antiquation*.

The whole question turns upon the point whether an annual allowance of about 3 per cent. all round upon the capital expenditure is sufficient to provide for depreciation and antiquation. Most local authorities deem the sinking fund of about this amount sufficient for all purposes, with which view I concur; but Glasgow, for instance, makes deductions, on the following bases :—

	Per cent.
Land and buildings	1
Machinery and Plant	7½
Accumulators	10
Mains and cables	2½
Meters	7½
Electrical instruments	5
Furniture	5

The aggregate of the amounts so deducted for 1896 equals 6-36 per cent. upon the average capital for that year.

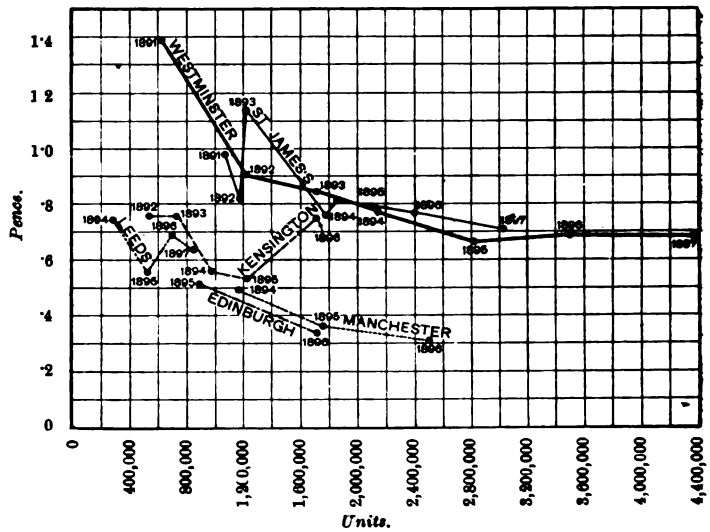

DIAGRAM X. (*a*).—Curves showing Relation between Management Expenses per Unit and Units Sold.

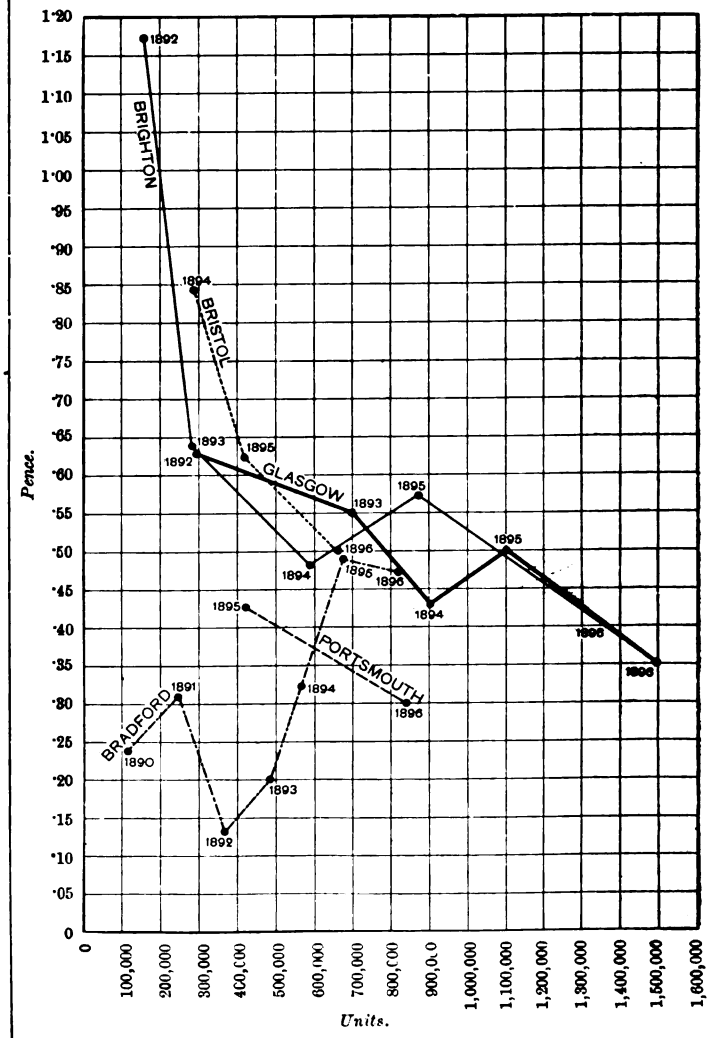

DIAGRAM X. (*b*).—Curves showing Relation between Management Expenses per Unit and Units Sold.

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Aberdeen adopts the following bases :—

	Per cent.
Buildings	1
Machinery	5
Mains and services	1½
Electrical instruments	2½
Meters	5

which upon the average capital gave in 1896 an all-round percentage of 2·60 per cent. In addition to the sinking fund, Bradford set aside in 1896 for depreciation the sum of £3,060, which upon the average capital was equal to 3·46 per cent. Several other local authorities, too, provide annually a sum for depreciation.

Companies, who are not burdened with an obligatory sinking fund for the redemption of their capital, pay less attention to this item, and are contented in setting aside either for reserve or depreciation much less sums than those set aside by local authorities. On the whole, I am of the opinion that companies do not debit their net revenue account with a sufficient item under this head, and I venture to suggest that they would put their concerns into a sounder position if, before distributing dividend, they set aside annually to a reserve or depreciation fund at least 3 per cent. upon their capital expenditure. The only companies that set aside this percentage in 1896-97 are given in the table at the top of next column.

Taking Westminster as a basis, the setting aside of 3 per cent. for depreciation and reserve would have entailed a charge of 0·85d. per unit sold, so enhancing the cost from 2·19d. per unit to 3 04d. per unit. A charge of 0·85d. per unit is indeed a heavy one, and if it were compulsory to add it to each unit sold it would render the price to the consumer prohibitive for power purposes. The increase of the load-factor in any works, through the introduction of a demand for "power," would greatly reduce the "depreciation charge" per unit sold. Thus, taking a case where the depreciation charge worked out 1·00d. per unit on a load-factor of 12 50 per cent. and "units sold" of 1,000,000 units, the effect of doubling the load-factor and the units sold would be to divide the "depreciation charge" per unit thus :—

Units sold.	Load-factor.	Depreciation charge per unit.
	Per cent.	d.
1,000,000	12·50	1·00
2,000,000	25·00	0·50
3,000,000	37·50	0·33
4,000,000	50·00	0·25

Amounts Allowed for Depreciation by some Companies.

Name of place.	Year.	Amount set aside for depreciation and reserve.	Percentage to average capital outlay during the year.
Norwich	1896	£2,500	4·18d.
Leeds	1897	5,439	4·08d.
House-to-House	1896	4,704	3·96d.
St. James'	1897	9,656	3·89d.
Sheffield	1896	2,794	3·59d.
Kensington	1896	7,388	3·38d.
Westminster	1897	15,415	2·96d.

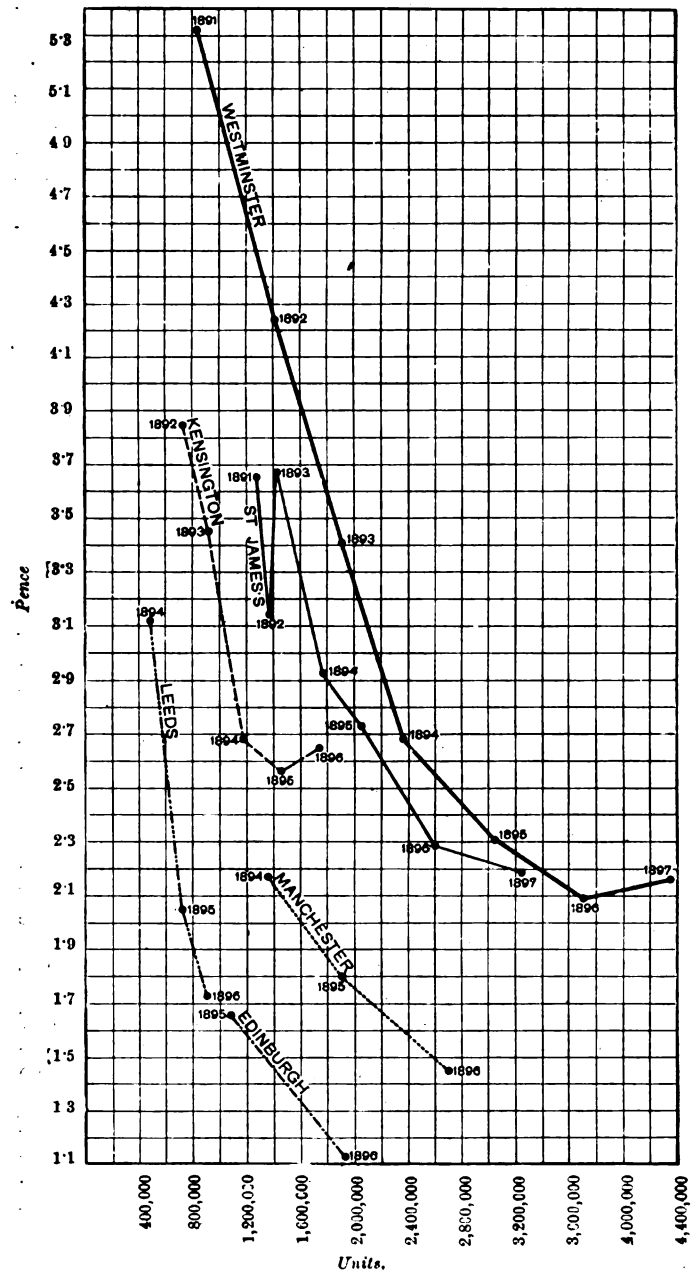

DIAGRAM XI. (*a*).—Curves showing relation between Total Works Costs per Unit and Units Sold.

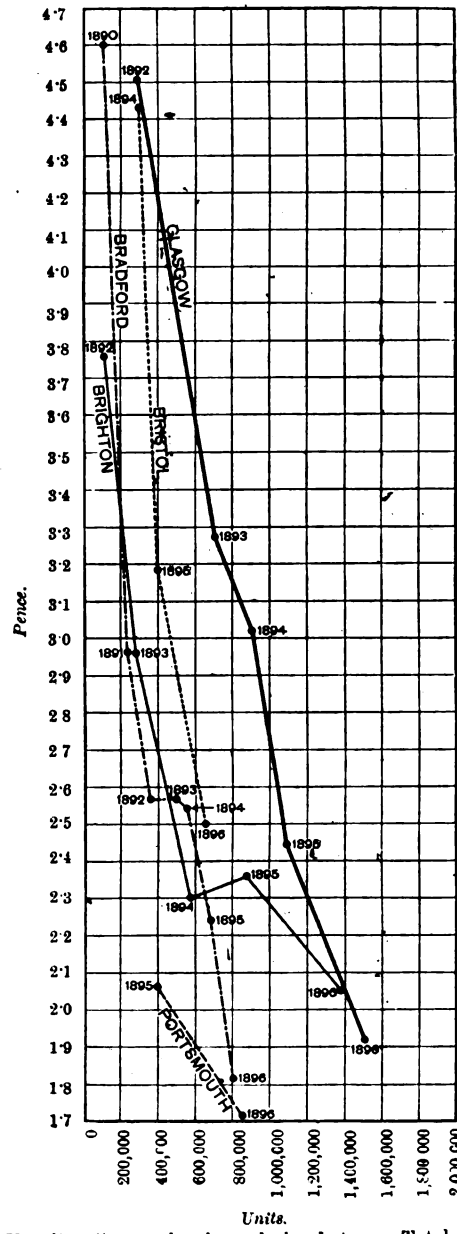

DIAGRAM XI. (*b*).—Curves showing relation between Total Costs per Unit and Units Sold.

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Conclusion.

As the Institution in 1894 had a prophecy laid before it of the reduction of costs in London works to 1·32d. per unit sold, on an output of 5,000,000 units, I will venture upon a prophecy as to the reduction of costs in works situated in an industrial centre, and I will locate my prophecy at Leeds. My opinion is that when the Leeds output reaches the ideal figure of 5,000,000 units the costs of production and distribution will work out somewhat as follows :—

Prophetic Leeds Costs when Output reaches 5,000,000 Units.

	Per Unit Sold. d.
Coal and other fuel	0·20
Oil, waste, water and stores	0·03
Wages	0·17
Repairs and maintenance	0·10
Works Costs	0·50
Rates and taxes	0·03
Management expenses, including engineer's superintendence	0·22
Total Costs	0·75

ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Bedford (Municipal)	March 4	Leeds (Company)	April 8
Clerkenwell (Company)	March 18	Notting Hill (Company)	March 11
Dover (Company)	March 11	Oxford (Company)	April 1
Hanley (Municipal)	April 8	Richmond (Company)	March 4
Huddersfield (Municipal)	March 25	Scarborough (Company)	April 1
Kingston-upon-Thames (M'cip'l)	March 25	Wandsworth (Company)	March 18

Two comparatively small, but nevertheless instructive, electric supply undertakings are dealt with this week in our tabulated analyses of accounts, both of these concerns having been in operation for several years.

Burton-upon-Trent Electric Supply Works.

In 1894 the Gas Department of the Corporation of Burton-upon-Trent started an electric supply sub-department, the small station for the generation of electric current being situated within the precincts of the gas works, and being under the control of the gas engineer, Mr. F. L. Ramsden. A description of the station at the time of its inauguration appeared in *The Electrician*, Vol. XXXIII., p. 157. The progress of the undertaking during its four years of working is summarised in the following table :—

Progress of Burton-upon-Trent Electric Supply Works since Inauguration.

Year ended Dec. 31.	No. of consumers.	Lamp connections in 8-c.p. lamps.	No. of units sold.	Working expenses.	Revenue.	Working profit for year.
1894	53	2,064	19,291	£844	£529	- £315 (loss)
1895	68	2,734	40,094	1,343	1,051	- 292 (loss)
1896	80	3,066	58,189	1,232	1,521	+ 289 (gain)
1897	104	3,893	79,492	1,369	2,073	+ 704 (gain)

It is to be observed, however, by reference to the table on the opposite page, that, notwithstanding the steady improvement shown by the yearly working profit, the electricity sub-department is a burden upon the ratepayers to the tune of a deficit of £1,164, though this unhappy state of affairs is an improvement upon the deficit of £1,579 for the previous year. In the pages of *The Electrician* we have frequently and consistently deprecated the placing of a municipal electricity department under the control of a gas committee, and we have pointed out more than one instance in proof of our assertion that the practice is objectionable and unfair to the electricity department. Burton-on-Trent, we fear, affords another instance, and the results of the past year's working show, by comparison with other municipal undertakings of a similar magnitude and scope, lamentably small progress in the development of the undertaking. Many of the items of expenditure, it is true, are reasonably low, such, for example, as the cost of fuel, the proximity of the boilers to the gas works and the consumption of waste fuel from these latter serving to keep this item at a minimum figure; but what is needed is that the standing charges should be brought down by a better load-factor and a much larger output, and to attain this end the Gas Committee must push their sub-department more than they have done in the past. Further comment on the analysis shown on the opposite page is unnecessary, except to point out that the enormous works costs of 3·6d. per unit are principally made up of the item under "Wages," this item representing 2·69d. per unit. We may also note that the working profit for the year, some 3 per cent. on the capital, is insufficient to pay the interest on the loans. Still, the year's accounts show all-round improvement.

Northampton Electric Light and Power Company (Limited).

Seven years ago electric supply was commenced by the Northampton Electric Light and Power Company (Limited), and since that time the undertaking has made steady though not very rapid progress towards financial success, and it is now at a stage when a modest 2 per cent. dividend on the Ordinary shares is possible. The following figures will indicate in some degree the progress that has been made :—

Progress of the Northampton Electric Supply Works since Inauguration.

Year ended Dec. 31	Lamp connections in 8-c.p. lamps	Working profit for year.	Sum set aside for depreciation.	Balance available for interest and distribution as dividends.
1891	...	- £460 (loss	nil	...
1892	...	+ 308	nil	£308
1893	4,600	+ 536	nil	536
1894	5,300	+ 762	£100	662
1895	6,130	+ 819	250	569
1896	8,014	+1,351	500	851
1897	11,084	+1,409	500	909

The authorised capital of this Company is £100,000, including £50,000 in Debentures; of this £4,000 in Six per Cent. and £3,000 in Five per Cent. £1 Preference shares, £3,250 in Five per Cent. and £6,050 in Four per Cent. Debentures, and £10,590 in £1 Ordinary shares, have been issued. A capital sum of £30,880 has been expended, of which £8,520 has been spent during the past year. The extensions represented by this last-named sum include a 240 H.P. engine and dynamo, a new boiler of a capacity "equal to all the three original boilers combined," *i.e.*, 400 H.P., a furnace economiser, a feed-water storage tank of 33,000 gallons capacity, and a new storage battery. It is intended shortly to change over the mains from the two-wire to the three-wire system.

The salient features in the comparative analysis of the accounts for 1896 and 1897, as set forth in the table on the opposite page, comprise: An *increase* from 50 per cent. to 57 per cent. in the percentage of total costs to gross revenue, offset, however, by an increase from £1,352 to £1,410 in the working profit for the year, owing to the greater volume of business done. The introduction of the Brighton system of charging, no doubt, is responsible for the improvement in this last respect, as also for the fall in the revenue per unit sold. This new system of charging at Northampton has been much appreciated by the consumers, and it is anticipated by the Company that it will benefit the shareholders likewise. The Company estimate the rebates on the Brighton system at £488 for the year; but, notwithstanding this direct loss of income, electric supply has been so popularised by the new system of charging that the result on the whole is said to be beneficial. Among the items of expenditure it is worthy of notice that generation expenses have slightly increased from 2·84d. to 2·96d. per unit, and are at a deplorably high figure, that the standing charges have been swelled by the addition of £60 to the item of "Rent, rates and taxes," and £118 to "Management," and that "Wages" have increased in a greater ratio than the saleable output. Altogether it is evident that there are many economies must be effected before the Northampton undertaking can claim to stand in the front rank, even of concerns of its own order of magnitude.

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	BURTON-UPON-TRENT.		NORTHAMPTON.	
Undertaking Worked by	Corporation of Burton-upon-Trent.		Northampton Electric Light and Power Co.	
Date of Commencement of Supply	1894.		1891.	
System of Supply	Alternate-current transformer sub-stations.		Continuous-current two-wire with batteries.	
Chief Engineer	F. L. Ramsden.		W. E. Heenan.	
YEAR ENDED DECEMBER 31st.	**1896.**	**1897.**	**1896.**	**1897.**
QUANTITIES—				
Units generated	—	—	95,652	121,926
„ **SOLD (TOTAL)**	58,189	79,492	89,445	114,676
„ sold to consumers	58,189	79,492	89,445	114,676
„ sold for public lighting, &c.	—	—	none	none
„ used on works	—	—	6,297	7,250
UNITS SOLD PER 8 C.P. LAMP CAPACITY	8·8	9·7	11·2	12·8
Maximum supply demanded	100 kilowatts	134 kilowatts	177 kilowatts	182 kilowatts
Number of public lamps	—	—	none	none
Connections to mains in 8-c.p. lamps	6,132	7,786	8,014	11,084
CAPACITY OF PLANT IN 8-C.P. LAMPS	6,600	8,190	7,920	8,921
CAPACITY OF PLANT IN KILOWATTS	200	270	240 kilowatts	270 kilowatts
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£30,993 / £155	£30,993 / £115	£100,000 / £417	£100,000 / £370
Share	— / —	— / —	50,000 / 208	50,000 / 136
Loan (including Debenture charges)	30,993 / 155	30,993 / 115	50,000 / 208	50,000 / 136
RECEIVED (TOTAL)	30,993 / 155	30,993 / 115	23,300 / 97	26,890 / 100
Share	— / —	— / —	14,000 / 58	17,590 / 65
Loan (including Debenture charges)	30,993 / 155	30,993 / 115	9,300 / 39	9,300 / 34·4
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	— / —	76,700 / 318	73,110 / 271
Share (unissued)	— / —	— / —	36,000 / 150	32,280 / 119
Share (uncalled)	— / —	— / —	— / —	130 / —
Loan (including Debentures)	— / —	— / —	40,700 / 168	40,700 / 151
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	—[d] / —	—[f] / —
DEPRECIATION FUND	— / —	— / —	850 / 3·54	1,350 / 5·0
EXPENDED (TOTAL)	29,065 / 146	30,472 / 112	22,360 / 93·2	30,880 / 114
Lands and buildings	4,902 / 24·5	4,921 / 18·3	3,707 / 15·4	5,992 / 22·2
Plant	8,924 / 44·6	8,959 / 33·2	8,272[a] / 34·5	10,967[a] / 40·6
Mains	13,382 / 66·9	14,335 / 53·0	8,401 / 35·0	11,578 / 42·8
Miscellaneous	1,857 / 9·8	2,257 / 9·0	1,979[b] / 8·3	2,344 / 8·6
BALANCE OF CAPITAL ACCOUNT	+1,928 / +97	+521 / +20	+940 / —	−3,990[e] / —
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£1,521 / 6·32d.	£2,073 / 6·27d.	£2,737 / 7·34d.	£3,295 / 6·91d.
Revenue from supply	1,455 / 6·00d.	1,989 / 5·90d.	2,583 / 6·76d.	3,032 / 6·36d.
„ meters, &c.	55 / 0·23d.	71 / 0·23d.	104 / 0·27d.	114 / 0·24d.
„ public lighting	— / —	— / —	nil / —	nil / —
„ sale of lamps, &c.	2 / —	7 / —	— / —	— / —
„ miscellaneous sources	8 / —	5 / —	50 / —	149 / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£1,232 / 5·06d.	£1,369 / 4·14d.	£1,386 / 3·69d.	£1,886 / 3·94d.
WORKS COSTS	1,066 / 4·39d.	1,195 / 3·60d.	1,121 / 3·00d.	1,444 / 3·03d.
Generation of electricity	*1,051 / 4·33d.*	*1,180 / 3·55d.*	*1,058 / 2·84d.*	*1,412 / 2·96d.*
Fuel (including cartage, &c.)	141 / 0·58d.	177 / 0·53d.	393 / 1·05d.	509 / 1·06d.
Oil, waste, water, stores	56 / 0·23d.	56 / 0·17d.	79 / 0·21d.	91 / 0·19d.
Wages at station	824 / 3·39d.	892 / 2·69d.	481 / 1·29d.	688 / 1·44d.
Repairs and maintenance at station	30 / 0·14d.	55 / 0·16d.	107 / 0·30d.	123 / 0·26d.
Distribution of electricity	*15 / 0·06d.*	*16 / 0·05d.*	*63 / 0·17d.*	*32 / 0·07d.*
Wages, &c.	— / —	— / —	— / —	— / —
Repairs, renewals of mains, &c.	15 / 0·06d.	16 / 0·05d.	63 / 0·17d.	32 / 0·07d.
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	167 / 0·67d.	173 / 0·54d.	265 / 0·69d.	443 / 0·92d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*70 / 0·28d.*	*71 / 0·23d.*	*49 / 0·13d.*	*109 / 0·23d.*
Management	*97 / 0·39d.*	*102 / 0·31d.*	*216 / 0·56d.*	*334 / 0·70d.*
Salaries	50 / 0·20d.	50 / 0·15d.	110 / 0·29d.	110 / 0·23d.
Stationery, &c.	— / —	— / —	25 / 0·07d.	64 / 0·14d.
Establishment charges	27 / 0·11d.	40 / 0·11d.	36 / 0·09d.	61 / 0·13d.
Law charges, &c.	20[a] / 0·08d.	12[a] / 0·04d.	45[c] / 0·12d.	99[g] / 0·21d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£289 / 1·0%	£704 / 2·4%	£1,352 / 6·3%	£1,410 / 5·3%
Sum carried to Depreciation Fund	nil / —	nil / —	500 / 2·3%	500 / 1·9%
Sum carried to Reserve or Sinking Fund	992 / 3·4%	992 / 3·3%	nil / —	nil / —
Net interest on loans (incl. Debenture charges)	875 / 3%	875 / 3%	363 / 1·8%	411 / 1·5%
BALANCE FROM LAST ACCOUNT	— / —	— / —	+47 / —	+64 / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	536 / 2·5%	563 / 2·1%
Deficit	*1,579 / 5%*	*1,164 / 4·1%*	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	2% / —	2% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	80%	66%	50%	57%
Expenditure per kilowatt capacity	£6. 3s. 2d.	£5. 1s. 5d.	£5. 15s. 5d.	£5. 19s. 10d.
REVENUE PER KILOWATT CAPACITY	£7. 12s. 0d.	£7. 13s. 0d.	£11. 8s. 0d.	£12. 4s. 0d.
Expenditure per 8-c. lamp capacity	3s. 8d.	3s. 1d.	3s. 6d.	3s. 7d.
REVENUE PER 8-C.P. LAMP CAPACITY	4s. 7d.	4s. 8d.	6s. 11d.	7s. 8d.
Price charged for lighting, per unit	6d.	6d. to 3d.	8d.	8d. (1 hr.) to 4d.[h]
Price charged for power, per unit			3½d.	3½d.
Price charged for public lighting, per lamp	—	—	—	—

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BRITISH ELECTRIC TRACTION.

Electric traction in Great Britain is rapidly on the ascendant. The able speech of Sir CHARLES RIVERS WILSON, Chairman of the British Electric Traction Company (Limited), at a recent meeting of the Company, a report of which we give in another column, affords an instructive and pleasing insight into the currents and healthy undercurrents of financial enterprise which are gradually working an important revolution in the street and inter-urban traffic of this country. British electric traction may, indeed, never attain to the gigantic proportions brought about by the introduction of the overhead trolley into the United States; but, if this should prove to be the case, the sole reason will be the one that alarmed the Yankee, in a recent number of *Punch*, when he trembled at our railway speeds for fear the train should run off our "darned little island." Our island home, however, though it can boast neither as great a square mileage of land nor as long a lineal mileage of paying streets and roads, from the traction point of view, has a population per square mile about 15 times as dense as that of the United States; and it is largely upon this basis, for any given district, that success must depend in the introduction of electric tramways or light railways, or, in fact, any means for transportation. The outlook, therefore, though it does not reveal a field as extensive and rich for the manufacturer of electric traction plant as has been found in America—where no less than 15,000 miles of tramways are already equipped on the trolley system—is one that justifies the expectation of large dividends in the near future for companies undertaking to operate lines electrically; or, regarded from a different but sometimes more popular standpoint, it gives assurance to municipalities and other local authorities that, if properly managed by such authorities, electrically operated tramways need be no burden upon the ratepayers. But we de not wholly base our argument in favour of electric traction upon the fact that because it has been found to pay so well in America it must necessarily pay well here, where the conditions are so much more favourable; for there

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is direct evidence as to this point. On more than one occasion in the past we have cited, in support of the superiority of electric traction over horses for street tramways, the fact that in numerous instances tramway companies controlled by men absolutely unbiassed towards the electric trolley, or, in some cases, confessing at first a decided prejudice in favour of horses, have been, after a short experimental trial of electric traction, so convinced of its superiority that they have striven to obtain powers for its introduction over their entire systems of lines. This, for example, is practically what has occurred at Bristol, in the case of the Bristol Tramways and Carriage Company; and at Dublin, where the Dublin United Tramways Company, after first equipping electrically their Dalkey section, and some twelve months afterward their Clontarf section, have decided to operate their entire system by electric traction; and, again, the Imperial Tramways Company, which operates lines in various parts of the country, and the London United Tramways Company. Either of these furnishes as readily as a considerable number of others, which we have not space to mention in particular, examples of the directors of business undertakings, whose main duty it is to raise their undertakings to the highest dividend-earning pitch, discarding horses and rejecting every rival mode of mechanical traction in favour of the electric trolley. It is not to be supposed for one moment that these independent business men would risk the success of their concerns for the furtherance of a chimerical idea; and to the supposition that they are convinced of the commercial value of their choice there is only the absurd alternative that they are one and all mad. The claims of electric traction are thus abundantly justified on grounds quite independent of a presumably self-interested electrical profession.

But notwithstanding the marked success which has everywhere attended the adoption of electric traction, timid persons both inside and outside of tramway companies are continually raising various objections. It is, for example, said that the trolley is suited only to lines where the gradients are so severe as to put horse traffic at a disadvantage; though, as a matter of fact, electric traction has proved its superiority whether on the flat roads around Dublin and Leeds, or on steep gradients and sharp curves at Bristol and Coventry. Objectors disagree as to the unsuitability of electric traction to a dense or a light traffic, though they agree that it is unsuited to one or the other; regardless of the fact that the Bristol line and considerable portions of the Leeds and Coventry lines pass through dense traffic, while Hartlepool and the Isle of Man furnish instances of lines of a lighter and inter-urban character. As finally disposing of this ridiculous objection we need only cite the uniform success of the electric trolley, whether in the crowded streets of Chicago, Baltimore, Buffalo or other American cities, or in the inter-urban light railways that abound in the United States, many of which latter carry a by no means frequent traffic. We have seen paying trolley roads in America ranging from a half-hour single-car service to a half-minute service with a motor car and one, or sometimes two, trailers. Another objection we may, perhaps, in passing stoop to notice: it is the outcry that is sometimes raised, though rarely with sincerity, that electric traction brings with it speeds dangerous to life and limb. It will be evident to every engineer that the limiting speed of an electric tramcar is a quantity that is open to effective regulation, and it is quite feasible to so construct a motor car that its speed shall not exceed that limit. But it usually happens that the public, emancipated from the crawling pace of horse cars, is only too thankful for the accelerated service the advent of the trolley renders possible. Nevertheless, if any local authority deems low speed advisable in the tramcars passing through its district the condition may be as readily and more cheaply fulfilled by electric traction than by the most jaded of horses.

Turning now to consider some of the aspects of Sir CHARLES WILSON'S speech, we may first of all direct attention to the magnitude of the aggregate and of many of the individual undertakings of the British Electric Traction Company. Remembering that there are but 1,080 miles of tramways in the United Kingdom, not more than 10 per cent. of which are now operated electrically, it will be seen that the 200 miles of electric lines for which concessions have actually been, or are in process of being, acquired by this Company represent a very important slice of the tramway enterprise of the kingdom. No less than 18 separate schemes are already well advanced, some of them of considerable magnitude. Thus, for example, the Company's South Staffordshire scheme represents alone upwards of 50 miles of electric line, and is designed to serve districts with an aggregate population exceeding 427,000. Besides these already well developed schemes, there are a number of undertakings now in preliminary negotiation, bringing the total number of projected lines up to about 50. When it is considered that these are the efforts and results of but one, albeit an important one, of several concerns interested in the extension of electric traction in this country, it will be realised that substantial and even rapid progress is being made. A matter of the utmost importance regarding the future development of tramways and light railways in the United Kingdom is discussed towards the end of Sir CHARLES WILSON'S speech, in terms with which we are in hearty accord; we allude to the municipalisation of these undertakings. The following extract contains the gist of the matter:—

> The municipality is only able, *primâ facie*, to carry out its operations within the limits of its own boundaries; and inasmuch as for the economical and efficient working of such tramways it is necessary that there should be communication from the outside, you will see at once how much more desirable it is that the lines should be constructed upon a uniform system, and be, as far as possible, within the same district, under one single management. Electric traction is particularly suitable for the working of tramways extending over long distances, and for the purpose therefore of connecting adjacent and outlying villages with large towns. Municipal boundaries do not coincide always with the centres of population, and if the municipalities construct tramways they have to confine themselves to their own boundaries, so that the outlying villages and towns are not reached. It does not appear reasonable that municipalities should have the right to use the ratepayers' money for the construction of tramways in districts which do not contribute to their rates. I fear, therefore, that one of the results of the municipalisation of tramways would be that one of the great advantages of electric traction—that of providing outlying villages and towns with cheap and quick communication with larger adjacent towns—will be sacrificed, for it is only in conjunction with the larger business within the municipality that it will pay to work the relatively less profitable sections lying outside the borough.

In fact, however plausible a case may be made out for the municipalisation of such public works as lie wholly within an area controlled by one public body, it must be evident to all intelligent and fair-minded persons that the same advantages cannot be realised in public works, such as railways, tramways, telegraphs and telephones, which extend through the areas controlled by many independent local authorities. We have only to conceive of the chaotic result of attempting to work the Post Office telegraphs or, say, the London and North-Western system of railways, upon the principle of local municipal control, to discover, on the one hand, how insistence upon this principle must conflict against the construction of lengthy inter-urban light railways and tramways, and, on the other hand, how certainly it would result in difficult and inefficient working, in the event of such a line ever being constructed and operated under such control.

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We are strongly of the opinion that for such extended works as railways, tramways, telephones and the like, the only possibly successful alternative to continuing to permit of their being worked by companies would be to place each under the control of a single Government department.

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

(*Continued from page 799.*)

Magnetic Separator.—Some manufacturers even use a magnetic separator after the material has been ground down to a powder, to insure against iron particles that may have got mixed with the carbon. As this process is not expensive it can be recommended as a safeguard. There are some firms that make magnetic separators, which are not expensive, similar to those first designed by T. A. Edison. The crushing mill shown in Fig. 1 is made by J. C. Braun, of Nürnberg, who makes a speciality of carbon machinery, and it may be mentioned that he has supplied machines of all kinds to the most celebrated carbon firms. The following are the dimensions of the crushing mill :—

Height of the mill with pounder-up	2,350mm.
Length, including pulleys (fixed and loose)	1,500 „
Breadth	800 „
Diameter and width of pulleys .....680mm. by	120 „
Weight of the whole mill .....about	1,120kilo.
Revolutions per minute .....about	45 to 50
Horse-power required to drive the mill .....about	2

It may be mentioned that the crushing mill should be placed on a good and solid foundation, so as to prevent the jars, &c., from being communicated to the neighbouring buildings.

If petroleum coke has been crushed it is then taken and packed into retorts, which are sealed up in order to prevent combustion, with the exception of a vent or two to allow for the escape of the gases which arise from the volatile matter and water when the coke is heated to incandescence. As already mentioned above, petroleum coke when calcinated loses about 30 per cent. of its weight, and it is thus necessary to calcinate it first before working it into carbons, which would otherwise, when baked, be porous. If a well-adapted furnace is built especially for calcinating the raw material, it will do its work in 10 to 12 hours ; in fact, it can be done in less time, as the raw material does not need to be heated gradually, as the carbons do in order that they do not warp, for in the raw material no consideration can be taken in regard to warping or shrinkage, as it is of no account. The principle on which a calcinating furnace should be built ought to be on the Siemens regenerative plan. It may be said that calcinating by means of retorts is expensive, but the writer can only say that when a good carbon is desired the method of using retorts or troughs, either for calcinating or baking the carbons, is the only sure and reliable way, and in the end cheaper, while the handling is convenient. Some manufacturers pile their material and also the carbons into the furnace, cover them up with carbon dust and chamotte slabs. On this pile the flames are to act on all sides, but it will be shown later that this single furnace system is a thing of the past for modern makers, and that those firms that still use such furnaces cannot be expected to compete with those makers that have the modern furnace, either in quality or commercially. One of the main things in the manufacture of carbons is the *furnace*, and no doubt therein is the secret that has baffled many in their attempts to produce a good carbon. Many have worked upon the system of preparing the raw material, thinking the secret of a good carbon must be in the selection of some special material, whereas it may be simply stated that one of the most vital necessities in the production of a good carbon, is the furnace, and that, although good material may be used, if the furnace in which the carbons are baked is not adapted to the requirements, the carbons will not be up to the standard quality demanded in our days. After the petroleum coke has been baked, or rather calcinated, care should be taken that the retorts with their contents have cooled down sufficiently before the raw material is taken out. When taken out of the retorts it will be found to appear dry and crisp, having a grey, metallic appearance, and if pure or of a good quality it does not cake.

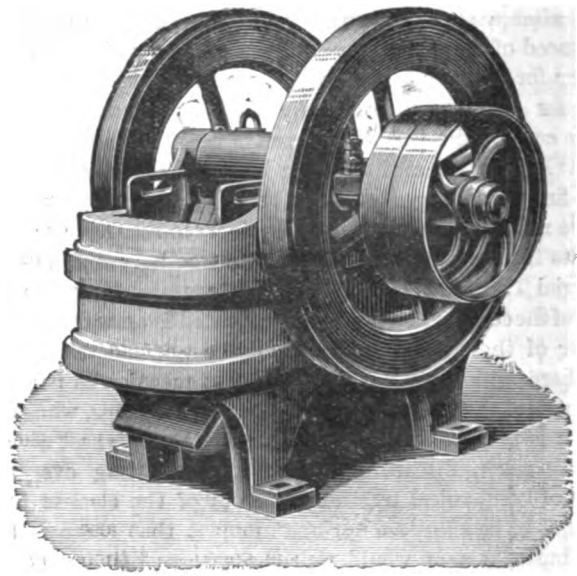

FIG. 2.—Braun's Graphite Breaker.

Fig. 2 represents another kind of crusher or breaker made by J. C. Braun especially for gas retort carbon, in which the cheeks can also be adjusted to break the raw material into various sizes, while at the same time they can be easily replaced when damaged. The machine is made in two sizes. On the whole, however, the writer prefers the crusher shown in Fig. 1 for breaking the petroleum coke or gas retort carbon. The gas retort carbon need not, of course, be calcinated if dry.

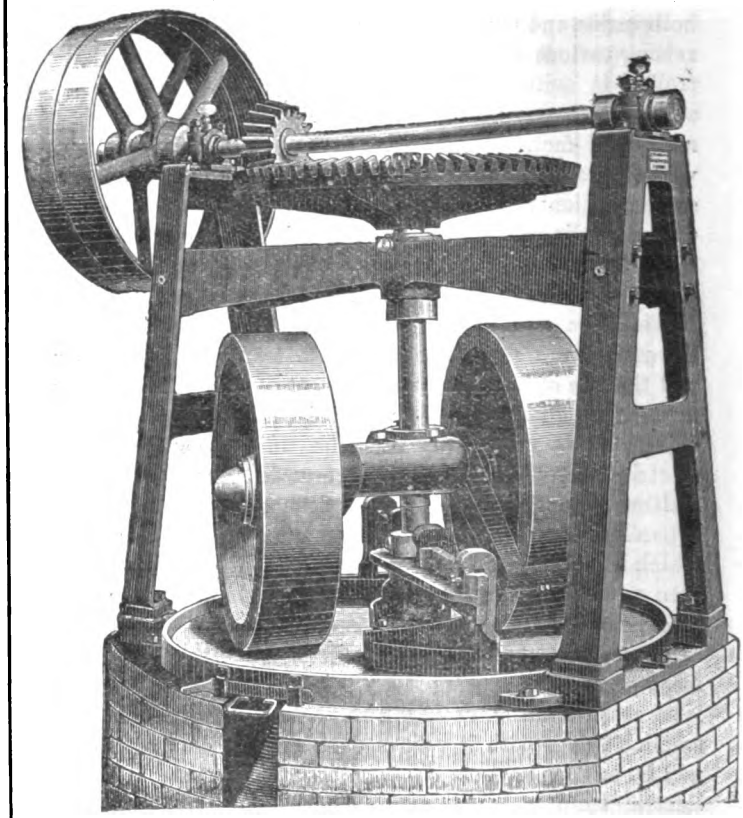

FIG. 3.—Braun's Crushing Mill.

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Crushing Mill.—The material, after having passed the crushers (petroleum coke being already calcinated) is passed on to the crushing mill with vertical runners, shown in Fig. 3. This, as will be seen, resembles somewhat the old-fashioned mills used in grinding corn. The mill consists of two heavy vertical runners connected together by an arm that is rotated from the vertical shaft, to which power is communicated by means of a bevel gear, as shown. To the vertical shaft are also attached two scrapers that mix and stir the material, pushing it constantly into the path of the runners. The following are the dimensions of the mill:—

Diameter of the vertical runners	1,000mm.
Width " " "	250 "
Diameter of the grinding surface on which the runners revolve	1,600 "
Length of mill, including pulleys	2,200 "
Height up to tip of pulley	2,150 "
Width of mill	1,650 "
Diameter and width of fixed and loose pulleys	980mm. by 160 "
Revolutions of the pulley per minute	72
Horse-power required to drive mill	about 5
Weight of complete mill	" 3,900 kilos.

Another neat crushing mill is shown in Fig. 4; this one is made by F. Pemsel. The material is taken away from this

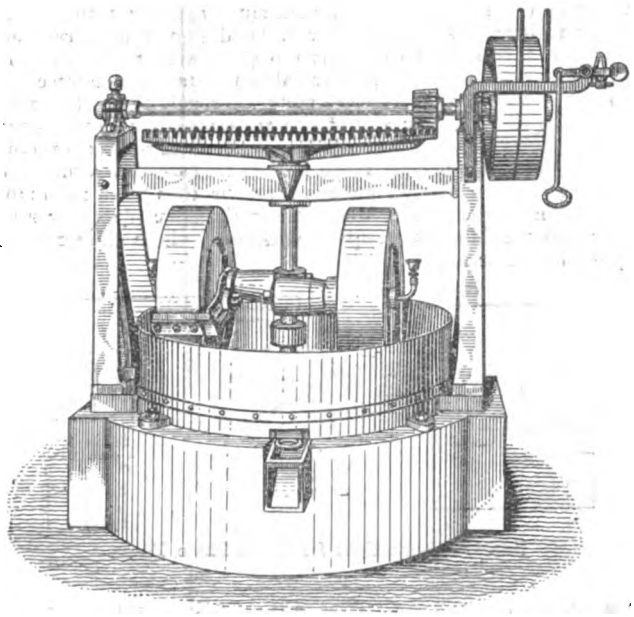

Fig. 4.—Pemsel's Crushing Mill.

machine from time to time and passed through a sieve, the fine or ground part being passed into the rolling mill, while the coarse part is returned to the mill with the vertical runners.

(*To be continued.*)

THE ELECTRICITY SUPPLY OF LONDON.

At an ordinary meeting of the Institution of Civil Engineers on Tuesday, April 5th, Mr. W. H. Preece, C.B., F.R.S., Vice-President, in the chair, a Paper was read on "The Electricity Supply of London," by Mr. Arthur H. Preece, Assoc.M.Inst.C.E. The supply of electricity on a commercial scale had been started in London after the passing of the Act of Parliament in 1888, which amended the Act of 1882, principally by extending the date for compulsory sale to the Local Authority from 21 years to 42 years. In 1888 many companies applied for Provisional Orders, and, in determining which were to be granted powers, and the districts over which the powers were to extend, the Board of Trade decided that competition would be advantageous to the public, and that it was advisable to allow one direct-current system to compete with one alternating-current system. There were now in London eleven important companies and five vestries supplying electricity, and three other companies and three vestries were taking steps to start works. The capital invested in the industry amounted to £6,000,000, and plant was installed to the extent of 80,000 H.P., the equivalent of 2,000,000 8 c.p. lamps being connected to the mains. The total annual revenue was £800,000, and the total annual expenditure, £450,000.

Of the systems for supplying electricity in London, the alternating current was applicable to large areas where consumers were scattered, and it enabled the generating works to be established by the riverside, or where land was cheap and coal was easily unloaded. The undertakings using this system were the City of London Company, the Metropolitan Company, the London Electric Corporation, the County of London Company, the House-to-House Company, the Hampstead Vestry, the Islington Vestry and the Hammersmith Vestry. The direct-current systems were divisible into two classes, the high-pressure and the low-pressure. In the former rotary transformers were used to reduce the high pressure to a low pressure, while the latter produced and distributed electricity at the same pressure at which it was supplied to consumers. The direct-current systems were applicable to compact areas, and, with the use of high pressure, to scattered or isolated compact areas. The chief advantages of the direct-current system were the possibility of using storage-batteries, which could not be employed with the alternating-current systems, greater efficiency in distribution and greater adaptability to motive power. The undertakings using the system were the Chelsea Company (high pressure), Charing Cross and Strand Corporation (high pressure), the Westminster Corporation, the St. James's and Pall Mall Company, the Kensington and Knightsbridge Company, the Notting Hill Company, the St. Pancras Vestry, and the Metropolitan Company (at one works).

The generating works of the several undertakings in London contained many interesting features. No less than twenty different works had been erected. The boilers used comprised the water-tube, marine, Lancashire, and miscellaneous types; but the preference for the water-tube boiler was very marked. The works were liable to sudden demands through fogs, and the quick-steaming properties of this type of boiler were of great advantage. The boilers were fired chiefly by hand with Welsh coal, but in the works of the City of London Company and the County of London Company mechanical stokers and cheaper coal were used. The use of extensive systems of steam-pipes was now being dispensed with. The multiplicity of valves was unnecessary, and the number of valves was being reduced, and arrangements were made as simple and with as few joints as possible. The present tendency was towards engines of the marine type for large outputs. The high-speed engine was not used for larger powers than 750 H.P. Some engineers, however, found engines of 350 H.P. sufficiently large and the most convenient unit to adopt. The dynamos were similar in most works, and were always connected direct to the engines. Storage by secondary batteries was not extensively employed in London, as their maintenance had hitherto proved expensive. But a few works used them entirely for maintaining the supply after midnight, and in the daytime in summer. The author gave the results of a test of a small marine engine and alternator, showing the combined efficiency to be 85·5 per cent. The question of vibration had been of great importance in many works; no cure had been found effective when once vibrations were set up. High-speed engines must have three cranks to be free from appreciable vibration.

The favourite methods of distributing electricity were to transmit current at a high pressure in heavily-insulated cables in iron pipes, and current at a low pressure in insulated cable in stoneware conduits or in cables heavily armoured and laid direct in the ground. Rubber was now little used, paper and jute, impregnated with insulating compounds, having been extensively adopted.

The usual system of measurement of the electricity supplied was by meter, and the average charge was 5½d. per unit. The average charge in 1890 was 7½d., so that the price of electricity had been reduced in eight years no less than 25 per cent., equivalent to a reduction in the price of gas from 4s. to 3s. A curve was given to show the variations in the price of gas since 1870. The average price had varied between 4s. and 2s.; it was now 2s. 7d. The cost of generating and distributing electricity had been greatly reduced in the last few years. In 1892 it was seldom supplied for less than 4½d. per unit. The usual cost was now 2½d. to 3d. The actual cost of generating was about 1½d. per unit, and the cost of management, &c., about 1d. The direct current was everywhere produced at a cheaper rate than the alternating current. The difference was between ½d. and 1d. per unit, or 20 per cent. cheaper.

Since 1888 an important inquiry had been held by the Board of Trade regarding the maximum pressure permissible in consumers' premises. The result of this inquiry in 1896 was to increase the pressure from 150 volts to 250 volts.

A comparison was made between the two largest companies in London—namely, the City of London Company, which supplied alternating current, and the Westminster Corporation, which supplied direct current. Both companies had nearly the same number of lamps connected to their systems, the number of 8-c.p. lamps connected being 270,898 and 269,939 respectively. The capital expended was respectively £945,829 and £546,434; the annual incomes per 8-c.p. lamp, 11s. 9d. and 7s. 9d.; the annual expenditures per 8-c.p. lamp, 4s. and 3s.; and the costs per unit, 7·6d. and 5·8d.

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The industry was growing so rapidly that most undertakings had to seek new sites for generating works, and the tendency was to erect large works on the outskirts of London, where coal could be conveniently brought to the site, and where water could be obtained for condensing. The powers granted under Provisional Orders were limited as regards the compulsory purchase of land, and further powers were being sought by some companies from Parliament, so that they might be placed on the same footing as railway companies. No less than 40,000 H.P. was now being installed in London in order to meet the demand for electricity in the immediate future.

THE PRACTICAL OPERATION OF MULTIPHASE CURRENTS.*

BY T. HAWKINS.

For power plants where the distance between the generator and the various motors is not too great, and permits of a low-pressure system being used (say 200 volts), a generator with a revolving armature makes a cheap and efficient type of machine. Where, however, the electromotive force exceeds 500 volts, it is better to have the armature stationary, which allows of increased facilities for securing and maintaining the insulation necessary for high voltages. In this case the field-magnet is made to revolve, and the exciting coil or coils need not have a difference of potential exceeding 100 volts, even for very large machines.

The generators in use for the different plants described in this Paper are of the "Inductor" type. This is undoubtedly a more mechanical piece of machinery than either of the foregoing. The armature consists of two laminated iron rings, enclosed by a cast-steel frame. This frame serves both as a support and as a magnetic path between the two laminated rings. Sufficient space is left between the two laminated rings for the insertion of the single exciting coil. The armature conductors are embedded in holes close to the inner circumference of the laminated rings. To prevent eddy currents, the pole-pieces of the inductor are made up of laminated iron strips.

A multiphase induction motor has two distinct electrical circuits, viz., the primary and the secondary. The primary circuit, when supplied with multiphase currents, produces a rotary magnetic field. The action of this rotating field is to induce in the secondary circuit currents of low potential. It is the reaction between the rotating magnetic field and the induced currents in the secondary which sets up a torque giving the required rotation. Either the primary or secondary can be designed to revolve. If the primary circuit were made to revolve, it would be necessary to fit it with sliding contacts, so as to connect it electrically with the feeding circuit. One advantage attained by this method is, that it allows of easy insertion of a starting resistance into the circuit of the secondary; but as there is no difficulty experienced in inserting a resistance in a rotating secondary, if required, it is better to fix the primary and dispense with the sliding contacts.

It is now the usual practice to have the primary or inducing circuit stationary, and to allow the secondary to revolve, so as to take advantage of the very low potential at which the currents are induced in the secondary circuit; also, because the circuit in this part is enclosed on itself, and is independent of the feeding circuit. Small motors up to 8 or 10 H.P. are switched into circuit directly from the mains by means of an ordinary three-pole switch without the use of any resistances; but for larger machines it is advisable to use starting resistances, either in the stator or rotor circuit, otherwise excessive current will be taken from the mains. For large motors, not requiring to start against a heavy load, starting resistances can be used in the stator circuit. These resistances may be of two kinds: either inductive, known as automatic transformers, or non-inductive, which may be either liquid or metallic.

The maximum torque of a motor having a permanently short-circuited rotor, *i.e.*, a rotor which is not connected to an outside resistance is obtained when its full electromotive force is across the stator. If, however, the motor is not called upon to develop its maximum torque, a lower torque can be obtained by reducing the electromotive force across the stator terminals to such a point as will give the necessary strength of field for the required torque, the object of this being to reduce the starting current to a minimum and still enable the motor to get away. The automatic transformer is of simple construction, and is similar to the "economy coil" used in alternating-current arc lamps for obtaining a reduced voltage across the arc. As an example, we will suppose the motor is designed to work on a 200-volt circuit; the transformer is divided into four parts, giving 200, 175, 150, and 100 volts. The motor may be connected to any one of these four voltages. We will assume it gives the required torque at 150 volts; a throw-over switch is required, one side of which is permanently connected across the 150 volts, and the other side across the maximum voltage of the circuit. To start up, the switch is put on the 150-volt side, and when the machine has attained its normal speed it is thrown over to the 200-volt side, the automatic transformer being at the same time thrown out of circuit. If a liquid resistance is used, it is made sufficiently large to prevent a sudden rush of current when the circuit is closed. The plates are then lowered into the liquid until there is sufficient electromotive force across the stator to start the machine. When the machine has attained its proper speed this resistance is entirely cut out.

If it is necessary that the motor shall develop its maximum torque at starting, it is obtained by inserting a resistance in the rotor circuit (see Fig. 1.) A starting resistance of this description is necessary, for the following reason: When primary current is switched on, the rotary is, of course, at rest, and the lines of the rotating field are cutting the rotor conductors at a maximum rate, thereby inducing very large currents in the rotor, which has a very low resistance. These reduced currents in turn react on the stator field and weaken it. To obtain the greatest torque, we must keep up the strength of the stator field, and this is got by introducing resistances into the rotor circuit. Of course, the result of introducing the external resistance is to check the currents in the rotor, and so prevent them from unduly overpowering the stator field. There is a certain resistance which allows the exact amount of current in the rotor to obtain maximum starting torque. The starting resistance should, however, be designed with resistance in excess of this, so as to prevent too great a current in the line when closing the circuit. This variable resistance is connected in the rotor circuit in a three-phase motor, through three slide rings; the winding of the rotor and of the resistance box being in three circuits. This resistance is gradually switched out while the machine is running up to its normal speed; when this speed is attained the resistance is shortcircuited and the three brushes lifted; the motor is now running quite free, without any sliding contacts or resistances; and for all constant-speed machinery these slide rings are only used for starting up.

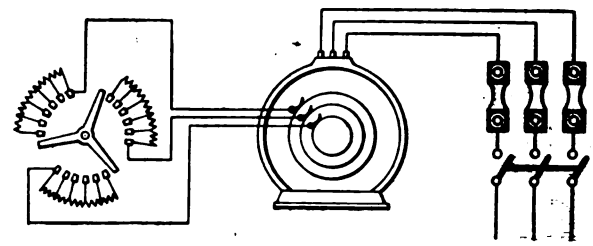

FIG. 1.—Connections for Three-Phase Motor.

I think I am right in stating that there is a much larger demand for constant-speed motors than for motors with a variable speed. It certainly is more economical to run the machines at the speed at which they are designed to give their maximum efficiency, and obtain, if possible, the variations by mechanical methods. Of course, this cannot always be done. I have described to you the three ways which are commonly used for starting up multiphase motors. Motors up to 10 H P. to be merely switched into circuit without resistance; motors of large sizes requiring to give, say, twice their normal running torque at starting, to be switched in with the resistance in stator; and motors above 10 H P., requiring to develop their maximum torque, to be fitted with sliding contacts, these sliding contacts to be used for starting purposes only. Now, in a power plant calling for an aggregate of say 300 H P. in motors, it is likely that only a small number would be required to develop their maximum torque, and these could be supplied with a starting arrangement and slide rings. We can suppose there are 20 motors below 10 H P. absorbing a total of 130 H P., four motors of 15 H P. with automatic transformers, two motors of 30 H.P., and one motor of 50 H.P. with slide rings making in all 27 motors, three of which would be fitted with slide rings. Here is a fairly large installation, requiring only three starting boxes amongst 27 motors, 24 having no sliding contacts whatever, and three having sliding contacts in use for starting purposes only. If this were a continuous current installation, there would be, to begin with, 27 boxes; and to compare the motors, there would be 27 commutators, and about 150 carbon brushes and brush holders.

The stator we may consider as corresponding to the field-magnet of a continuous current motor. Both can be made reliable, and as a rule, give little or no trouble. But it is to the merits of the rotor I particularly wish to call your attention. It is minus the commutator, brushes, and intricate brush work, and instead of taking the full potential of the circuit it has a difference of potential of only a few volts. It is simply a laminated cylinder, with holes

* Abstract of a Paper read at the Northern Society of Electrical Engineers, March 14, 1898.

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round its periphery, in which are placed solid rectangular bars connected at either end by a copper or brass casting, as per Fig. 3. The only part which has any insulation at all is the conductor, which has a light covering of tape, and this is only put on to confine the induced currents to the copper. This insulation gives a slightly increased efficiency, but should it fail the motor will still work, as the bars are already purposely short-circuited at certain points to the iron supports of the rotor. Fig 3 shows a rotor in which these bars are bolted directly to the end rings; no solder is used. The bolts have split spring washers under the nuts to allow of expansion and contraction of the metal and still keep good contact. I may say that this particular rotor is one constructed by the Westinghouse Company. You will notice, too, that there is no need for any binding wires or string. Not only is this part of the machine simplicity itself, but we have dispensed with comparatively high voltages, and as the machine is commutatorless and brushless, we can, once and for all, dismiss from our minds any anxiety as to sparking, even with sudden overloads, as sparking cannot occur unless the circuit of the primary or secondary is forcibly broken. The only limit to output is the heating of the stator on continuous overload. Wear and tear is reduced to the friction of the bearings, and as long as these get their proper supply of oil the machine requires no other attention. As an example the multiphase motors at the General Electric Company's works at Manchester are only inspected once a month, and then only for the purpose of supplying fresh oil, if necessary.

The constant-speed multiphase motor is a good regulator. Between no load and full load for an average size machine the variation of speed is about 4 per cent. The speed at which the motor runs depends upon the speed of the rotating field, and the speed of the rotating field is controlled by the number of the stator poles and the frequency which is being used in the installation.

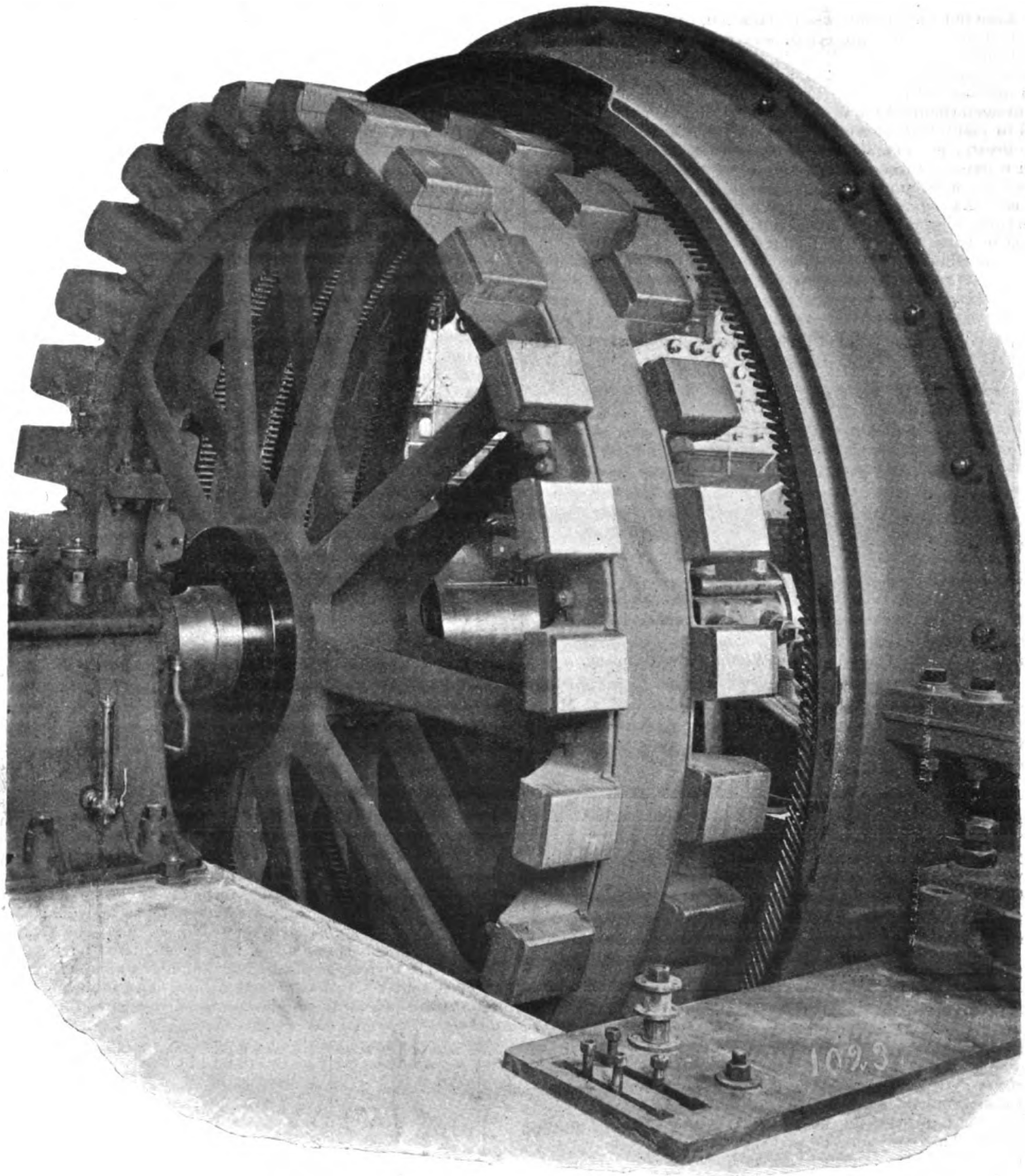

FIG. 2.—1,000 H.P. Inductor Generator, constructed by the Oerlikon Company.

At this point it would be as well to state that one cannot lay down a general law as to what frequency is best. As a rule for motor work it is not more than 60 cycles. The frequency is one of the two factors which control the speed, and it depends in a great measure on the class of machinery which is to be driven as to what is the best frequency to adopt. One would be inclined to keep it as high as possible so as to keep down the weight, and therefore the price of the machine, as the speed varies directly as the frequency. For instance, a motor giving 10 H.P. at 60 cycles and

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1,150 revolutions per minute would at 30 cycles run at 575 revolutions per minute and give only 5 H.P.

The other way of decreasing the speed of the motor is to increase the number of stator poles, but this is not usually done, as to have too large a number of poles means great leakage, and, as a rule, the motors are, in the first place, designed with the maximum number of poles compatible with high efficiency.

I have stated that the multiphase generator need have no rotating windings at all; the only rotating part being a steel or iron casting. This reduces the attention and upkeep to a minimum, and I may here state that some installations which have been running in this country for two years have, as yet, required no repairs whatever, and are practically as good to-day as the day they were put in. In a power installation, the generator is the part which is usually well protected, and gets the best attention. If a continuous current machine is used, the brushes will, at intervals, require to be adjusted and renewed, and the commutator trued up and kept clean; still there is always a skilled attendant at hand to keep the machine in order. It is, however, the motors, scattered in many instances over a considerable area, which have often the greater strain and harder work to do, and yet have less attention where the three-phase system to my mind has the advantage, especially where motors are only required to run at one constant speed. As regards the line, a saving of copper is effected by using the three-phase instead of the continuous-current system, but there must be three wires if the former be used, which brings the cost of the distribution on a low-pressure system to about the same.

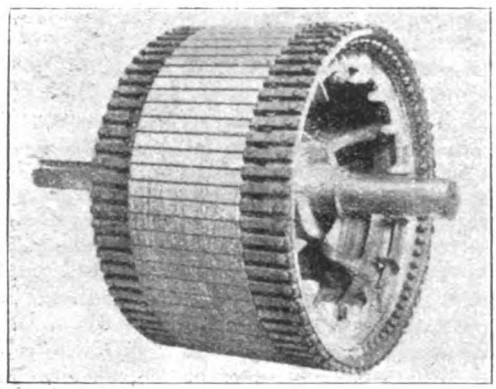

FIG. 3.—Rotor, constructed by the Westinghouse Company.

At the works of the General Electric Company, Limited, at Manchester, there is a three-phase power plant. The generator has an output of 100 H.P. at a pressure of 190 volts, and runs at 450 revolutions per minute, giving 45 cycles. The following is a list of the motors:—

No.	H.P.	Speed.	Geared to.	Kind of gearing.	Starting device.
1	24	910	Shafting	Belt	Liquid resistance in stator.
1	18	910	Shafting	Belt	"
1	9	910	Shafting	Belt	None.
1	3½	910	Boring machine	Belt	"
2	3½	1,360	Shafting	Belt	"
1	3	1,360	7ft. radial drill	Worm gear ...	"
1	2	Variable	Lathe	Belt	Resistance in rotor.

The 24 and 18 H.P. motors are not working on more than ¾-load. Each motor drives a 120ft. length of main shafting at 300 revolutions per minute, the main shaft being loaded along its entire length by high-speed lathes and other machinery. The other belted motors drive shafting in the erecting shop, and are loaded nearly to their rated capacity. In addition to the above, there are three motors (6 H.P., 4½ H.P., and 1 H.P.) used on a 5-ton 3-motor crane. The reduction of speed is obtained by worm gearing running in an oil bath. This gearing is most carefully cut, the thrust of the worm being taken up by ball bearings. The 6 H.P. and 1 H.P. motors are mounted on the crab and have only one speed, being switched in and out of circuit without the use of any starting device. The lifting and transverse motions are limited to one speed. The 4½ H.P. motor gives the longitudinal motion, and has two speeds—full-speed and half speed. The higher speed is obtained by halving the number of stator poles, this operation being performed by a throw-over switch. The starting and reversing is done by a second throw-over switch. For cranes above 5 tons the lifting and longitudinal motors are equipped with a starting device, connected to the rotor through slide rings. Such an arrangement has not the peculiar property of the series wound continuous-current motor, of self-regulation of speed in accordance with the weight being lifted; but this is the only advantage that the continuous-current motor has over the three-phase machine. This, I think, is fully compensated for by the less delicate and complicated equipment the latter requires. The three-phase motor will stand a heavy overload or sudden reverse without fear of damage. Usually the lifting motor is designed for a maximum speed at heaviest load. This speed cannot be increased for lighter loads, but can be regulated at will under such a limit.

The Liverpool Grain Storage and Transit Company (Limited) have adopted a three-phase plant for their storage warehouse at Bootle. It has been running some 15 months, and there are at present nine motors giving a total of 150 H.P. The generator has an output of 165 H.P., and is coupled direct to a Belliss engine. They have no reserve generator, and do not stock any spare parts for either generator or motors. An extension of this plant is now in progress, consisting of two 48 H.P. and one 60 H.P. motors. This installation furnishes an example where lighting and power is taken from the same mains. There are about 200 lamps, which are connected across two phases; the lamps being arranged so that the current is distributed equally over the three circuits, so as to maintain the balance of the system. Another method of combining lighting and power on a three-phase system is to run a fourth wire from the common junction if the star connection be used. The lamps are connected between this fourth wire and any one of the three main cables; thus doing away with the necessity for balancing the three circuits.

For mining work, the multiphase system is specially adapted, and already a considerable amount of work has been done in this direction. The General Electric Company (Limited) have recently sent out, from their Manchester works, some three-phase plant for several South African mines. The largest of these plants was one sent to the Vogelstruis Mine:—The generating plant consists of two 150 kilowatt three-phase generators. They are belt driven, at a speed of 300 revolutions per minute, with a frequency of 30 cycles, and a pressure of 950 volts. Three triplex single-acting pumps, with plungers 6½in. by 8in., coupled direct by means of single reduction gear, to 35 H.P. motors. These motors run at 360 revolutions per minute. The pumps are designed to work at a crank shaft speed of 45 revolutions per minute against a water pressure of 300lb. per square inch; they are of American design, and were made by the Gould Company. Twelve triplex single-acting pumps, with plungers 4½in. by 8in., of the same general design as the foregoing, coupled direct by means of single reduction gearing to 20 H.P. motors, running at 360 revolutions per minute. These smaller pumps are also designed to work at a crank-shaft speed of 45 revolutions per minute against a water pressure of 300lb. per square inch. The main cable is triple concentric; each conductor having a copper area of 0·118 sq. in. The length of this main cable is 1,666yds. The branch cables are also triple concentric. There is one length of 430yds., the sectional area of each conductor being 0·047 sq. in. and another length of 1,300yds., with an area of 0·0314 sq. in. for each conductor. The above cables are lead covered and steel armoured.

Another plant was sent to the Knight Central Mine, consisting of two 100-kilowatt generators, running at 450 revolutions per minute; the voltage and periodicity being as described for the Vogelstruis Mine. There are three triplex pumps 6½in. by 8in., and eight pumps 4½in. by 8in., coupled direct by single reduction to 35 H.P. and 20 H.P. motors respectively. The length of the main triple concentric cable for this mine is 900yds.; each conductor having a copper area of 0·145 sq. in. The total length of the branch cables is 830yds.; each conductor having a copper area of 0·118 sq. in. A plant exactly similar to the Knight Central has been sent to Witwatersrand Mine. The following is a complete list of the motors supplied to the above three mines:—

All motors; 30 cycles 950 volts.

No.	H.P.	Speed per minute.	Starting Device.	How connected.
7	35	360	In rotor circuit.	Geared to pumps.
3	35	360	" "	Belted to machinery.
28	20	360	" "	Geared to pumps.
1	10	870	Switched into circuit without resistance.	Belted to machinery.
6	5	870	...	...

The generators for these three mines are all of the inductor type. At full load they give a commercial efficiency of 91 per cent., and the rise in temperature after long continuous runs is 25°C. The main switchboard is so arranged that the generators can be run in parallel. As these mines are very wet, the motors were designed with water-tight and ventilated covers. To enable the 20 H.P. and 35 H.P. motors to start up smoothly and gradually, they were supplied with starting resistances in the rotor. The 20 H.P. motors

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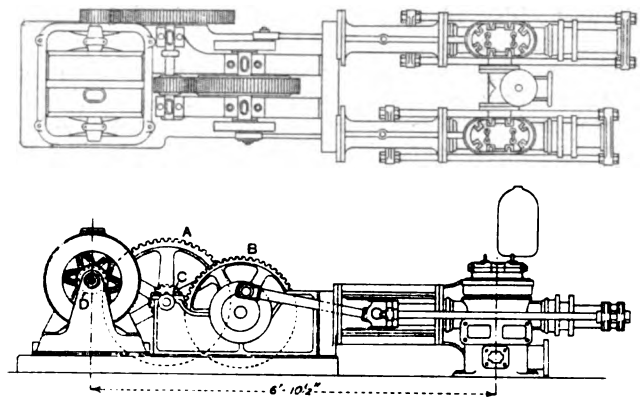
were made in Manchester, by the General Electric Company, Limited, and each machine was coupled to its pump, and tested separately at its full load for six hours, the rise of temperature being 25°C.

The York Gold Mining Company of South Africa have just installed a power plant, consisting of two belt-driven 50 H.P. three-phase inductor type generators, running at 75 revolutions per minute. These supply power to two 24 H.P. motors, the motors being coupled to Eastern, Anderson and Goolden belt-driven pumps. They have one 3 H.P. motor connected to a centrifugal pump and several small motors, which are belted to various kinds of machinery; and one 9 H.P. motor coupled direct to a continuous current dynamo, the output of which is 15 volts 300 amps., used for cyanide work. The electromotive force at the generators is 960



A. Wheel, 30in. diam., 90 teeth; B. Wheel, 26in. diam., 65 teeth, 3½in. face; C. Pinion, 8in. diam, 20 teeth, 3½in. face; D. Pinion, 6in. diam., 18 teeth, 3in. face.

FIG. 4.—Electrically-driven Duplex Pump.

volts at 50 cycles, the length of the line being 835 yards. The power is transmitted through bare overhead conductors, supported on porcelain insulators. The station and line are fitted with Wurts' lightning arresters.

Fig. 4 is a drawing of one of three horizontal 5in. by 9in. duplex pumps made for the Consolidated Gold Fields of South Africa. Each pump is capable of raising 200 gallons 60ft. per minute, and is coupled to a 9 H.P. three-phase motor through double reduction gearing. The speed of the motor is 1,150 revolutions per minute, with 60 cycles and 110 volts between two phases.

Fig. 5 is a drawing of an electrically-driven coal cutter, fitted with two 10 H.P. three-phase motors. The motors are wound for 500 volts, and are switched into circuit without any starting device.

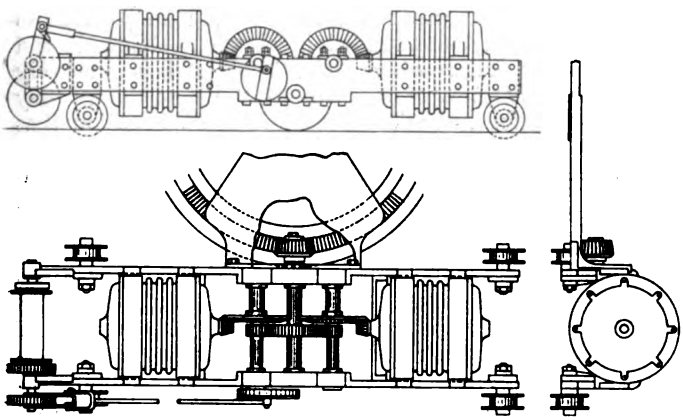


FIG. 5.—Electrically-driven Coal Cutter.

Their speed is 960 revolutions per minute; this being reduced to nine revolutions per minute at the cutter through treble reduction gearing. The diameter of cutter wheel is 5ft. 8in. This machine has been constructed for Messrs. Pope and Pearson (Limited), for use in their colliery at Normanton. The distance between the generators and coal cutters is about a mile.

The plants described in this Paper have all been supplied within the last two years, and although, I am sorry to say, it is a very small amount when compared with what is being done in the United States, Germany, or Switzerland, it is some satisfaction to know that a little progress has been made in this country in the manufacture of this class of work. Even those who do not admit of any or sufficient superiority of the three-phase over the continuous-current system to induce them to take up the manufacture of the former for use in England, must acknowledge that many large and valuable orders for our colonies and elsewhere are given to foreign firms, which ought to be executed in this country, but unfortunately so little has been done here that so far we are not in a position to compete.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 25, 1898.*

American Patents during 1897.—The report of the Commissioner of Patents for the year ending December 31, 1897, furnishes many interesting facts. During the year, 45,661 applications for patents were received. There were 23,729 patents granted, and 12,926 expired during the year. The total receipts over expenditures were £50,560. Of the patents issued to citizens of foreign countries, 706 were granted to residents of England. This number stands at the head of the list of patents granted to foreigners. The number of applications filed in 1897 exceeded by over 2,000 the total number filed in the 24 years of 1836 to 1860. The patent system of the United States differs from the English system, in that an examination into the novelty and patentability of every application for patents is made as a preliminary to the grant of the patent. Carried out to its full intent this system would result in the grant of valid patents only, and would prevent the issuance of a patent for any invention not new and useful. While it is not possible to determine with absolute certainty the novelty of every invention for which application for patent is made, it is possible to determine with certainty whether the invention has ever been patented or described in a patent or printed publication prior to the time when it was made by the applicant. This is the work of the Patent Office, and it is done with a completeness and accuracy which is remarkable. The Commissioner calls attention to the influence of patented inventions in the creation of new industries of enormous magnitude since 1880—that is, within the term of patents now in force or but recently expired. Of these new industries the most noted are those directly connected with the development of electrical inventions, such as the manufacture of electrical apparatus and supplies, supplying of electricity for lighting and power purposes, electric railways and the telephone. Shortly before 1880 there were 76 establishments engaged in the manufacture of electrical apparatus and supplies. In 1890 the number had increased to 189, employing 9,485 persons, and producing an output valued at £3,822,943. The increase in this industry has been very large since 1890. In the electric light and power industry there were but three establishments in the United States in 1880, employing 229 persons, and producing an output valued at £91,680. At the close of 1894 there were 2,124 central station and 7,475 isolated plants. The capital invested in the central stations was estimated at £51,791,250, and in the isolated plants about £40,000,000. An estimate of the number of persons employed at that time would not be under 45,000. Since then the growth of the industry has been steady and rapid. The total mileage of electric railways in the United States up to October, 1897, was 13,765 miles out of a total mileage of 15,718, of which but 947 miles were horse-car lines. The total capital invested was £169,226,338, and the total number of employés is estimated at not less than 166,000. At the close of 1896 there were 967 telephone exchanges and 832 branch offices, using 536,845 miles of wire and employing 14,425 persons. The total amount invested in telephone property in 1895 was £15,500,000.

Calibrating Ammeters and Electrodynamometers.—Prof. H. S. Carhart, of the Michigan University, calls attention to a method of obtaining alternating currents for calibrating ammeters and electrodynamometers, which, although obvious, he is inclined to believe is new to a great many engineers. The particular advantage of the method lies in the fact that it requires only a small amount of power and no lamp load, non-inductive resistance, &c. It assumes that one has avail-

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able a standard instrument for the measurement of alternating currents, such as a Kelvin balance of the requisite capacity. A source of electromotive force of small output is all that is necessary in addition to an ordinary transformer. Prof. Carhart uses a small alternator capable of giving a voltage up to 135 volts. He connects this directly to the primary transformer whose secondary must have a current capacity equal to the maximum current of the instrument to be calibrated. He then connects in series a standard instrument and the one to be calibrated, so as to short circuit the secondary of the transformer through them, using short, stout wires for making the connection. It will now be possible to obtain any current up to the maximum by adjusting the voltage of the small generator by varying its field excitation, beginning with low values. Since the only resistance in the secondary circuit is that of the instruments and of the secondary itself, the power absorbed is very small. When no small generator giving a lamp voltage direct is available, the secondary potential difference of any transformer may be applied to the primary of the transformer employed for calibrating purposes, with an adjustable resistance in series between the two step-down transformers.

Constant-Current Acceleration Controller.—On March 1st last three patents were issued to Prof. S. H. Short, covering the maximum constant-current acceleration controller invented by that gentleman and described in the American and English electrical journals last August. The function of this controller is to provide a constant current through each of the motors propelling a car or train, of such a strength as to just avoid slipping the wheels during the time of acceleration, the current to be reduced, as soon as the train reaches its full speed, to a value sufficient to maintain it at that speed. The advantages of such a method of control, both in point of saving of time and of power, are evident. The whole arrangement obviously provides a means for removing from the control of the motors the personal element of the motorman, his duty in the matter of accelerating the train consisting simply in setting the controller on the first notch, after which it automatically acts to accelerate the train with a certain given power consumption, the motorman being, of course, able at any time to instantly disengage the automatic apparatus and cut off the power. This acceleration with constant power consumption, of course, gives constant acceleration so long and only so long as the load is constant. The greater the weight to be accelerated the less the acceleration, the two being inversely proportional to each other, and the acceleration being also varied by such factors as grades, &c. The patents state that the device is particularly designed for use on elevated roads and such service where frequent starts and stops are required.

April 1, 1898.

Women in the Electrical Field.—There are a few women in this country who have received a technical education in electricity, and one that I can call to mind at the present time is practising the profession in Pittsburg, holding a position of some responsibility with the Westinghouse Electrical Manufacturing Company. Another instance of the business capacity of women in this direction is that of a Southern lady, who is an electrical engineer and contractor, and seems to be equal to the average engineer of the male persuasion. Another female, this time in Ohio, has acquired some prominence as a superintendent of a prosperous electric railway. She is only twenty years of age, and from all accounts is not behind her male competitors in operating the line. In New York State there is a female wire contractor, and she does considerable business in this line in her section of the State. New Jersey also enjoys the distinction of having an eccentric female, who runs an electric car on one of the Jersey roads. She seems to be fascinated with the work, but it is stated she has recently been persuaded to give it up, chiefly on account of the objections on the part of her male companions on the road and of her husband.

Electric Towing on Canals.—The question of utilising some electric system of towing on the canals of this State has been agitated for several years past, but nothing of a practical nature has yet been accomplished in this direction. Prof. S. H. Short has devised a system which has the stamp of common sense and practicability, which is more than could be said of some of the systems heretofore proposed. Experiments are about to begin at Tonawanda, on the Erie Canal, on Prof. Short's plan. The scheme is to haul a tow of boats by means of a locomotive on a track, along and parallel to the canal banks. The mining type of locomotive is to be used, and it will be powerful enough to haul a tow of five boats, each of 50 tons burden, at a speed not exceeding six or eight miles an hour. The overhead trolley system is to be used in the experiments, and in its main features it is practically a street railway system, the locomotive, or motor car, hauling the boats behind it. Prof. Short believes that the cheapness and economy of operation of this system will commend itself to the authorities, who are looking for a practical system to adopt on the canals.

American Institute of Electrical Engineers.—The next general meeting of the American Institute of Electrical Engineers will be held at Omaha on June 27th next, and will continue for three or four days. Omaha this year will be the Mecca for all scientific bodies which hold annual conventions, on account of the Trans-Mississippi and International Exposition which will be held there this summer. The Omaha Exposition promises to meet all the expectations of its projectors in the matter of number, quality, and size of the exhibits.

CORRESPONDENCE

TELEGRAPHY ACROSS SPACE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Some time ago, when Prof. Trowbridge represented himself as hardly done by that English experimenters in "space-telegraphy" appeared to "ignore" what he had previously done in that direction, you were good enough to afford me the opportunity of claiming, in your pages, a very much earlier publication of what he thought was a discovery of his own, and I am also glad to say identical with that just practically accomplished by Mr. Preece in the connection of a fort on the Flat Holm, in the Bristol Channel, with Laverock on the mainland opposite. I am not troubling you this time to urge any claim of my own, but to direct your attention to recent speculations on the subject of wireless telegraphy generally, and particularly to what Prof. S. P. Thompson is stated to have said at the rooms of the Society of Arts a few days ago—that "he was confident it would be possible to establish electrical communication between England and America across intervening space." It strikes me very forcibly that advocates of this sort of thing nowadays only jump at conclusions, and do not take into consideration that we are dwelling on a *globe* and not on a "flat earth."

Prof. Thompson bases his confidence in the ultimate accomplishment of transatlantic "space telegraphy" on certain results supposed to be obtained with "tuned or syntonic instruments," doubtless to be played upon, or influenced by Hertzian waves generated on "throwing electrical energy into the transmitting medium." It will certainly not be contested that all this energy must result in practically direct courses of influence from the generator in every direction; and, therefore, in the case of even so short a distance from England as St. John's, Newfoundland, it would have to travel in the direction of the chord joining the two places through at least 1,000 miles of water, without, indeed, the ray should be endowed with a certain prescience of the difficulty to be encountered, and seeking to avoid it—after the manner indicated on one of the diagrams that served to illustrate Mr. Preece's lecture at the Royal Institution—took a trajectorial flight *over* the curved surface of the water instead of going *through* it. In my opinion, neither of these courses would be taken. It goes without saying, that should the energy *not* pass through miles of water, the height to which it would be necessary to elevate the "syntonised instrument" above the surface of the earth to meet a tangential "ray" from the generator side would be impossible and inaccessible—not to say hundreds of miles high.—Yours, &c.,

J. W. WILKINS.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: Considering the immense amount of attention that is being given to this subject just now, I venture to inquire whether it is not desirable to lay some stress on the fact that commercial applications of this system of telegraphing must, so far as can be seen at present, be much more limited than one would imagine, to read the Papers that are published and to listen to the lectures that are being delivered on the subject. In Prof. S. P. Thompson's lecture at the Society of Arts last week, he very wisely laid stress on the fact that an important element in directing signals sent by inductive methods or Hertzian waves to their proper destination lay in the use of "syntony," a receiver being tuned to pick up signals of one particular wave length. Now it is precisely on this ground that I venture to think limits to the applicability of signalling in this way will be found. I do not wish to dogmatise, and I know that there is nothing more risky than to attempt to predict what can *not* be done, but is it not clear that the range within which instruments can be tuned or syntonised must lie within an octave of wave length? To take a crude example from acoustics, it is common knowledge that if any one note of a piano be struck successively with all the dampers raised, an increasing body of sound is heard, from the vibration of all the other strings of the piano which can vibrate in multiples or integral fractions of the periodic time of the first note, producing *overtones* or *harmonics*. Now are we not justified in expecting that the same phenomena will be observed in wave telegraphy? If we are, the limitations of the new method are at once obvious. The experiments hitherto recorded have been conducted by one transmitting party signalling to one receiving party at a time, and it seems to have been rather hastily concluded that an entire telegraphic or telephonic system, such as that of the metropolis, for example, could be carried on in the same way.

The syntonising of receivers to correspond with given rates of transmission signals would appear also to be not the only element in the success of signalling between ship and ship. In Prof. Lodge's lecture on Hertzian waves at the Royal Institution on June 1, 1894, he explained the principle of syntony by putting the receiving apparatus into and out of tune with his oscillators. The means adopted to tune the receivers in those experiments were of a somewhat coarse character, such as the shifting of a loop of wire along the neck of another loop, the varying of the impedence of a circuit by moving the iron core within a transforming coil, and the like; which suggests that if we suppose there be two hostile fleets within signalling distance of one another, it would be an easy matter for a person on a vessel of one fleet, with a receiver capable of wide adjustment, by the exercise of some patience, to pick up any signals that might be passing between the ships of the other fleet.

The above reflections are suggested by Prof. Thompson's Society of Arts' lecture of last week. If they are incorrect, I shall be glad of enlightenment.—Yours, &c.,

Thames Iron Works, Blackwall, E. CHARLES E. GROVE.
April 5, 1898.

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office." No. 13, Vol. LXXXII. Published by Authority of Congress. (Washington: Government Printing Office.)

"Report of the United States Commissioner of Patents for the Year ending December 31, 1896." (Washington: Government Printing Office.)

"Radiography and the X-Rays." By S. R. Bottone. (London: Whittaker and Co.) Price 3s.

"Alternate Currents in Practice," translated from the French of Loppé and Bouquet by F. J. Moffett. (London: Whittaker and Co.) Price 15s.

"The Theory and Practice of Electrolytic Methods of Analysis,' by Dr. Bernhard Neumann. Translated by John B. C. Kershaw. (London: Whittaker and Co.). Price 10s. 6d.

"Science Abstracts." Part 3, Vol. I. Edited by J. Swinburne. Issued under the direction of the Institution of Electrical Engineers and the Physical Society of London. (London: Taylor and Francis.) Price 3s. net.

LEGAL INTELLIGENCE.

Taskers v. London and Counties Hotels Company.

At the Coventry County Court last week Taskers (Limited) sued the London and Counties Hotels Company (Limited) for £63. 6s. 2d. for goods sold and delivered, work done, and materials supplied in fitting up the King's Head Hotel, Coventry, for the electric light. The order for the work was given in May last, and the work was carried out and completed in August. No complaint was made until an application was sent for payment in October, when a long correspondence ensued, in which defendants disputed the accounts, and said that the work was most unsatisfactory, alleging that the arc lamps made a great deal of noise and disturbed the customers. Mr. J. W. Manley, local manager for the plaintiffs, deposed to the carrying out of the work, which was satisfactorily done. The current was received from the local electricity supply works, and was on the alternating-current system, with which it was impossible for the work to have been done any better. The arc lights on an alternating current, he said, always made a certain amount of noise. Mr. Radford, also in Messrs. Taskers' service, gave evidence. Mr. Gilbert S. Ram, electrical engineer to the Coventry Corporation, stated that the arc lights in question were fitted in a proper manner, and were very quiet of their kind. Colonel Newitt, for defendants, stated that he was perfectly unacquainted with electrical science, and the arc lamps were placed on the advice of Mr. Radford, who said nothing about them making an offensive noise. This noise was so great that it drove the customers away. His Honour pointed out that this could not be a defence in law. It did not appear that he called in the plaintiffs as advisers, but simply as contractors to carry out the work. He decided against the defendants, and gave judgment for plaintiffs for £59. 8s. 8d. and costs.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. *Now ready.* Price 6s., post free; abroad, 6s. 6d. Digest post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. *Now ready.* Prospectus on application.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. New Edition now ready. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. *Now ready.*

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J WADE. *In the Press.*

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

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"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d.; by post, 7s. 9d. abroad, 8s. A fine large paper edition with wide margins can be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"The Electrician" Electrical Trades' Directory and Handbook.—This Directory and Handbook for 1898 is *now ready*. Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary.

Tenders Invited.—The Bethnal Green (London) Board of Guardians require tenders for the supply of electric lighting plant and for wiring their new infirmary at Palestine-place. An advertisement elsewhere contains further particulars, and plans can be seen at, and specifications obtained from, the architects (Messrs. Giles, Gough and Trollope), 28, Craven-street, Charing Cross, W.C. Tenders must be delivered to the Clerk to the Board (Mr. David Thomas), Guardians' Offices, Bishop's-road, Victoria Park, London, N.E., by 10 a.m. on Tuesday, May 17.

——— The Corporation of Sunderland require tenders for the supply of a high-speed 225-kilowatt steam dynamo and Lancashire or Galloway boilers. Further particulars are given in our advertisement columns, and specifications can be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street. Tenders (addressed to the Chairman of the Lighting Committee), must be sent to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon on Friday, the 29th inst.

——— From our advertisement columns it will be seen that the Bootle Corporation require tenders for the supply and erection of arc and incandescent lamps, lamp-posts and accessories. Drawings, &c., may be seen at the office of Mr. Thomas L. Miller, M.Inst.E.E., 7, Tower-buildings N., Water-street, Liverpool, and tenders, addressed to the Watch Committee, Bootle, must be delivered at the office of the town clerk (Mr. J. H. Farmer) by 5 p.m. on Monday, the 25th inst.

——— The Accrington Corporation require tenders for the supply and erection of (*c*) three sets of steam dynamos, feed water heater, feed pumps, steam, exhaust and water pipes, &c.; (*d*) a storage battery having a capacity of 750 ampere hours; (*e*) switchboards, instruments, apparatus, cables, wires, &c., at the electricity station; (*f*) cables, wires, street boxes and connections. Tenders to Mr. Aitken, town clerk, Town Hall, Accrington, by Tuesday, the 19th inst.

——— The Belfast Harbour Commissioners require tenders for the supply of three belt-driven continuous-current series-wound dynamos. Tenders to the secretary (Mr. W. A. Currie), Harbour Office, Belfast, by Monday, 18th inst.

——— The Belfast Harbour Commissioners also require tenders for the supply and erection of three compound two-crank self-lubricating single-valve quick-revolution vertical engines. Tenders to Mr. W. A. Currie, by Monday, 18th inst.

——— The Glasgow Corporation invite tenders for the supply of earthenware casing for the electricity department. Tenders to Town Clerk by 18th inst.

——— The Corporation of Eccles invite tenders from "free" wiring firms for wiring premises in the borough. Tenders to Town Clerk by 22nd inst.

——— The Cardiff Corporation require tenders for the wiring of the old post office buildings, St. Mary-street. Tenders to Town Clerk by 20th inst.

——— The Wallasey Urban District Council require tenders for the erection and completion of extension to the engine and boiler house at the electricity supply station, Seaview-road, Liscard. Tenders to the clerk (Mr. H. W. Cook), Public Offices, Egremont, by 21st inst.

——— The Wallasey District Council require tenders for the supply of 12 months' stores for the gas, water and electricity department, including electricity meters, lamp columns, switches, and cut-outs, &c. Tenders to the Clerk of the Council, Egremont, by 21st inst.

——— The Winchester Town Council require tenders for the lighting of the streets of that city for three or five years from Nov. 1. Tenders to the Town Clerk by 30th inst.

——— Tenders are invited until May 31 by the Municipal Authorities of Ixelles, near Brussels, for the concession for electric lighting and power for 26 years. Particulars from and tenders to Le Secretariat de la Commune d'Ixelles, Brussels.

Tenders Invited.—The Belgian State Railway Authorities require tenders for the laying down of an electric lighting plant at the Gaud Sud railway station and the locomotive sheds and workshops at Ledeberg. Particulars from and tenders to La Bourse, Brussels.

——— The Roumanian Post and Telegraph Authorities invite tenders until the 30th inst. for the supply of 5 tons of tinned copper wire, 50 tons of galvanised iron wire and 10 tons of galvanised steel wire. Tenders to La Direction Générale des Postes et Telegraphes, Bucharest, Roumania.

——— The Telegraph Department of the South African Republic invite tenders for the supply of insulators with brackets and hard-drawn copper wire. Tenders to the Consul-General, 9, Nicolaas Witsenkade, Amsterdam, by 24th inst.

Tenders Accepted.—The Redditch District Council have accepted the following tenders for electric lighting plant:—

Gas engines—Wells Bros.	£2,814
Dynamos—United Ordnance and Engineering Company...	1,313
Cables—Henley's Company	1,200
Building—T. Surman	993
Gas-producing plant—Dowson Economic Gas Company ...	625
Transformers—Nalder and Hilton	572
Switchboards—Nalder and Hilton	220

Fresh tenders for belting, shafting and pulleys are to be obtained.

——— Subject to the confirmation of the Local Government Board to the requisite loan, the Blackpool Town Council have accepted the following tenders for extensions at the Corporation Electricity Works, viz.:—

Boiler and superheaters	Babcock and Wilcox.
Condensers and storage tanks	Cole, Marchent and Morley.
Rectifiers	S. Z. de Ferranti (Limited).
Boosters	Chas. J. Cowan.
Cables	British Insulated Wire Co.
Transformers	Nalder and Hilton.

——— The Bootle Town Council have accepted the tender of the Chloride Electrical Storage Syndicate for supplying two storage batteries at £1,079, and for the maintenance of same at £64 per annum.

——— The contract for the electrical equipment of the Hartshill (Dudley)-Stourbridge tramway has been let by the British Electric Traction Company to a leading firm of contractors.

——— The Electric Lighting Committee reported at Wednesday's meeting of the Walsall Town Council that they had accepted the tender of the Callender Company, for supplying and laying new feeders and relaying old ones for £1,815. 9s. 2d.

——— The tender of Messrs. Myles and Warner, of Sett-street, Stalybridge, has been accepted by the St. Pancras Vestry for the erection of a chimney shaft at the Regent's Park supply station at £4,878. 10s.

Tenders Received.—The following tenders have been received by the Leyton District Council for the supply of: (1) two dynamos and one continuous-current balancing transformer, (2) two gas engines and connections, (3) building, and (4) switchboard for the Electricity Supply Department:—

Contract No. 1.		*Contract No. 2.*	
Rosling and Appleby	£578 10 0	Wells Bros.	£1,707 6 0
General Electric Co.	647 16 6	J. E. H. Andrew & Co.	1,803 2 0
Johnson and Phillips	716 15 0	Crossley Bros.	1,900 0 0
Laing, Wharton & Down	732 0 0	*Contract No. 3.*	
Paterson and Cooper	736 0 0	F. J. Coxhead	2,594 15 0
Siemens Bros. and Co.	737 0 0	J. Haydon	2,643 4 9½
India Rubber Company.	738 0 0	*Contract No. 4.*	
United Ordnance Co.	761 0 0	Laurence, Scott & Co.	150 0 0
Laurence, Scott and Co.	771 0 0	Veritys (Limited)	153 4 9
Brush Company	827 7 0 / 771 10 0	Laing, Wharton & Down	157 10 0
		Bertram Thomas	175 15 8
Electric Construction Co.	854 0 0	James White	181 12 9
Thomas Parker (Ltd.)	931 10 0	Siemens Bros. & Co.	239 5 0

No tenders have yet been accepted.

——— The following tenders have been received by the Bournemouth Town Council for the supply and erection of electric lighting plant for lighting the Pier and Lower Pleasure Grounds:—

Cash, Robinson & Co.	£1,252 17 0	L. G. Tate	£1,602 0 0
Bournemouth & Dist. Electric Supply Co.	1,415 0 0	Laing, Wharton & Down	1,707 0 0
E. G. Bryant	1,458 6 0	Brush Company	1,740 0 0
Fippard and Cooper	1,521 18 0	Johnson and Phillips	2,255 18 0
Brit. Insulated Wire Co	1,583 14 9	Crompton and Co.	3,204 0 0

Five informal tenders were also received. On the advice of the Surveyor, the tenders of Messrs. Cash, Robinson and Co. and the Bournemouth Company were reserved for further consideration by the Pier, Winter Gardens and Parks Committee.

Appointments.—Mr. Herbert Stansfield has been appointed lecturer in physics and mathematics at the Blackburn Municipal Technical School at a salary of £250 per annum.

——— Mr. Gordon Bryant, assistant engineer, has been appointed borough electrical engineer at Great Yarmouth, in suc-

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cession to Mr. A. W. Ranken, who recently resigned the position. The salary is to be at the rate of £175 per annum for the first six months.

Appointment Vacant.—The Technical Instruction Committee of the Borough of Accrington require a head master for their Organised Science Day School. Salary, £300. Applications to the Town Clerk.

Vacancy.—The Vestry of St. Mary, Islington (London) require a switchroom attendant. Salary, 30s. Applications to the Electrical Engineer, 50, Eden-grove, Holloway, N., by noon on Monday, the 25th inst. See advertisement.

Business Notice.—The Zurich Incandescence Lamp Company, of 47, Victoria-street, Westminster, London, S.W., are now connected with the National Company's telephone system, No. 488, Westminster.

Dissolution of Partnership.—Messrs. Herbert Willoughby Ellis and Edward William Townsend Ward, electrical engineers, 113, Edmund-street, Birmingham, have dissolved partnership. Debts by Mr. Ellis, who will continue the business under the same style.

Bankruptcies.—John Dewhurst, electrician, &c., 52, North End-road, West Kensington, will apply for his discharge on May 4 at Bankruptcy-buildings, Carey-street, W.C.

——— The first meeting of creditors in the failure of James Fletcher and John Arthur Hirst, of Burnley, and lately trading as electrical engineers under the style of Fletcher, Hirst and Co., at Chester and Derby, takes place on the 19th inst. at the Official Receiver's, Byrom-street, Manchester. Public examination on the 29th inst. at the Court-house, Burnley.

Liquidations.—The British Electrozone Corporation, Limited, is to be wound up voluntarily. Mr. A. E. Edwards, Broad-street-avenue, London, E.C., is liquidator.

——— A meeting will be held at 6, Old Jewry, London, E.C., on May 16, at 11 a.m., for the purpose of receiving an account of the voluntary winding-up of J. C. Howell, Limited (old company), and of fixing the remuneration of the liquidator (Mr. S. F. Isitt).

——— A meeting of the Electrophone (Limited) will be held on May 14 at 34 and 35, Gerrard-street, London, W.C., to receive an account of the winding-up. Mr. J. Thompson is liquidator.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) on April 6 and 7, with the ports of destination:—

Argentina—La Plata, £12. *Australasia*—Albany, £15; Sydney, £653; Wellington, £100. *Holland*—Amsterdam, £100. *Hong Kong*—£812. *India*—Bombay, £19; Calcutta, £56. *North Atlantic*—£11,520 (telegraph cable). *Portugal*—Lisbon, £75. *South Africa*—Cape Town, £1,102; Delagoa Bay, £16; Durban, £201; Port Elizabeth, £258. *Sweden*—Gothenburg, £22. *United States*—New York, £1,150. *West Indies*—Antigua, £16 (telegraph material). Total (for two days) £16,127, against £17,768 for the week ended April 13 last year.

Telegraphic Communication to the Philippines.—The Eastern Extension Telegraph Company announce that, with a view to improving telegraphic communication with the Philippines by making it independent of the long landline between Cape Bolinao and Manila, they have extended the cable from Hong Kong to Manila direct.

Electric Bells, Telephones and Accessories.—Messrs. Dobsons and Curtis Bros. (Limited), of Dublin, forward a well-illustrated list of electrical supplies, which can be obtained from stock at their central Dublin stores.

Lord Kelvin's Electric Instruments.—Mr. James White, of 16-20, Cambridge-street, Glasgow, has just issued a very complete catalogue of Lord Kelvin's electric instruments for laboratory and central station use. The catalogue also deals fully with instruments and apparatus for general use by electrical engineers, and, in addition to its value as a price list of a vast number of instruments in everyday use, supplies an interesting and very readable review of the work which the various instruments are designed to perform. Included in the catalogue is the table of fees for examination or testing of electrical instruments by the Board of Trade Electrical Standardising Laboratory.

Ayr.—The Police Commissioners have decided, on the recommendation of the borough electrical engineer (Mr. A. J. Fuller), to light the Racecourse-road, Midton-road, and Carrick-road districts electrically at an estimated cost of £1,187.

An application for permission to introduce the overhead trolley system of electric traction on the local tramways has been refused, the Council considering that "it is too early to decide the form of traction to be adopted."

Barnsley.—The consulting engineer (Mr. T. L. Miller) has presented his report on the electric lighting question, and this will be considered by the Council on the 23rd inst.

Belfast.—The statement of accounts of the electricity department for the year ended Dec. 31 shows the undertaking to be in a prosperous condition.

Blackpool.—At the meeting of the Town Council last week it was resolved that the approved standard clauses issued by the Electrical Engineering Plant Manufacturers' Association and the Municipal Electrical Association, for adoption among the general conditions of specifications for electrical engineering plant, be referred to the Town Clerk and Borough Electrical Engineer (Mr. Robert C. Quin) for inclusion, if considered fit, in any conditions of specification for electrical engineering plant issued by the Electric Lighting Committee.

Bolton.—The Electricity Department of the Corporation has made considerable progress during the past year. The number of consumers has increased from 223 to 373, and in lamp connections there has been an increase of 66 per cent.

Bootle.—The Local Government Board have sanctioned the borrowing of £33,594 for electric lighting purposes. The sum of £1,406 in respect to machinery for the lighting of the Town Hall, and which it was proposed to supersede, has been excluded from the proposed loan.

Bournemouth.—A Local Government Board inquiry was held here on Thursday by Mr. F. Tulloch, into the application of the Town Council to borrow £16,000 for carrying out various improvements, including the electric lighting of the pier and public gardens.

Brighton.—By the narrow majority of 18 votes to 17 the Town Council has rejected the recommendation to reduce the price of electric current, after the first hour's use, from 1½d. to 1d. per unit.

Camberwell (London).—A report presented by the General Purposes Committee to the Vestry states that the estimated cost of the work done in the parish by the County of London and Brush Provincial Company to the present date is £3,200. The Committee recommended the Vestry not to proceed with the proposed purchase of the Company's undertaking, and the proposed purchase has therefore been abandoned. The Company is now proceeding to lay mains in several streets in the district.

China Furniture and Electrical Fittings Association.—An association has recently been formed with the object of consolidating and protecting the interests of the firms engaged in the china fittings branch of the electrical industry, and at a dinner held last week at the Grand Hotel, Birmingham, to celebrate the formation of this combination, Mr. E. J. Smith, chairman of the Association, presided. Mr. W. Woodall, M.P., a prominent member of the trade, was the guest of the evening, and, in responding to the toast of his health, said the first inquiry respecting the new combination movement came from his firm, and the principles of the proposed scheme of co-operation appealed to him as being in theory just what was required in the interests of employers, workmen and customers. He had always believed in profit-sharing, and had found no difficulty in devising methods by which it could be done. His difficulty had been that he could make no profits to divide with anyone. It would be scarcely possible to make a more startling confession when the peculiar character of their trade was remembered. Anyone who had a knowledge of the enormous difficulties with which they had to contend, the skill and patience which were required to keep pace with electrical requirements, and the very few people who had even attempted to master these difficulties, would naturally suppose that they had a great monoply from which fortunes could easily be made. Yet it was within the knowledge of all concerned that the opposite of this result had prevailed in their trade. It was too early yet to pronounce a decided opinion as to the final effect of the scheme upon their position as traders. It was, perhaps, sufficient for the present to say that it had effectually stopped the downward tendency of prices, and had placed their trading upon a sounder basis, while it had also established an understanding between themselves and their workpeople of a most amicable and satisfactory character. Moreover, it had brought the members of the trade together in a friendly way, breaking down jealousies and misconceptions, and establishing united action for common good. That there was a necessity for some such a co-operation was evident from the fact that in a trade like theirs, which really had a claim upon the public for remuneration upon a basis somewhat higher than that of ordinary mechanical skill, they had been unable to obtain, without combination, anything like an adequate return for their capital and intelligence. The scheme they were now trying had undoubtedly prevented disaster.

Croydon.—The electricity supply works were taken over on quarter-day by the Corporation from the British Thomson-Houston Company. Application has been made to the Local Government Board for sanction to borrow £3,000 for the extension of the buildings and other works at the electricity station and another sum of £26,000 for the extension of mains to South and Upper Norwood. The Corporation has given formal notice to the Crystal Palace District Electric Supply Company of their intention

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to acquire so much of the Company's undertaking as lies in the Croydon area.

Dartford.—The Electric Lighting Committee have received an offer for a transfer of the Dartford Provisional Order, and are collecting details of the terms upon which similar Orders have been transferred by other Councils, and also particulars of the terms upon which electric lighting works have been taken over by Local Authorities from local companies. As soon as this information is presented the whole question of electric lighting for the district is to be fully considered.

Dudley.—At the meeting of the Town Council last week the Mayor (Mr. G. H. Dunn) announced that a deputation from the Midland Electric Corporation had recently waited upon the Electric Lighting Committee and laid before them an amended offer for the supply of electric current. The Company offered to lay mains to supply electricity for the first hundred hours at 5·5d. per unit per quarter, and at 2½d. for extended use. If the Town Council laid the mains the prices would be 5d. for the first hundred hours and 2d. afterwards. The supply of electricity in bulk was offered at a uniform rate of 3·25d. per unit if the Company laid the mains, and 2·75d. if the Town Council laid the mains. The cost for public lighting would be 1·6d. per unit, and for traction purposes for not less than 100,000 units per quarter, 1·33d. per unit, subject to certain conditions as to distance of supply.

Dundee.—For the eleven months ended March the electricity receipts amounted to £4,224. 16s. 10d., an increase of £441. 8s. 8d. on the same period of the previous year.

A lengthy report on the proposed extension of the electric lighting area has been prepared by the borough electrical engineer (Mr. W. H. Tittensor). The following tabular statement shows the progress made by the electricity department since the commencement of supply in 1893:—

	Lamps.	Units sold.	Increase.
1893	8,470	66,228	—
1894	11,860	156,843	90,615
1895	14,001	202,437	45,594
1896	17,945	254,278	51,841
1897	22,897	323,187	68,909

The length of streets through which mains were laid for supply up to the end of 1897 was four miles. In the extended area the total length would be eight miles. In the new districts Mr. Tittensor anticipates a demand for 25,000 lamps after five years, exclusive of public lighting. The distribution mains of the new area would be fed from the present generating station through four sets of feeder mains. The whole of the extended area could be supplied with current from the present station, which would have to be considerably extended. Additional boilers, engines and dynamos equal to 900 H.P., together with the necessary steam pipes, pumps, economiser, and switching gear would be required. The cost of the extensions are estimated as follow:—Distribution mains, £14,400; feeder mains, £4,000; buildings, &c., £3,600; boilers, seatings and fittings, &c., £1,800; engines, dynamos, steam pipes, &c., £9,200; switchboards and instruments, £1,400; economisers, &c., £600—total £35,000. This sum includes spare culverts along the existing tramway routes for the reception of feeder mains in the event of electrical traction being adopted. The three-wire system of distribution at 200 volts at consumers' terminals is recommended for the extension. Of the 22,897 lamps connected in the old area, 16,000 are being supplied at the old pressure of 100 volts, and 6,897 at 200 volts, and Mr. Tittensor advises that the whole be converted into a 200-volt supply. The most serious objection to the change was that the customers of the Council at present taking current for only one arc lamp installed would be paying double the present rate. Mr. Tittensor therefore suggests that all those mains supplying customers at 200 volts be connected up to the new system to be laid as a three-wire system at 200 volts, and those mains supplying the older customers at 100 volts be inter-connected as a modified five-wire system supplying at 100 volts, until such time that it might become necessary or expedient to gradually change on to the 200-volt supply, after which the whole of the old and new area would resolve itself into one three-wire system at the higher voltage. Present requirements would be the extension of the present buildings at the generating station, the laying down of the three-feeder mains to the north, east and west districts, and the erection of one boiler, engine and dynamo with the necessary piping, &c., at an estimated cost of £9,300. The question is to be considered by the Committee.

Durham.—Members of the Town Council are beginning to take a more active interest in electric lighting matters. Some time ago an electric lighting company obtained permission to put down plant for lighting the cathedral, and also for supplying current to private consumers, but at last week's meeting of the Council the Gas Lighting Committee recommended "that specifications and estimates be obtained for the supply and erection of plant capable of supplying current for public and private lighting." The matter was finally referred back to the committee in order that terms may be obtained from private persons to carry out these objects.

Douglas (Isle of Man).—The Town Council discussed with their consulting electrical engineer (Prof. J. A. Fleming) yesterday the project for establishing municipal electricity supply works.

Electricity in Mining.—Messrs. Robert Holliday and Sons, of East Ardsley, have decided to put down an electric light and power plant at their collieries.

Electric Traction in the Dudley District.—The British Electric Traction Company, who have practically purchased all the shares in the Dudley and Stourbridge Company, have entered into contracts for the conversion of the present line from Hart's Hill to Stourbridge into an electric system, and within six months the line will be electrically equipped. A site has been purchased near Canal-street, Brierley Hill, and plans for a power generating station are being prepared, the contract for the alterations to the permanent way, as well as for the electric equipment having been already placed. The lease of the line from Dudley to the borough boundary at Hart's Hill expires in about four years, and the Corporation propose taking over that portion of the tramway and working it themselves by electricity. The Dudley Town Council have also decided to construct and electrically equip a new tramway from Queen's Cross to Cradley Heath or Brierton's Bridge. The Corporation have decided to oppose the application of the British Electric Traction Company for an Order to carry out a similar undertaking.

Exhibition.—An Art Metal Exhibition will be opened at the Royal Aquarium, London, on May 27.

Fulham (London).—The Electrical Development and Finance Corporation recently submitted proposals for the transfer of the Vestry's Provisional Order and for the erection of electricity supply works in the district, and a sub-Committee has recommended that negotiations be entered into with the Company on the basis of their offer. This recommendation has, however, been rejected by the Electric Lighting Committee, who advise the Vestry to themselves carry out the terms of their Provisional Order.

Gloucester.—At the last meeting of the Electricity Committee the consulting engineer (Mr. Robert Hammond) submitted plans of the proposed arrangement of the electricity and dust-destructor works. The plans were approved, and Mr. Hammond was authorised to obtain plans and estimates for four dust-destructor cells from four firms.

Great Grimsby.—The local tramway company have submitted to the Town Council the terms upon which they are willing to convert their system into electrical lines. These conditions are: The time at which the Corporation are to have the power to purchase the lines to be extended for another 21 years; the Company to re-construct the lines and to bond the rails suitable for electric traction; the Corporation to erect the standards and trolley wires, the Company paying for their use such a sum as would cover interest and sinking fund upon the capital expenditure, and if the standards are used for electric lighting, the cost to be divided between the Company and the Corporation; the Company to maintain and renew the trolley wires, or if done by the Corporation, to pay the net cost; the Corporation to allow the Company to alter the position of any of the existing passing places or lines, and to construct such additional passing places as may be necessary for the efficient working of the tramways by electricity; the Corporation to provide the feeders and other appliances necessary to supply the electric current for running the cars; the Company to pay to the Corporation 1½d. per unit for electric current, and to guarantee a minimum of 360,000 units per annum; the Corporation to undertake to supply the electric current to the Tramway Company, under a penalty for any failure to do so from any cause whatever.

Great Yarmouth.—The quarterly statement of the Electricity Department, presented at Tuesday's meeting of the Town Council, showed total receipts £1,203. 5s., and after deducting expenditure there was £564. 2s. 9d. to meet interest and sinking fund. For the nine months ended December (after allowing for interest and sinking fund) there was a deficiency of £327. A report from Mr. Ranken recommended that another steam-engine and alternator be put down at the station. The number of lamps connected during the last two years had been increasing at the rate of about 2,500 lamps per annum, and assuming that this rate of increase continued during the next 18 months he estimated that the number of lamps connected would, in September, 1899, be about 14,700, necessitating additional machinery to allow for 10,000 lamps being alight simultaneously, together with the necessary reserve plant. This would require another 150-kilowatt steam alternator, which would bring the capacity of the station up to 12,000 lamps alight at one time. The cost of this steam alternator would be £2,500. £1,600 would also be required for additional high and low-tension mains, and £400 for transformers and transformer stations, bringing the total proposed additional expenditure up to £4,800. The Council have decided to carry out the extensions suggested, and to apply to the Local Government Board for sanction to borrow the necessary funds.

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Holborn (London).—In reference to the applications by the Charing Cross and Strand Corporation and the County of London and Brush Provincial Company for Provisional Orders for this district, the Board of Trade propose to divide the district into two areas, one company to have the part south of Holborn and the other the northern part. At the last meeting of the Board of Works Mr. Jacobs moved that the Board of Trade be informed that both companies should be allowed to come into the district. The Clerk reminded the Board that there was a company already in the district, and it was also open to the Board itself to apply for an Order to supply electricity, but Mr. Jacobs' motion was adopted.

Kingston (Jamaica).—The West India Electric Tramway Company, who recently received a licence from the Privy Council of Jamaica to construct tramways in this town and district, have commenced the work of construction.

Klondyke.—The United States Consul at Vancouver states that the town of Skagway, on the United States side of the Yukon, is now a well-established township, with a population of 4,000 people; that the electric light is in general use, and that telephonic communication is established with an outside locality boasting a population of between 500 and 600 persons.

Lecture.—The energetic convener of the Electric Lighting Committee (Bailie Mackenzie) delivered an interesting address before the members of the Edinburgh Association of Science and Art in the National Portrait Gallery on Monday evening on "The Progress of the Electric Light in Edinburgh." A discussion followed, and after answering a number of questions, Bailie Mackenzie was warmly thanked for his address.

Leyton.—At the monthly meeting of the District Council last week the tenders recently sent in for the supply of additional plant for the electricity department were opened and referred to the Electric Lighting Committee for consideration and report. A full list of these tenders is given in another column. In his annual review of the proceedings of the Council the chairman (Mr. C. G. Musgrave) said that a large revenue was now being derived from the electricity works, and there could be little doubt that in the near future a large profit would result from this branch of the Council's enterprise. He thought they might congratulate themselves that the works were not constructed too late, as the district was still only in a partial state of development; as they knew the capacity of the works was now strained to the utmost, and they had already sanctioned an additional expenditure of £15,000 to proceed with extensions as rapidly as possible. The street lighting had given universal satisfaction. He had little doubt that when the department could show a net profit on the working the Committee would, in the first instance, apply that profit to the improvement of the public street lighting. The engineer (Mr. H. C. Bishop) had informed him that the units sold during the year were 122,544. The net sales amounted to about £2,308, and the net expenditure, after deducting stores in hand, to £1,785. Interest and repayment of loan come to £1,203. 13s. 3d., leaving a deficiency on the year's working of £680. 13s. 3d. Their engineer had estimated that next year there would be a net profit of about £90. On the recommendation of the Electric Lighting Committee the Council have decided to revise their scale of charges for current as from July 1 next. The new rates will be 5d. per unit for the maximum demand for the first hour and a-half and 2d. per unit after. The West Ham Guardians have been offered supply on these terms, or at a uniform rate of 3d. per unit.

Light Railway Scheme.—The Llandudno Town Council have decided to support the scheme for the construction of a light (electric) railway to connect Colwyn Bay, Llandudno, and Deganwy. Some time ago the Light Railway Commissioners held an inquiry into a similar project, but the Council opposed it, and brought forward a project for the construction of local tramways. Thereupon Lord Mostyn blocked the Council's scheme, hence this latest decision to support the proposal for a light railway for the whole district.

Lincoln.—At the meeting of the City Council last week the Electricity Works Committee's report, an abstract of which was given in our last issue, was presented, and, after discussion, adopted.

Lowestoft.—It has been found that the site originally selected for the erection of an electricity supply station is unsuitable, and the surveyor has been instructed to report upon other available sites.

Motor-Carriage Tour.—The general opinion of the public as to the turn-out made by the Automobile Club of Great Britain for its Easter six days' tour on wheels was that the cars (or rather carriages) presented a more workable and dapper appearance than at any previous gatherings of the kind. Only one electrically-driven carriage was in evidence.

Paisley.—At a meeting of the Town Council on Tuesday the scheme of the British Electric Traction Company, for the extension of the present tramway system and for the introduction of electric traction, was further considered. Rival proposals have been submitted by Mr. R. Bickerdyke, of Montreal, and the question was postponed pending a report from the borough electrical engineer (Mr. Francis Teague) upon both schemes.

Private Bill Legislation.—The report of the Board of Trade upon all Bills relating to railways and tramways and electricity supply has been issued. The number of Bills relating to tramways is 34, and power is sought to construct 105 miles of tramway, and to raise capital to the extent of £1,837,580. Compared with 1897, the number of Bills shows an increase of two and a decrease of £2,892,444 in the capital. There are four Bills relating to the supply of electrical energy, in one of which the proposed capital is £1,000,000.

Rathmines (Dublin).—The Electric Lighting Committee have been requested to consider and adopt the steps necessary to preserve the Commissioners' rights under the Order-in-Council authorising the erection of electricity supply works.

Redditch.—The District Council at their last meeting considered tenders for the supply and erection of electric lighting plant, and contracts for various items were let. The consulting engineer (Mr. J. A. McMullen) was also authorised to engage an engineer to superintend the erection of the electricity works and to undertake the charge of same when complete.

Salford.—On the recommendation of the Electric Lighting Committee the Council have decided to purchase land at Bedlam-lane as a site for a new electricity generating station. In supporting the recommendation the Chairman of the Committee (Mr. Haworth) said they had to make arrangements for supplying a large amount of power in the near future for working the tramways, and they had now a very large demand for current for both lighting and power purposes. The site is on the canal, and close to the railway. The Council will apply for borrowing powers for electric lighting purposes for £33,000 instead of £50,000, as originally proposed.

Shannon Electric Power Scheme.—The Limerick Fishery Conservators last week received a deputation from the Shannon Electric Power Syndicate on the subject of the scheme for the utilisation of the water of the river Shannon in the generation of electricity. The deputation consisted of Lord Lurgan, Col. Sir Gerald Dease and the engineer (Mr. H. J. Fuller). Lord Lurgan explained that the Syndicate proposed to take the overflow from the river in the winter months, and to maintain the present level by utilising steam power when necessary in the driest months. If the scheme were a success it would lead to the development of the business and the industrial resources of the district. Mr. Fuller said the horse-power to be used all the year round at their works at Castleconnell was 5,000, the maximum being 10,000. After lengthy discussion the matter was adjourned.

Sheffield.—At a meeting of the City Council on Wednesday a formal resolution approving the Council's Bill now before Parliament for the purchase of the undertaking of the Sheffield Electric Light and Power Company was passed.

South African Telegraphs.—The anxiously-awaited report of the Directors of the British South Africa Company for the last two years states that the Company's overland telegraph system was increased by 126 miles in 1896 and by 200 miles in 1897. On Sept. 30, 1897, 1,856 miles of line and 2,583 miles of wire had been erected. The total amount expended by the Company on telegraph construction up to March 31, 1897, was £139,677, and the net profit for the financial year to that date, after deduction of cost of maintenance, was £13,391. Many of the forts in Matabeleland have been connected with Bulawayo by telephone lines, the total mileage being 182 miles. The section of the African Trans-Continental telegraph line between Salisbury and Tete, destroyed during the native disturbances, has been replaced by a section from Umbali to Tete. Considerable progress has been made with the line through the British Central Africa protectorate towards Tanganyika, which has been completed to Kota Kota, a distance of 263 miles north of Blantyre, and 595 miles north of Umbali, and this section is being rapidly pushed forward.

Southport.—The Town Council decided on Tuesday to increase the salary of the borough electrical engineer (Mr. C. D. Taite) from £230 to £300 per annum.

Stage Mechanism.—A Paper is to be read by Mr. E. O. Sachs before the Society of Arts, on Wednesday next, on "Scenic Art and Stage Mechanism." The lecture will be largely interspersed with limelight views, and special reference will be made to the electric turntable stage at Munich.

Stirling.—At the meeting of the Police Commissioners on Monday, a report was presented by Mr. R. F. Yorke on the water power available at the Touch Reservoirs in the generation of electric current for street lighting. The report states that by utilising the available water power the Commissioners may obtain a constant guaranteed output of 54 B.H.P. from the turbines, which, after allowing for all sources of loss, is capable of producing a supply of 618 units per day, or sufficient for supplying the extended area of the town with 8,000 8 c.p. lamps connected. If in future additional power were required it could be obtained from

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the No. 4 reservoir, at present untapped, to the extent of 4,000 more lamps. The capital outlay he estimates at £13,500, and allowing £675 per annum for interest and sinking fund (5 per cent. on capital outlay) the total annual cost is reckoned at £1,325. Taking 100,000 units as sold per annum, and charging 4½d. per unit, the revenue would be £1,875, leaving a profit of £550. This report, as well as that recently presented by Prof. Kennedy, are being considered by the Lighting Committee.

Stockport.—The Town Council have decided to negotiate for the purchase of the undertaking of the local tramway company, and to introduce electric traction. The Local Government Board has sanctioned the borrowing of £24,600 by the Town Council for electric lighting purposes. The amount for which sanction was asked was £25,000.

St. Pancras (London)—Mr. Sydney W. Baynes, electrical engineer to the Vestry, has been investigating the advisability of utilising the waste heat from the refuse destructor at the electricity supply works. Already steps have been taken by the Electricity and Public Lighting Committee of the Vestry to utilise this waste heat, and so far 437 electrical units have been so generated.

The Officers Committee have discussed the question of the present salary of the chief electrical engineer (£600 per annum), and have decided that this is a fair and adequate remuneration. Upon this subject being discussed at the last meeting of the Vestry, Mr. H. J. Menzies, chairman of the Electricity Committee, moved that, while £600 should be approved as the present salary, in view of the developments taking place no maximum or minimum salary should be fixed to the appointment. This was approved. It has been decided to fix the minimum salary of the manager of the Regent's Park supply station at £250 per annum, increasing £10 annually to a maximum of £300, with apartments, coals and light.

The Home Secretary has notified the Parliamentary Committee, that in connection with the Workmen's Compensation Act, 1897, which comes into operation on 1st July, he is advised that electric lighting works, where electricity is generated by the use of mechanical power and is supplied to consumers, are factories, and that therefore the Act will apply in all such cases.

The Vestry are likely to be in conflict with the Gas Light and Coke Company in respect to the laying of a new 4in. gas main in one of the chief thoroughfares. The gas company decline to remove old disused mains, and the Vestry, as the electric lighting authority, consider that the public should be protected from a possible source of danger by the too close proximity of these old unused mains to dwelling houses, and they consequently decline to allow the gas company to proceed with the work until this question is settled to their satisfaction. The Vestry consider that the footways of the parish should be left exclusively for the use of the electricity department in supplying current to public and private lamps. The gas company threaten to appeal to the Board of Trade for protection in this matter, and the Vestry notify their willingness to contest the point before that body.

Sunderland.—Various extensions of the electric light plant and mains, estimated to cost about £10,000, were authorised by the Town Council on Wednesday. In moving the adoption of the Electric Lighting Committee's report recommending this expenditure, the Mayor (Alderman W. Bruce), who is chairman of the Committee, said the demands on the electricity supply department had become so great that an extension of the station buildings and plant had become imperative. The requirements of the town and the condition of the finance in connection with the electric lighting undertaking warranted the Committee in submitting the present proposals. He explained that a report and detailed estimates of the proposed expenditure had been furnished by the borough electrical engineer (Mr. J. F. C. Snell), and a sum of £10,000 would meet present requirements, but they considered it would be desirable to apply to the Local Government Board for powers to borrow £26,000 so as to obviate the necessity for making further application later. As will be seen from our advertisement columns, the Committee are already in the market for additional plant.

Torquay.—An easy wiring system, similar to that about to be adopted at Plymouth, has been brought forward by Councillor F. J. Crocker. Details of the scheme are at present under the consideration of the Electric Lighting Committee.

Waterford.—The Town Council have granted a concession for the construction of an electric tramway from the terminus of the Waterford, Dungarvan and Lismore Railway to the municipal boundary, the concession to be for 75 years, with power to the Council to purchase after 50 years. For the first 10 years the rent is to be a nominal one, and afterwards 5 per cent. on the amount of dividend paid. The line is to be constructed in three years.

Workhouse Lighting.—Owing to the intention of the Gas Light and Coke Company to raise the price of gas, the Visiting Committee of the Paddington (London) Guardians has been requested to inquire into and report upon the probable cost of installing the electric light in the north block of the workhouse, the chapel and dining hall.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

March 14, 1898.

6,179. O. HAMILTON. Northamptonshire. Improvements in secondary batteries.
6,182. A. L. BURGESS. Guernsey. A new medical electrical device.
6,184. E. M. BROWN. London. Improved electric light for use as a search or signal light or for photographic and other purposes.
6,223. C. M. WHITE. London. Improvements in electric railways. (B. C. Seaton, United States.)*
6,235. J. W. BOCH. London. Improvements in electrical insulators and methods of making the same.*

March 15, 1898.

6,270. F. W. HEATON and H. SMITH. Manchester. Improved electrical lamp-holder.
6,328. C. O. BARROWS and C. H. SMITH. London. A new or improved method of and apparatus for generating electricity.
6,350. J. J. WADDINGTON. London. Improvements in or connected with the manufacture of carbons for electric arc lamps.
6,357. W. P. THOMPSON. Liverpool. Improvements in or connected with electric motors for cars or other vehicles and in brakes therefor. (T. von Zweighbergk, United States.)*
6,360. J. W. STRAUSS, J. G. CHAPMAN and H. FOSTER. London. Improvements in or relating to electric light carbons.
6,362. T. GILLIES and E. HORNIDGE. London. Improvements in electric switches.
6,371. H. LEA. London. Improvements relating to the driving of sewing machines by electricity.

March 16, 1898.

6,414. T. TOPPING. London. Improvements in or relating to electric plug and ordinary switches.
6,451. J. S. MORRISON. Liverpool. Improvements in apparatus for electro-plating pins and other small objects.

March 17, 1898.

6,478. R. F. HALL. Birmingham. Improvements in electrical connections for lamp holders and other electrical appliances.
6,482. E. LIGHTHEART. Glasgow. Improvements in electric light advertising.
6,498. F. A. DARTON and F. G. PHILLIPS. London. An improved arrangement for forming or mounting the armatures of field magnets of small electromotors.
6,525. W. G. LUXTON and THE UNITED ALKALI COMPANY, LIMITED. London. Improvements in apparatus for electrolytic purposes.
6,526. W. G. LUXTON and THE UNITED ALKALI COMPANY, LIMITED. London. Improvements in apparatus for electrolytic purposes.
6,535. W. E. KENWAY and T. V. HUGHES. London. Improvements in propelling barges and boats on canals and other water-ways by electricity.
6,559. G. C. FRICKER. London. Improvements in electric arc lamps.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1896.

27,188. VERNON and ROSS. Electro-mechanical indicating and recording apparatus.

1897.

2,272. DOBELL. Electric batteries.
5,360. COX. Method of and apparatus for utilising electric energy.
5,826. SCHANSCHIEFF. Active material of secondary batteries.
6,251. WALLING. Combination watch-stand accumulator or storage battery and electric lantern.
6,929. TAYLOR, COOK and MONTGOMERY. Apparatus for electrolysing sodium, chloride or other salts.
7,027. MARQUAND. Secondary batteries or accumulators and manufacture thereof.
7,373. SMITH and ELPHINSTONE. Apparatus for controlling the action of electric motors at a distance.
8,115. TAYLOR and DUCKWORTH. Means for conducting electricity along railway trains for the purpose of communication and lighting.
8,295. VEDOVELLI. Electric traction and apparatus employed therein.
8,602. VERITY'S (LIMITED) and COTTERELL. Electric lamp-holders and connectors.
10,411. KEEN. Supports for incandescent and other electric lamps.
11,017. HALL. Telegraph cables or the like.
11.155. BOULT. (Pellett and Déjardin.) Electric arc lamps.
11,609. RICHARD. Automatic transmitting apparatus enabling an instrument to act at a distance.
16,764. LUHNE. Electromagnetic cut-in and cut-out.
17,609. ROBERTS. Electric furnaces. (Date applied for under International Convention, December 29, 1896.)

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COMPANIES' MEETINGS AND REPORTS.

British Electric Traction Company (Limited).

The second ordinary general meeting of this Company was held on Thursday, last week, at Donington House, Strand, London, under the presidency of Sir Charles Rivers Wilson, G.C.M.G., C.B.

The SECRETARY (Mr. Charles Walmsley) read the notice calling the meeting, and the report and accounts having been taken as read,

The CHAIRMAN said: Gentlemen, there are certain points of interest in connection with the Company that you will be anxious, no doubt, to make yourselves acquainted with. The present Company, the shareholders will remember, was formed at the end of 1896, and the first ordinary general meeting, usually called the statutory meeting, was held in December, 1896. The report and accounts which are now submitted to you are for the period from the registration of the Company to the end of 1897—a period of 14 months. At the statutory meeting I explained generally the character of the business we proposed to develope and I stated in general terms the policy we intended to pursue. At the end of our first year, I am glad to be able to state that we have already succeeded in establishing a business of considerable magnitude, and one which we have every reason to believe will become very profitable to the shareholders. As will be seen from the report our gross profits amount to £14,422, and after deducting such of the general expenses as are chargeable to revenue account, and also the expenses which we have incurred in connection with schemes and undertakings which we have thought it well to initiate, but which for various reasons, we have dropped, there remains a profit of over £9,800. I think the shareholders will agree with me that this must be considered a very satisfactory result of the first year's operations, more especially when it is considered that we are in the course of building up a very large and extensive business which must obviously take some little time to become thoroughly efficient and remunerative to its fullest extent. Our net balance of profit represents about 3½ per cent. of the capital employed during our first complete year of work. The Directors, however, do not think it expedient for this profit to be distributed in dividends. The extensive business which we are establishing requires that the Company should occupy a very strong financial position, and in the opinion of the Board it will be more to the interests of the Company that this amount should be carried forward to next account, as it will be more satisfactory to the holders of Preference shares that the dividend on those shares should be secured and in hand independently of any profits which we expect to earn during the present year. This brings me to say a few words on the subject of the capital account. Original shareholders will remember that the whole of the Ordinary shares were offered for subscription at the time of formation of the Company, but the shares were not then all subscribed for, and in order to secure a quotation of the shares on the Stock Exchange the Electric and General Investment Company and their friends made up the subscription to 20,000 shares, and the remaining 10,000 shares were subsequently issued at a small premium. The net amount received in respect of the premium, after deducting expenses was £1,218 15s., which amount, as will be seen on reference to the balance sheet, has been applied in the reduction of preliminary expenses. Last month the Directors made an issue of 10,000 Six per Cent. Cumulative Preference shares of £10 each, and the strong position which the Company occupies enabled these shares to be issued at a premium of £2 10s. per share. The proceeds of this issue do not appear in the accounts now presented to you, which are made up to the end of last year, but will come into the accounts for the current year. It is exceedingly probable that occasion will arise during the year for further issues of capital, and the Directors hope to be able to issue from time to time the remaining 20,000 Preference shares at a substantial premium. It may be expected, therefore, that the balance sheet which will be submitted to you at the next annual meeting will show the Company to be in a very strong position. Having reviewed the items in the balance sheet *seriatim*, and pointed to the scientific accuracy which the accounts of the Company necessitated, in view of the possible purchase of some of their undertakings by the local authorities in whose areas such tramways were situated, Sir Rivers Wilson continued: With regard to the item of cost of testing and developing electric traction systems, you may remember that when I had the pleasure of meeting you on a former occasion, I told you that this Company had acquired the rights of a patent system of electric traction by means of surface contact. It is known as the Esmond System, from the name of the inventor. Since that time we have been making further experiments and tests of this and other systems, and we have laid down an experimental track which has been very useful for the purpose of enabling us to investigate the merits of various new devices. We are still of opinion that for the most part electric traction will have to be carried out on what is known as the overhead system, but the licences we have acquired and the experience we have gained will be of great advantage to the Company in cases where the overhead system cannot be adopted. The item of "investments" (£148,179. 17s. 4d.) is, and will always remain, relatively large, as it includes debentures and shares which we hold in associated companies, and the more we develope our business the larger will become our investments in subsidiary and other companies. After deducting the amount of £24,940, our holding in the Pioneer Electric Traction Company's shares, there remains an amount of £123,239, invested in debentures and shares, and the fact that we have received nearly £3,000 in dividends in respect of the past year, in spite of the fact that many of the investments were not made until towards the end of the year, is evidence that they are of a remunerative character. Turning to the profit and loss account, the only item that may require some explanation is that of £4,618 on the debit side for proportion of general expenses not charged to contracts and undertakings, including expenditure on undertakings not proceeded with and written off. Our general expenses are charged to the various matters engaging our attention in the proportion of the time devoted by the staff in attending to each matter, and of course many of these items do not come under the category of contracts and undertakings appearing in the balance-sheet, and the general expenses appertaining to these matters are debited to the profit and loss account. That account is also debited with the amounts standing against such contracts and undertakings as have not been proceeded with. In initiating a business of this character we are obliged from time to time to examine schemes which are presented to us, and which, after examination, are found not to be sufficiently good to justify their being taken up by the Company. The expenses incurred upon all such matters, together with their proportion of general charges have been debited to profit and loss account, so that the item under contracts and undertakings appearing in the balance sheet includes only such expenditure as offers a reasonable hope of realising a profit. Having now sufficiently explained the items on both sides of the balance sheet, you will, no doubt, like to hear something generally as to the character of the business we have entered upon and are in course of carrying out, but I must tell you at once that it would be highly prejudicial to the interests of the Company for me to make a public statement with regard to the details of all the important negotiations which are pending with various companies and local authorities. Foremost among our enterprises are those in Staffordshire, both in the North, generally known as the Potteries, and in the South, generally known as the Black Country. In the Potteries District our scheme embraces all the principal towns and covers a total route of upwards of 36 miles of tramways and light railways. Needless to say, we have been brought face to face with many unforeseen difficulties in carrying out a scheme of this magnitude, and there has been much more delay than we had reason to anticipate, but I am glad to say that within the last few days further agreements have been concluded with the North Staffordshire Tramways Company by which we shall be able to proceed with the work of constructing and equipping the tramways in this district without further delay. Our South Staffordshire scheme has been already explained to the shareholders at the last meeting. We have made an arrangement with the South Staffordshire Tramways Company by which the working of the portion of that Company's lines which is already electrically equipped was transferred to this Company, and we have worked these lines at a profit since August 1st last year. The arrangement with that Company also provides for the promotion of the necessary parliamentary powers to enable the rest of their lines to be electrically equipped and worked by this Company. Then with regard to the Dudley and Stourbridge Tramways Company, we have purchased practically all the shares in that Company, and are virtual owners of it. The lines are being worked at present by steam, as heretofore; but the necessary arrangements have already been made with all the local authorities, except Dudley Corporation, for the adoption of electric traction on those portions of the lines within their respective jurisdictions, and steps are being taken to equip and work electrically the line from Brierley Hill to Stourbridge. Light Railway Orders have also been granted by the Commissioners (subject to confirmation by the Board of Trade) for important extensions of these lines. Negotiations are still pending in regard to the Wolverhampton and the other lines embraced in the original scheme. The whole of this South Staffordshire scheme, when carried out, will embrace a total mileage of upwards of 50 miles of line. The population of the towns which will be served were, in 1891, 427,000. The Oldham, Ashton and Hyde electric tramway is an important line extending over about eight miles in the neighbourhood of Manchester, and for which we obtained a Provisional Order in 1896. We had decided to cede an interest in this undertaking to our friends the British Thomson-Houston Company, and we found that the most convenient way of giving effect to this combination was by the formation of a separate company which facilitated the distribution of the capital among the various parties interested. That Company has been formed, the work of construction is well in hand, and we expect that during the present year the tramways will be open for traffic. The Kidderminster and Stourport Electric Tramway, about four miles in length, for which we obtained an Act of Parliament in 1896, is also in course of construction, and we hope will be open for traffic in the course of next month. At Hartlepool we have acquired a Provisional Order for new tramways, and the Light Railway Commissioners (subject to confirmation by the Board of Trade) have granted us a Light Railway Order for further extensions. Here, also, considerable progress has been made with the work of construction. At North Shields we have purchased all the shares in the existing steam tramway (the North Shields and Tynemouth Tramway), and we are now applying for a Light Railway Order for extensions of the present system. At Gateshead we have made an agreement for the purchase of the undertaking of the tramways company, and we are now negotiating with the local authority for the adoption of electric traction. At Paisley we have also made an agreement with the Tramways Company, and we are now negotiating with the local authority. Some of these agreements for the purchase of tramway undertakings are, of course, conditional upon our obtaining powers for working the lines by electricity, but in the case of Swansea, where the Tramway Company had already obtained these powers, we have made an absolute agreement for the purchase of the undertaking. In addition I ought to mention that the British Thomson-Houston Company have ceded us a participation in the Cork Electric Tramways and Lighting Scheme. We have also promoted and obtained, subject to the sanction of the Board of Trade, Light Railway Orders at Crewe, Kinver and Middleton, and are at the present time applying for Orders in other parts of the United Kingdom. It will serve to give you some idea of the magnitude of the business we are engaged in carrying out when I tell you that we have upwards of fifty schemes under consideration, and that the agreements and contracts we have entered into and the concessions we have either

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obtained or applied for, cover a total mileage of electrical tramways and light railways in the United Kingdom of upwards of 200 miles, and it is not looking very far into the future to say that a total capital expenditure of between £2,000,000 and £3,000,000 will have to be provided. The total tramway mileage in this country is 1,030, and of these under 100 miles are worked by electricity. When you consider the smallness of that mileage, contrasted with the possibility there is of extension, I think it will be apparent to you what an extensive field there is for the development of our Company. To show how the public appreciate even the very imperfect and inefficient service they now have, I will give you these figures: in 1878 when the mileage of tramways was 367 the movement of passengers was 146,000,000, while for the year ended June 30, 1897, when the mileage was 1,030, the movement of passengers was 789,000,000. There is one matter I should like to say a few words upon, and that is the movement which is abroad among the larger corporations to municipalise, as it is called, these undertakings. On more than one occasion, where we were encouraged to initiate undertakings within such and such a borough of considerable magnitude, we have had to recede from our endeavours in face of this growing inclination on the part of the authorities to undertake the work themselves That is, to a certain degree, a matter of regret. My own belief is, and I do not say so merely because I happen to be connected with this Company, that in this, and perhaps other matters of a similar description, the work can be better and more efficiently and usefully carried out by means of a company such as ours than by a corporation of itself. That observation applies very particularly to the electric tramway enterprise, and for this reason, that the municipality is only able, *prima facie*, to carry out its operations within the limits of its own boundaries; and inasmuch as for the economical and efficient working of such tramways it is necessary that there should be communication from the outside, you will see at once how much more desirable it is that the lines should be constructed upon a uniform system, and be, as far as possible, within the same district, under one single management. Electric traction is particularly suitable for the working of tramways extending over long distances, and for the purpose therefore of connecting adjacent and outlying villages with large towns. Municipal boundaries do not coincide always with the centres of population, and if the municipalities construct tramways they have to confine themselves to their own boundaries, so that the outlying villages and towns are not reached. It does not appear reasonable that municipalities should have the right to use the ratepayers' money for the construction of tramways in districts which do not contribute to their rates. I fear, therefore, that a result of the municipalisation of tramways would be that one of the great advantages of electric traction—that of providing outlying villages and towns with cheap and quick communication with larger adjacent towns—will be sacrificed, for it is only in conjunction with the larger business within the municipality that it will pay to work the relatively less profitable sections lying outside the borough. Then, with regard to the question of intercommunication. Assuming that each local authority constructed the tramways within its own area, arrangement would have to be made for mutual running powers, which are very difficult, if not impossible, and then comes the question of variation of gauges. There are many instances at the present time of one town possessing tramways with 4ft. 8½in. gauge, and another town possessing tramways with 3ft. 6in. gauge. Unless municipalities can agree for one or the other to alter its gauge, intercommunication between the two towns would be physically impossible. But the question arises, Which of the two towns is to go to the expense of altering its gauge for the benefit of both? This question is not answered by the suggestion that the two municipalities can agree to divide the cost, for is it likely that Parliament would ever give a municipality the power of spending its rates on the alteration of a tramway gauge in another town? All these practical difficulties seem to be overcome by a powerful and responsible company dealing with these questions in a comprehensive way. And I may add that the difficulties referred to are not imaginary; they exist at present in the cases we are dealing with. One may be in favour of the munipalisation of electric lighting because that it is a business which can be confined within a particular borough, but an enterprise like tramways or railways, which depends for its success upon the efficiency with which it can move people about from one borough to another is surely not suitable for municipalisation. Apart from these physical objections are other questions into which I need not now go, involving labour questions and matters of that sort, which I think would arise in the event of the development of these enterprises by municipalities, but all of which, I think, would be obviated by adopting the system I have ventured to suggest to you. For my own part, I think the more the public understand this business the more they will see it is for the interest of the community at large that a widespread organisation of this sort should be conducted outside the narrow area of a corporation, and that they would be wise to entrust all these matters and interests to companies such as our own. We do not claim any monopoly in the matter. There will be, I have no doubt, a great deal of competition—wholesome and useful competition—but I think I have said sufficient to show you that the field is large enough for more than one company such as our own. I do not think there is anything more to trouble you with, except that it is my melancholy duty to allude to the grievous loss the Company, and especially the Board of Directors, have sustained by the death of Lord Suffolk. Only this day fortnight he was attending a meeting of our Board with his usual brightness and cheerfulness, but he has now passed away, and with him has passed away a man who had very sincerely at heart the welfare of this Company. Lord Suffolk, from the inception of the Company, occupied himself fully, and with the most intelligent interest, in all our operations, and looked forward with the greatest interest to participting in its development. I will not speak of his personal qualities which endeared him to his many friends, but I feel I could not meet you to-day without giving utterance to the feelings of deep regret that we all entertain for the loss of such an excellent colleague. I beg now to move the following resolution:—

"*That the Report of the Directors and the Accounts to December 31, 1897, now before the meeting, be, and the same are hereby received and adopted.*"

Mr. EMILE GARCKE seconded the motion, and it was carried unanimously.

Sir Charles Rivers Wilson and Sir Charles W. Fremantle were re-elected to their seats at the Board, and Mr. F. W. Smith, C.A., was re-appointed auditor to the Company.

A very cordial vote of thanks to the Directors, to Mr. Garcke, the Managing Director, and to Mr. Sellon, the Company's engineer, was carried unanimously.

At an extraordinary meeting subsequently held, resolutions approving certain Railway Orders submitted to the meeting, and a modification of one of the Articles of Association of the Company, were passed unanimously.

Rand Central Electric Works (Limited).

The annual general meeting of shareholders in this Company was held at Winchester House, Old Broad-street, yesterday (Thursday), under the presidency of Sir C. Rivers Wilson, G.C.M.G., C.B.

The SECRETARY (Mr. H. Militz) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said: Gentlemen, before I make any observations upon the report and balance-sheet I should like to say a few words in explanation of our having called the meeting just before the holidays, as to which, I believe, certain criticisms have been expressed. The fact is we were extremely desirous, for the convenience of the shareholders, that the meeting should be called at the earliest possible moment, in order that the dividend might be declared and the cheques for the dividends distributed among the shareholders. As a matter of fact, this day last week was the very first—the very earliest date at which we were in a position to take that course. The settlement of accounts as between ourselves and Messrs. Siemens and Halske was a matter of very prolonged examination and discussion, and then the auditors' report had to be obtained, and this was not secured at a period earlier than the date which I have just now mentioned. I can therefore only say that in fixing that date—the last day just before the holidays—we fixed the very earliest date we could, and it was a date which we hoped would be for the convenience of the shareholders. Unfortunately, however, a quorum was not present, and we therefore had to adjourn the meeting until to-day, but not very much time has been lost in consequence. Your Board met you so very recently, and upon that occasion went so fully into the position and the situation of the affairs of the Company, that my observations to-day may be very brief, because nothing of material importance has taken place since that date—the latter end of December—and the present time. But for the first time we are now able to lay before you a complete and entire balance sheet, and if you have examined it you will observe that provision is made for the payment of a dividend, and I daresay one point has struck you—I know it has struck some of you—as to which I should like to make a few remarks, namely, the fact of there having been a deficiency on last year's working. For my part I am surprised that any astonishment should have been expressed on that point, because those of you who have followed our proceedings, and have also done us the honour to consider what we said at the last meeting, will understand that until even a late period of last year our working was very partial, a portion of the work being almost experimental. You must not, therefore, by any means regard the operations of last year as a criterion of our operations for the future. In fact, I consider that the situation in which we find ourselves, as explained in the figures before you, is entirely satisfactory. You will remember that the arrangements under which the Company was formed were considered with great foresight, and what has taken place was anticipated—namely, that the great works could only come slowly into operation and partially; and, as I say, with great foresight it was provided that during these early periods the shareholders should be assured of a substantial return for their money. For the past year you are about to receive a respectable dividend of 6 per cent; in the current year, whatever the working may be, you are assured of a dividend of 8 per cent.; and next year you are assured of a dividend of 10 per cent. I therefore think that the shareholders may consider that they are in a very satisfactory position. Reverting once again to what no doubt may appear at first sight unsatisfactory, but which to my mind is not at all unsatisfactory—the deficiency on last year's working—I would remind you that we only began working in a partial and tentative manner about May; but we have been gradually increasing our operations, as we have been able to complete our communications with the various mines, until we are now receiving a very respectable and considerable return. I will not trouble you with any detailed figures, but I may mention that whereas for May and June we only received a return of about £700, that amount had risen by September to over £1,600, by November to over £1,900, and by December to considerably over £2,300. I need not trouble you—it is not within the four corners of our discussion to-day—with January, although I may just mention that for January considerably over £3,000 has been earned. That, I think, will explain to you what our position is in that respect. To revert to the question of our arrangements with Messrs. Siemens and Halske, I explained at considerable length, last December, the nature of the compromise we had effected—a compromise which I venture to think of the most satisfactory character to the shareholders, because the guarantee of Messrs. Siemens and Halske took effect from the 1st of January last year, and since then they have had to bear all the expenses, which otherwise would have fallen upon you. I will just recall to your recollection that we have contracted for almost our entire horse-power. At the end of December last about 1,200 H.P. was actually in operation, and I believe that since then about 200 more horse-power has been established, raising the amount altogether to about 1,400 H.P. I now move that the report and

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accounts, as submitted, be adopted, and that a dividend of 6 per cent. be declared.

Carried unanimously.

Sir Charles Rivers Wilson and M. Carl H. von Siemens were re-elected as Directors, and Messrs. Price, Waterhouse and Co. were appointed auditors.

A vote of thanks to the Chairman and Directors terminated the proceedings.

NEW COMPANIES, STATUTORY RETURNS, &c.

DOUGLAS SINCLAIR AND COMPANY (LIMITED).—This Company was registered on April 4, with a capital of £50,000 in 5,000 Ordinary shares of £1 each, and 4,500 Preference shares of £10 each, to enter into an agreement with Messrs. Douglas F. Sinclair, Radcliffe Ward and Francis E. D. Acland, and to carry on the business of electro-chemical manufacturers, electricians, mechanical engineers, suppliers of electricity, and manufacturers of an dealers in electrical apparatus. The first subscribers (each with one share) are: Douglas F. Sinclair (electrical engineer), Francis E. D. Acland, W. S. Henderson, H. G. Stephenson, H. Peake, C. Mackintosh and H. G. Harwood, all of London.

J. GOODMAN AND CO. (LIMITED).—This Company was registered on April 7, with a capital of £7,000, in £1 shares, to acquire and take over the business now carried on under the style of J. Goodman and Co., and to carry on the business of electric supply merchants and dealers, electrical engineers and suppliers of electricity and electrical machinery. The subscribers (with one share each) are: Jacob Goodman (merchant), G. J. Mihr, E. Gutmann, W. Musk, W. Ashley (electric lamp maker), W. Tatum, and R. Sendall (engineer). Jacob Goodman is sole Managing Director.

MECHANICAL IMPROVEMENTS SYNDICATE (LIMITED).—This Company was registered on March 31, with a capital of £1,000 in £1 shares, to acquire, develop, work and deal with provisional patent No. 26,367 (1897), for an improved appliance in connection with electrical illumination.

YARMOUTH (I.W.) ELECTRICITY SUPPLY COMPANY (LIMITED).—This Company was registered on April 7 with a capital of £5,000, in £5 shares, to carry on at Yarmouth, Isle of Wight, or elsewhere, the business of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The first subscribers (each with one share) are: Lord Heytesbury, R. H. H. Eden, B. M. St. Aubyn, F. Christy, electrical engineer, C. Edmonds, Mrs. C. Edmonds, and J. T. Harwood. The first Directors are: Lord Heytesbury, R. H. H. Eden, C. Edmonds, and B. M. St. Aubyn.

BIRMINGHAM ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return to March 24 has been filed. The capital is £200,000, in £5 shares, all of which have been taken up, and the full amount has been called.

EASTERN TELEGRAPH COMPANY (LIMITED).—The annual return to Feb. 3 has been filed. The capital is £4,700,000, in £10 shares, of which 70,000 are Preference. 469,989 shares have been taken up, and the full amount has been called and received.

PERU TELEPHONE COMPANY (LIMITED).—The annual return to March 8 shows that only seven shares have been taken up out of a capital of £100,000, in £5 shares.

PONTYPOOL ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return to March 17 has been filed. The capital is £10,000, in £5 shares, of which 1,143 have been taken up. The full amount has been called on 669, and £4 per share on 474 shares.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since April 7, 1898). Price o silver 25 1/16d. per oz. (April 14). Consols (2½ per cent.) 110⅜—110½ for money, 110½—110⅝ for account; 2½ per cent. 103½—104 (April 14). Stock Exchange Settling Days: Consols, May 5; Stocks and Shares Continuation Day, April 27; Ticket Day, April 28; Pay Days, April 15 and 29; Mining Share Carry-over Day, April 26.

BRITISH COLUMBIA ELECTRIC RAILWAY COMPANY (LIMITED)—The half-yearly interest on Four and a-Half per Cent. Debentures and on the Six per Cent. Income Bonds, due 15th inst., will be paid at Messrs. Spurling and Co.'s, 8, Austin-friars, E.C.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS (LIMITED).—The Directors of this Company report a profit for last year of £736. A dividend of 3 per cent. on the Seven per Cent. Preference shares is recommended, leaving £265 to be carried forward. The retiring Directors (Messrs. Lowcock and Fawcus) do not offer themselves for re-election.

ELECTRIC STORAGE BATTERIES.—We learn that a prospectus will be issued in a few days of the Vaughan-Sherrin Electric Accumulator Company, formed to work the Vaughan-Sherrin patents for the design and manufacture of electric storage batteries, for the high efficiency of which many claims are made. We understand that favourable reports on the battery have been made by Dr. J. A. Fleming and Mr. H. R. Kempe.

GENEVA ELECTRICAL TRUST.—According to the *Financial News* an Electrical Trust, with a capital of £1,000,000 sterling, is to be formed in Geneva. The chief movers in the matter are said to be "the Union of Financiers," and London is credited with showing an anxiety to provide the necessary funds for the enterprise.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY (LIMITED).—The register of transfers of this Company will be closed from the 14th to the 27th inst. inclusive.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed the 20th inst. a special settling day in £100,000 Four and a-Half per Cent. Redeemable Stock of the Barcelona Tramways Company (Limited) and 10,000 Six per Cent. £10 (£4 paid) cumulative Preference shares (Nos. 30,001 to 40,000) of the British Electric Traction Company (Limited), and have ordered the same to be quoted in the Official List. Application has also been made to the Committee to allow the further issue of 8,000 Ordinary shares (Nos. 32,501 to 40,500) of the Chelsea Electricity Supply Company (Limited) to be quoted in the List.

SUBMARINE CABLES TRUST.—Notice is given that the coupon due on the 15th inst. will be paid in full by Messrs. Glyn, Mills and Co., 67, Lombard-street, London, E.C., between 10 a.m. and 2 p.m. Coupons must be left four clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended April 8 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2.581.

WESTERN UNION TELEGRAPH COMPANY.—This Company have issued their report for the quarter ended March 31, 1898. The following statement, dated March 9th, shows the condition of the Company at the close of the quarter ended Dec. 31, 1897:—

Surplus Oct. 1, 1897, as per last quarterly report		$7,910,001 61
Net revenues, quarter ended Dec. 31, 1897		1,553,514 35
		$9,463,515 96
From which deducting for—		
Dividend of 1¼ per cent. paid Jan. 15th	$1,216,976 25	
Interest on bonded debt	223,299 83	
		$1,440,276 08
Left a surplus Jan. 1, 1897, of		$8,023,239 88
The net revenues of the quarter ending March 31st, based upon nearly completed returns for January, partial returns for February, and estimating the business for March, will be about		1,200,000 00
		$9,223,239 88
From which appropriating for—		
Interest on bonds	$224,420 00	
Sinking fund	9,991 00	
		234,411 00
		$8,988,828 88
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,216,980 00
Deducting which leaves a surplus, after paying dividend, of		$7,771,848 88

In view of the preceding statements, the Committee recommend that a dividend of 1¼ per cent. on the capital stock of the Company be declared payable on and after the 15th inst.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Apl. 9	3,763	+451	...	...	...
Bristol Trams & Carriage	„ 8	2,810	+732	14	33,429	+ 5,115
City & South London Ry.	„ 10	884	−137	15	15,826	− 13
Dover Tramways	9	119	...	31	3,446	...
Dublin United (Southern)	„ 8	525	+189	14	5,677	− 173
Liverpool Overhead Rly.	„ 10	1,539	+186	15	20,295	+ 912
Sheffield Tramways	„ 10	976	+ 77	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price April 5.		Price Wednesday, April 13.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 9. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.					£ s. d.			
£19,196	£10	8/0	Central London Ordinary	10¼	10⅜	10¼	10⅜	2 15 10	June and December	10 1/16	10 1/32
143,106	10	1/9⅜	Do. (£6 paid)	6¼	6⅜	6¼	6⅜	2 18 4	„ „	...	...
£650,000	Stock	1½%	City and South London Railway Con. Ordy.	67	69	68	70	2 13 8	January and July	69½	68⅝
8,419	£10	5%	Do. 5% Perpetual Preference	15	16	15	16	3 2 6	„ „	..	..
£135,701	Stock	4%	Do. 4% Perpetual Debenture	138	140	138	140	2 17 2	May and November	..	..
540,000	Stock	3%	Waterloo and City Ordinary	135	138	135	138	2 3 6	June and December	136½	..
37,500	10	3½%	Liverpool Overhead Railway Ordinary	10 1/16	10 3/32	10 1/16	10 1/32	3 0 2	February & August	—	-
10,000	10	5%	Do. 5% Preference	15¼	16¼	15¼	16¼	3 1 6	„ „	—	-
125 000	Stock	4%	Do. 4% Debenture	109	111	109	111	3 19 0	January and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price April 5.		Price Wednesday, April 13.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 9.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£923,960	Stock	19/6	Anglo-American	61	64	61	64	4 13 9	Feb., May, Aug., Nov.	63½	62
£3,038,020	Stock	39/0	Do. Preferred	111½	112½	111½	112½	5 6 8	" "	113	111½
£3,038,020	Stock	5/0	Do. Deferred	12¾	13¼	12¾	13¼	— —	— —	13 5/16	12⅝
£137,400	£100	4%	*African Direct Telegraph (Red)	100	104	100	104	3 16 11	January and July	—	—
£25,000	10	..	Amazon Telegraph	7	8	7	8	— —	— —	..	—
130,000	10	3/0	Brazilian Submarine	16½	17	16½	17	4 2 4	Mar., June, Oct., Dec.	16¾	⅛
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	112	116	4 6 2	June and December	..	—
10,000,000	$100	$1½	Commercial Cable Capital Stock	185	190	185	190	4 4 3	Jan., Apr., July, Oct.	—	—
£653,586	Stock	4%	Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	105½	104½
16,000	10	6/0	Cuba Submarine	6½	7½	6½	7½	9 6 8	February and August	7	—
6,000	10	10%	Do. Preference 10 per Cent.	14½	15½	14½	15½	6 9 0	" "	—	—
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	—	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	—
£80,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	..	—
60,710	£20	3/0	Direct United States Cable, 1877	10¾	11¼	10¾	11¼	5 15 7	Jan., Apr., July, Oct.	11¼	..
£120,000	100	..	Direct West India Cable 4½% Reg. Deb. (red)	99	102	99	102	..	..	..	—
400,000	£10	2/6	Eastern	17⅞	18¼	17⅞	18¼	3 11 3	Jan., Apr., July, Oct.	18⅛	17 1/16
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference	18½	19½	18½	19½	3 1 6	" "	—	—
£1,302,615	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	128	131	128	131	3 2 0	May and November	128½	128
£89,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	101½	..
250,000	10	2/6	Eastern Extension	18¾	19¼	18¾	19¼	3 13 8	Jan., Apr., July, Oct.	18 13/16	18⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	128	131	128	131	3 1 8	February & August	..	—
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	100	103	100	103	4 17 3	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	99	103	99	103	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 16 2	February & August	102	102
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	107%	110%	107%	110%	3 13 9	May and November	—	—
180,227	10	1/9	Globe Telegraph and Trust	11½	12¼	11½	12¼	3 17 7	Jan., Apr., July, Oct	12	11⅝
180,042	10	6%	Do. 6 per Cent. Preference	17½	18	17½	18	3 6 8	" "	17 7/16	17½
150,000	10	5/0	Great Northern of Copenhagen	29½	30½	29½	30½	3 5 7	January, April, July	..	—
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	100	103	100	103	4 17 1	March & September	..	—
97,000	100	..	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	95	100	95	100	..	June and December	—	—
17,000	25	12/6	Indo-European	52	55	52	55	4 10 11	May and November	..	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	106	109	106	109	5 10 1	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red) 1942	105	108	105	108	3 13 5	June and December	—	—
11,839	8	4/0	Reuter's	8	9	8	9	4 8 11	April and October	—	—
3,381	£100 Cert.	6%	Submarine Cables Trust	140	145	140	145	4 4 3	" "	141	141
15,609	10	6/0	West African Telegraph	3½	4½	3½	4½	.. ..	.. ..	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	5 8 5	March & September	—	—
30,000	10	..	West Coast of America	¼	¾	¼	¾	..	..	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	108	105	108	3 14 9	June and December	..	—
88,321	10	1/0	West India and Panama	½	¾	½	¾	..	May and November	1/16	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7½	8	7½	8	7 10 0	..	..	—
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	..	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 2	January and July	..	—
64,256	15	3/0	Western and Brazilian	12	12½	12	12½	2 8 0	May and November	12½	12
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7¾	8¼	7¾	8¼	3 12 9	" "	7¾	7¾
33,129	7½	1/6	Do. Deferred Ordinary	4½	5	4½	5	..	" "	4⅝	4⅝
£382,230	..	4%	Do. 4 per Cent. Debenture Stock	106	109	106	109	3 13 9	June and December	106½	106½
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	—	—
£160,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	106	100	105	5 14 3	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chill Telephone (fully paid)	3	3½	3	3½	5 14 4	August	—	—
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1 1/16	1 5/16	1 1/16	1 5/16	..	July	..	—
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2	2½	8 0 0	October	..	—
484,597	5	3/0	National	5½	6	5½	6	8 0 0	February & August	6	5 7/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	"	—	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	15	17	15	17	3 10 7	..	..	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	5½	6	5½	6	4 3 4	" "	5½	5½
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	105	100	105	3 7 2	June and December	103	101
171,504	1	0/4	Oriental	⅜	⅝	⅜	⅝	6 13 4	April and October	—	—
58,000	5	5/0	United River Plate	4	4½	4	4½	5 11 1	July	—	—
£146,733	Stock	6%	* Do. 5 per Cent. Debenture Stock (red.)	105	108	105	108	4 18 6	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
£200,000	5	4½%	Birmingham Electric Supply (fully paid)	10¾		10¾			March	..	—
50,000	£10	20/0	City of London Electric Lighting (fully paid	25	27	26	27	3 14 1	February & August	27	26½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17½	18½	17½	18½	3 4 10	January and July	..	—
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	130	—
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp	13½	14½	13½	14½	2 8 6	February & August	13 13/16	—
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	6⅝	—
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—		—			January and July	—	—
£26,000	5	3/6	Chelsea Electricity Supply Ordinary	10½	10¾	10½	10¾	3 9 9	March	10⅝	—
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	115	117	115	117	3 17 5	June and December	..	..
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	14¾	15½	14¾	15½	..	..	15½	14¾
20,000	£10	6%	Do. 6% Cumulative Preference	15½	16	15½	16	3 15 0	March & September	15⅝	—
10,000	£5	4/0	House-to-House Electric Lighting Supply Ord.	10½	11½	10⅝	11½	1 14 9	..	11	10½
10,000	£5	3/6	Do. 7 per Cent. Preference	11⅝	12	11½	12	2 18 4	March & September	—	..
111,000	£5	..	London Electric Supply Ordinary	3¾	4¼	3¾	4¼	..	—	..	—
48,050	£5	..	Do. Preference	6½	7	6¾	7	..	..	..	—
49,900	10	7/0	Metropolitan Electric Supply Ordinary	20	21	19½	20½	2 18 6	April and October	20⅞	19⅞
12,500	10	6/0	Do. issued at 2 prem. (fully paid)	20	21	19½	20½	2 18 6	" "	20½	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	118⅝	118
6,452	10	12/0	Notting Hill Electric Ordinary	20	21	20	21	2 17 2	March	—	—
275,000	1		Rand Electric	1 7/16	1 9/16	1½	1⅝			—	—
£125,000	Stock	5%	River Plate Elec. Lt. Tr'ct'n, Ltd., 5% 1st Mor. Deb.	90	95	90	95	5 6 6	..	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares	143	148	143	145	5 10 4	..	—	—
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	103	105	103	105	4 5 9	April and October	..	—
31,980	5	11/0	St. James and Pall Mall Electric Ordinary	18	19	17½	18½	3 18 5	February & August	..	—
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	..	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	107	110	107	110	3 13 1	June and December	107	—
67,900	5	8/0	Westminster Electric Supply (fully paid)	17	18	16½	17½	3 8 9	March & September	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	5%	Brush Electrical Engineering	1¾	2	1¾	2	—	—	1¾	—
90,000	2	1/2⅞	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2¼	4 16 0	—	2⅜	2¼
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110	114	110	114	3 18 11	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 6 2	June and December	—	—
10,000	£10	..	British Aluminium Ordinary	—		—		—	—	—	—
20,000	10	..	Do 7% Cumulative Preference	..		—		—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	9	10	9	10	5 0 0	June and December	—	—
£90,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	110	113	110	113	4 0 0	" "	—	—
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1	1¼	1	1¼	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1¾	2¼	2	2½	—	—	—	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	86	91	87	92	5 10 2	January and July	—	—
99,261	5	1/6	Edison and Swan United ("A" Shares) (£3 paid)	2¼	2¾	2¼	2¾	6 0 3	February & August	2 1/16	2⅛
17,139	5	2/6	Do. (£5 paid)	4	5	4	5	5 10 0	" "	—	—
£200,000	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.)	103	105	103	105	3 16 2	June and December	—	—
110,000	£2	1/1	Electric Construction Co. (Limited)	2⅝	2⅞	2⅝	2⅞	3 13 1	February & August	2⅞	2 7/16
16,343	2	7%	Do. 7 per Cent. Cumulative Pref.	3½	3¾	3½	3¾	4 3 4	August	..	..
91,196	1	10/0	Elmore's Patent Copper Depositing	½	¾	½	¾	..	..	..	—
12,500	10	18/0	Henley's Telegraph Works Ordinary	22	23	22	23	5 4 4	February & August	23	22¾
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	—	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 3	" "	—	—
40,000	£10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21⅞	21⅝
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 14 6	March & September	—	—
37,350	12	24/0	Telegraph Construction and Maintenance	35	38	35	38	4 12 4	March and July	35⅛	35
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 3	January and July	..	—
£22,500	£5	3/6	Willans and Robinson Ordinary	8	8½	8	8½	4 2 4	April and October	..	—
£22,500	£5	3/0	Do. 6% Cumulative Preference	7	7½	7	7½	4 0 0	..	7	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	107	109	107	109	3 19 0	May and November	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for Income-tax.

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THE ELECTRICIAN:

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NOTES.

IT is pleasing to announce that the Judicial Committee of the Privy Council have recommended an extension for a period of five years of what is practically the master patent for the Parsons steam turbine, an engine the ingenuity of construction of which is only rivalled by its great utility as the most perfect form of rotatory engine yet built. The patent is No. 6,753 of the year 1884. In stating the decision of the Judicial Committee, Lord WATSON announced that the reasons for the decision would be given at a later date. The grounds upon which petition for extension of letters patent may be made are: (1) that the inventor has not been adequately remunerated during the normal life of the patent, and (2) that the invention is one of exceptional merit. Evidence was given by Lord KELVIN, among others, on this last point, who stated that the Parsons steam turbine was the first practicable engine of that type. It was also shown that this engine has been of immense value in superseding reciprocating engines; and, indeed, many central station engineers can testify to its merits in regard to absence of that vibration which on more than one occasion brought these stations into trouble when they were run by reciprocating engines. In regard to adequate remuneration, the opposition to this novel type of engine wasted some of the earlier years in the normal life of the patent, and it is only just that extension should be made, by way of compensation.

WERE there no newspapers in existence, the fact that there is a serious coal strike in South Wales might be learned from the chimney tops of more than one metropolitan electric supply station; for, instead of discharging invisible gases or, at most, white steam, these are now rivalling North-country coasting steamers in the thick darkness of their smoke. Evidently these stations are not burning Welsh coal. The same disagreeable phenomenon, of course, is also observable in other classes of works, as well as in railway locomotives and river steamers; but these are not directly of such interest to electrical engineers. Welsh smokeless coal having recently asserted its political importance, is now demonstrating its industrial superiority; but it may be doubted if it is altogether wise to rely so completely upon it in metropolitan and suburban electric lighting stations. The situation of these latter in the midst of residential districts renders smoke production a nuisance, no less real in a time like the present because it is technically condoned. Even at the best of times Welsh coal is costly fuel. Cheaper coals will develop smoke if burned in furnaces designed for anthracitic fuel; but where the furnace is properly arranged to suit the class of fuel, even the most highly bituminous coal may be burned without sensible production of smoke. In view of the great difference in the cost of the two classes of fuel, it is surprising that in so few electric lighting stations have arrangements been made for the smokeless consumption of the cheaper class.

Mr. J. A. JECKELL has sent us a sample of some wire which has been taken out of an installation in South Shields. The wire is merely insulated with a layer of pure india-rubber between two lappings of white cotton, the whole being covered with a braiding superficially coated with compound. The insulated conductor would be quite suitable, as Mr. JECKELL remarks, for outside bell work, but it is hardly the type to place in a lighting circuit, and hide away under the floor, running it without casing through holes bored in the joists, as was done in this case. Mr. JECKELL adds that the work was not done by a South Shields firm, but he does not say who was responsible for the job. It is difficult to see how occasional instances of such jerry work can be prevented. Central station engineers have merely the right to insist on a certain insulation resistance at the house terminals, although the majority of them seem to interpret so broadly the Board of Trade Regulation A 37 ("In delivering the energy to a con-

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sumer's terminals the undertakers shall exercise all due precautions, so as to avoid risk of causing fire on the premises.") that they issue to intending consumers more or less elaborate wiring rules, in which the word "must" is used very freely. The fire offices cannot—or, at any rate, do not—inspect every small item of wiring, and the consumer must protect himself. This he can do thoroughly by employing a consultant to specify for the work and to inspect it during progress; but if he does not wish to go to this expense he can still insist, in his own specification to the wiring contractor, on adherence to a code of wiring rules. In this way the rules issued by the central station serve a good purpose, as, coming from a local source and from the consumer's source of electrical energy, the latter will accept them readily.

We should prefer, as we have frequently said before, to see a single set of rules accepted and used as standards alike by fire offices, central stations and consultants. All agree that such a code of rules is necessary; all have shown their willingness to undertake the work, and their aptitude for it, by the excellent rules they have already issued; neither would an agreement as to the text of the rules be a very difficult matter; but it appears that neither the fire offices, the central station men, nor the Institution of Electrical Engineers are willing to form a joint committee with the others, and share the honour of producing this *desideratum*.

In another column we publish an abstract of a Paper by Mr. Ll. B. Atkinson, which is in the nature of a review of the various types of electrical resistances used on light and power circuits, with special reference to a new material, "relugite," in which Mr. Atkinson takes considerable interest. Although there is otherwise little new in the Paper it is well worth reading, for it brings before one the various considerations which should be taken note of in the construction and choice of resistances—considerations which are often lost sight of through a mistaken idea that these apparatus are so simple as to require no particular skill or forethought in their design. We would call particular attention also to the last paragraph in the paper. It is noticeable that the cost of accessories, such as resistances, large switches and cut-outs, &c., is much too high in comparison with that of other electrical apparatus, and this may be largely due, as Mr. Atkinson suggests, to engineers not availing themselves of manufacturers' existing patterns and standards. But we think that the manufacturers themselves are also considerably to blame for this. Even when they have standard patterns of all such accessories, it is seldom that large quantities of them are stocked or are manufactured at the same time, and the difference between the cost and time of delivery of standard and of special designs is frequently small. The manufacturer should not wait to lower the price of the former until the demand for them increases, but he should foster the demand by first decreasing the selling price, and by making it to the material advantage of his customer to use these patterns.

A report has lately been made by Prof. Henry Robinson, Prof. A. A. Kanthack and Dr. Rideal, on the sterilisation of sewage effluents and purification of water supplies by means of what is known as the "electrozone process." "Electrozone" is a name given to the product of the electrolysis of salt water, and may be taken without sensible inaccuracy to be a solution of chlorine, hypochlorous acid and hypochlorites, such as is obtained by electrolysing chlorides of the metals of the alkalies and alkaline earths and allowing the anode and cathode products to mingle. In short, it is similar to the material provided by our old friend the Hermite process, and, like it, is a means of conveying to a putrescible material, such as sewage, a powerful antiseptic, oxidant and deodorant in the shape of chlorine or hypochlorous acid. The pamphlet containing the report above-mentioned does not describe the method of preparing electrozone, nor does it afford any data for determining whether the necessary apparatus is such as would commend itself to sanitary authorities and their advisers. It is confined to a description of certain experiments at Maidenhead where sewage was treated with electrozone, and the character of the effluent and the degree of improvement which was effected were noted.

These experiments go to show that when the Maidenhead sewage was treated with a quantity of electrozone, such that one grain of available chlorine was added to about four or five gallons of sewage effluent, a marked reduction of the number of bacteria per cubic-centimetre was secured. The amount of putrescible organic matter in solution was, however, not sensibly reduced, and the treated effluent after the lapse of about four days again swarmed with bacteria. It is argued that this result is satisfactory, because in the first place there is a good chance that the pathogenic organisms in a given effluent may be slaughtered, and that their successors a few days hence may be harmless, and secondly that the temporarily sterilised effluent may be discharged into a large stream and its organic matter exposed to destructive oxidation before any secondary bacterial growth can occur. It is admitted, however, that the effluent would fail to satisfy that terrible person the analyst, whose views are moreover endorsed by the Thames Conservancy. Consequently it is advisable to oxidise the organic matter of the sewage as far as possible by judicious filtration and aëration, and then to sterilise the product by treatment with electrozone. Adopting this modification we are at one with the conclusion that a satisfactory effluent may be secured by the aid of this particular product of electrolysis with the proprietary name.

After this agreement let us turn to the question of cost. The efficiency of the process seems to be somewhat better than that of earlier similar methods, the output of available chlorine being about 33 per cent. of that calculated from the energy expended. The cost of each ton of chlorine consumed is not given, nor are any data afforded from which it may be calculated. And here lies the kernel of the whole question. It is not a new discovery that chlorinated products are excellent germicides. It cannot be gainsaid that an admirable effluent (already deprived of the bulk of its organic matter by filtration, oxidation and the like) may be obtained by their means. No competent person would dispute the claims of an electrolytic method to be considered for the preparation of such

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a sterilising agent. But the cost—what of that? Surely to the full and candid report of the gentlemen whom we have named some word on this matter might be added, to the contentment of the borough engineer and the conviction of his municipality.

The experiments on commutation in dynamos and motors which have been carried out by Messrs. W. H. Everett and A. H. Peake, and are described by them in an article we publish this week, have resulted in an important contribution to the general stock of information on a subject of great practical interest. These researches exhibit praiseworthy skill in arranging the apparatus and in conducting the series of experiments, and they have been logically pursued along a line of investigation that has led to definite conclusions of no small value. The investigators announce their intention of carrying these researches further and in several new directions, not the least important of which will be an investigation of the influence of slotted armature core upon the conditions of commutation.

New Telegraph Line in Central Africa.—A *Daily Mail* telegram announces that telegraphic communication was yesterday established between Blantyre, the capital of Nyassaland, and Umtali, 250 miles away in Mashonaland. The new wire passes through Tete, on the Zambesi.

Appointment Vacant.—One of the W. C. McDonald Chairs of Physics in the McGill University, Montreal, has become vacant by the recent appointment of Prof. H. L. Callendar to the Quain Chair of Physics in University College, London. An advertisement in another page of the present issue gives some particulars of the vacancy.

Erratum.—The fourth paragraph of Mr. C. W. Schaefer's letter on the Localisation of Faults in Submarine Cables, in our issue of February 25th, should read :—"It is at a moment when these complex disturbances are in progress that the inferred zero is selected, the measurement of f being affected by two distinctly different values and conditions, . . ."

The British Association.—During the meeting of the British Association at Bristol next September there will be an international conference on "Terrestrial Magnetism and Atmospheric Electricity." It has been arranged for this conference to be made a special department of the mathematical and physical science section of the Association, and to be presided over by Prof. Rücker.

Cable Interruptions and Repairs.—

	Date of Interruption.		Date of Repair.
Latakia—Cyprus	Feb. 10, 1898	...	—
Saïgon—Hong Kong	Feb. 28, 1898	...	—
Cayenne—Pinheiro	Mar. 24, 1898	...	—
Sierra Leone—Accra	April 9, 1898	...	April 19, 1898
Bissao—Bolama	April 12, 1898	...	—
Capetown—Mossamedes	April 14, 1898	...	—
Maranham—Para	April 17, 1898	...	—
Benguela—Mossamedes	April 20, 1898	..	—

Telegraph Lines in German East Africa.—The overhead telegraph line between Bagamojo and Dar-es-Salaam, which was commenced last October, was, says the *Elektrotechnische Zeitschrift*, completed a short time ago, so that now all the post offices on the coast of the German East African Protectorate from Tanga to Mikindani are in telegraphic connection with one another. The length of the new line is about 40 miles, that of the whole line from Tanga to Dar-es-Salaam 142 miles.

The "Little" Continuous Indicator.—We regret that in our description of Mr. Little's ingenious continuous integrating indicator for steam engines, in our issue of the 8th inst., we inadvertently stated that in measuring horse-power by this instrument the engine revolutions must be noted. In a letter we publish this week Mr. Little makes it clear that no revolution-counter or speed-indicator is necessary, the instrument itself making the necessary reading for determining the horse-power. The practical value of Mr. Little's indicator is, of course, enhanced by this fact.

Patent Expiring.—On the 24th inst. the patent No. 6,770, granted to Dr. Hermann Aron in 1884 for "Improved Means for Measuring Electric Currents," will expire. This patent covers the original form of the Aron meter, which was practically a modification of the historical "ergmeter" of Profs. Ayrton and Perry. The patent also claims the application of the same electromagnetic control principle to clocks "regulated by a vibrating spring." Since the date of the patent several further improvements have, however, been introduced in the instruments, the latest type (referred to in *The Electrician*, Vol. XXXIX, p. 666) being self-winding, and automatically compensating for inaccuracy in the regulations of the clockwork itself.

Receiver for Hertzian Telegraphy.—There seems to be a considerable amount of experimental work done in Germany in connection with Hertzian telegraphy, and trials of slight modifications in the instruments are announced from time to time. The latest is described by Dr. H. Rupp in the *Elektrotechnische Zeitschrift*. He has not been particularly successful with the electromagnetic tapper for de-cohering, and has in place of it adopted a simple contrivance for revolving the coherer about the axis of the leading-in wires. A slightly larger tube than usual is employed, in which the filings are very loosely packed. A hard rubber pulley is fixed on the tube, and the paper strip from the Morse ink-writer is led round this pulley. Small copper springs are used as brushes to make contact with the leading-in wires. Dr. Rupp has obtained good results with this arrangement.

Accumulator Cars in New York.—The Dry Dock, East Broadway and Battery Railway Company, of New York, says the *Street Railway Journal*, has recently put in operation three storage-battery cars, of which two are kept in regular service and one as a reserve. The charging station is in Grand-street. There is a three-cylinder 90 H.P. Westinghouse gas engine directly connected to a Westinghouse generator. The engine is self-starting by means of compressed air, which is stored in a special reservoir. Electrical ignition is used on the engine. The charging pit has room for two battery equipments. When the batteries are to be charged, the car is run over the pit and an elevator raises the frame containing the batteries a short distance, when they are automatically disengaged. The batteries are then lowered and wheeled on a truck to the connection terminals. The battery for each car consists of 72 cells. The cars are equipped with Walker motors, and weigh without the battery 10 tons, and with it 14 tons.

Accidents in Berlin.—In the morning of the 2nd inst. a defect in a cable in the Berlin network caused damage to a number of feeders running alongside of it. According to an account in the *Elektrotechnische Zeitschrift* it was necessary to interrupt the supply until the Spandauerstrasse station and the corresponding district had been disconnected. The remaining three stations were then immediately started again, and the Spandauerstrasse station at 2 o'clock in the afternoon. The district fed by the damaged cables had to remain disconnected until the afternoon of the next day, which was fortunately a Sunday, and part was only re-connected on the Monday morning.—There has also been an accident on one of the electric tramway lines in Berlin. At 11.30 p.m. on Easter Sunday a steel span, wire in the Ritterstrasse broke, but fortunately no further damage was done, as the cut-outs at the central station acted immediately. It is fortunate that this did not occur earlier in the day, as on Sundays German tramways are usually very heavily loaded.

An Electric Grain Elevator in Russia.—Apropos of the electric grain elevator at Buffalo, recently described in our columns, Messrs. Brown, Boveri and Co. have written to the *Electrical World* of New York, stating that some six years ago they put down a large grain elevator plant in Novorossisk on the Black Sea, worked entirely electrically. The generating station contains four three-phase generators coupled directly to horizontal steam engines running at 125 revolutions per minute, and giving 250 to 300 H.P. each. The elevators and conveyors are

worked by means of ten motors of 20 H.P. each, normal output, and 55 of 10 H.P., making a total of 750 H.P., normal output, but capable of being pushed to 1,000 H.P. without difficulty. It is interesting to note that they are started by means of auto-transformers in exactly the same manner as those described in the new plant in Buffalo. The frequency employed is 25, the same as at Niagara. It will be seen from the above figures that the plant is of very considerable magnitude; indeed Novorossisk is one of the most important grain shipping ports in the world.

The Welsbach Lamp Filament.—The patent taken out by Dr. Auer von Welsbach, for improvements in filaments for electric lamps, has now been published by the Austrian patent office. Dr. von Welsbach first claims the use of: (*a*) osmium; (*b*) osmium combined with other metals of the platinum group (*e.g.*, platinum, iridium, rhodium and ruthenium); (*c*) a filament of osmium coated with thoria; and (*d*) a filament of another metal of the platinum group coated with thoria, or alloyed with osmium and coated with thoria. Next, several methods of producing the filaments (*a*) and (*b*) are claimed. A thin metal wire is used as a core, and covered with an osmium or osmium compound, and afterwards the core is incandesced and volatilised. The coating is either precipitated on the wire by reducing in reducing gases a volatile osmium compound, such as the tetroxide, or thin layers of the osmium or osmium compound are laid on, with the help of a binding material, if necessary, or the coating is applied electrolytically. Another method is to lay the osmium or osmium compound, mixed if necessary with the binding material to the consistency of a thin paste, on to a vegetable or animal thread; and still another to make an emulsion of it with collodion, which is afterwards de-nitrated. The third claim is for the production of the filaments (*c*) and (*d*) by applying successive thin layers of thoria until a sufficient thickness of this oxide has been formed.

The "Arndt" Econometer.—A report on Arndt's Econometer—an instrument for continuously indicating, on the principle of the gas-balance, the proportion of carbonic acid in furnace gases, and consequently gauging the efficiency of the combustion—says the *Journal of Gas Lighting*, has been made to the Franklin Institute. After describing the apparatus, the report states that a practical test of its merits was made on a boiler furnace at the Baldwin Locomotive Works. Check analyses of the furnace gases were made by Prof. Keller; and thus the Committee were satisfied as to the substantial accuracy of the instrument. For all practical purposes, therefore, the Committee regard the Econometer as offering indications of the composition of furnace gases quite as reliable as ordinary analyses. They go further, and record their opinion that the use of such an appliance is calculated to be beneficial to the owners of steam boilers and industrial furnaces, as exhibiting at all times the more or less favourable conditions of combustion. At the Baldwin Works a Babcock and Wilcox boiler, burning anthracite, showed carbonic acid ranging from 3·6 to 11 per cent. in the waste gases; corresponding to a loss of fuel, due to excess of air, of from 45 to 16 per cent. The latter is a very fair result, and was arrived at by using the forced blast of a steam-jet blower. Directly the blower was put on the duty rose, and when it was taken off the results in carbonic acid fell again.

Sources of Commercial India-Rubber.—At the Society of Arts on Monday last Dr. D. Morris delivered the first of two Cantor lectures with the above title. Dr. Morris commenced by pointing out the dissimilarity between india-rubber and gutta-percha. True, each was a latex and chiefly composed of carbon and hydrogen, but whereas gutta percha softened in warm water and was attacked by certain acids, india-rubber did not soften in warm water and withstood the action of these acids. Again, gutta-percha was the juice of one particular plant found only in a limited area in the East Indies, while india-rubber was obtained from several varieties of trees spread all over the tropical regions of Central and South America, Africa, Asia and Australia. Although the material was discovered by Europeans in Columbus's second voyage, it is only in comparatively recent years that its use has become so widespread. At the end of the eighteenth century half a cubic inch cost 3s., and it was regarded merely as a curiosity which would erase pencil marks; in 1830 but 23 tons were imported into the United Kingdom, 7,000 tons in 1870, and in 1896 and 1897 about 20,000 tons each year. Then followed a mass of interesting statistical information as to the import of rubber and the magnitude of the rubber trade in various countries, but Dr. Morris had, unfortunately, except in very few instances, not been able to obtain returns in which the imports of raw and manufactured material were differentiated. It would appear, however, that England and the United States are by far the greatest rubber consuming countries. The methods of extracting the gum from the rubber trees were described—both the way it ought to be done and the way it ought not to be done,—and the dirty methods, in vogue in the various districts, for the coagulation of the caoutchouc were enumerated. It is gratifying to learn that, in one district in Central America, these crude methods are giving way to a more scientific system, due to Messrs. Howard and Giffen. The milk is mixed with 50 per cent. of water and then rapidly revolved in a sort of cream separator. The caoutchouc rises to the surface, and is skimmed or run out in the same way as cream. After removal the material is laid on porous bricks for a few hours, after which it is ready to be sent away. Central American rubber produced by this process has improved 25 per cent. in value. In Para, however, the old method of coagulation by means of smoke is still employed, the "hams," of the shape familiar to rubber importers, being formed on a sort of paddle blade. To those who would like to read a graphic account of the methods and habits of rubber collectors the lecturer recommended a novel entitled "The Voice of Urbano"—author and publisher not mentioned. In conclusion an instructive diagram was shown illustrating the fluctuations in the mean price of Para rubber each year from 1877 to the present day. In 1877 it was 2s. 1¼d. per pound, in 1878 1s. 11d.; then it rose steadily, reaching a mean of 4s. 4½d. in 1883, dropping to 2s. 8d. and 2s. 5d. in 1884 and and 1885 respectively, and then fluctuated with an upward tendency, rising from 2s. 10½d. in 1894 to 3s. 6½d. in 1897. During this year the price has been steadily rising, and stood last Friday at 3s. 11d.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 22nd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Paper to be read: "On a Method of Viewing Newton's Rings," by the Rev. T. C. Porter.

MONDAY, April 25th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II.: "Sources of Commercial India-rubber," by Dr. D. Morris.

TUESDAY, April 26th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. Seventh General Meeting in the Lecture Hall of the Literary and Philosophical Society of Newcastle-upon-Tyne. The discussion on Mr. James Andrews' Paper on "Cylinder Ratios" will be resumed. Paper to be read: "The Effect of Different Arrangements of Crank Angles upon the Economy of Quadruple Expansion Engines," by A. L. Mellanby.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Annual General Meeting.

WEDNESDAY, April 27th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7.30 p.m. Students' Meeting. Paper to be read: "The Commercial Development of the Electric Lighting of Small Towns," by C. Milton and H. Bell.

INSTITUTION OF MECHANICAL ENGINEERS.

7.30 p.m. Ordinary General Meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster, when the President will deliver his Inaugural Address. The following Papers will also be read and discussed as far as time permits: "First Report to the Gas Engine Research Committee: Description of Apparatus and Methods and Preliminary Results," by Prof. Frederic W. Burstall. Supplementary Paper and adjourned Discussion.

FRIDAY, April 29th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse, "Magneto-Optic Rotation, and its Explanation by a Gyrostatic Medium," by Prof. Andrew Gray, F.R.S.

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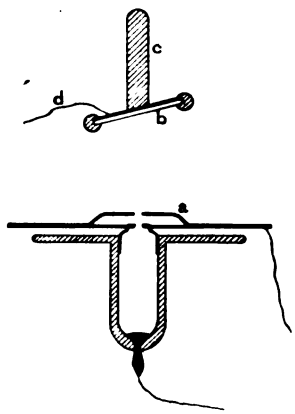
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

A New Experiment with Lenard Rays.—T. Des Coudres acknowledges the victory of the emission hypothesis of cathode rays, but doubts whether the "mass" of the cathode particle will prove to be constant and proportional to gravitational attraction, as in the case of ordinary matter. A weightless convergent-lines-of-force-structure, he says, would be legitimately described as an "occurrence in the ether." With this last blow on behalf of the derelict German hypothesis he goes on to describe a highly interesting experiment made by means of his ebonite thimble for the easier production of Lenard rays. The thimble, specially protected by a metallic diaphragm, *a*, is shown in the diagram. About 2cm. or 3cm. away from the window there is placed a barium platinocyanide screen, *b*. It is covered on the back with tinfoil, is held by the insulating rod *c*, and is protected against discharge by a shellac rim. The wire *d* may be connected to earth or to the positive or negative terminal of a very small influence machine. The wire is first put to earth, and the tube excited so as to produce well-defined fluorescence. Then when *b* is negatively charged, the screen darkens. On the other hand, when the fluorescence is feeble to begin with, it is enhanced by charging *b* positively. This result is quite in accordance with the kinetic theory. The velocity of the



cathode particles depends upon the potential gradient, and when that is reduced below a certain amount, the particles are incapable of penetrating the air, which, as we know from Lenard, is a turbid medium. The possibility of changing the velocity of cathode rays after their emergence from the tube is a valuable extension of our control.

[Des Coudres, *Verh. Phys. Ges. Berlin* 17, No. 3.]

Speed of Cathode Rays.—Before Wiechert had demonstrated the high velocity of the cathode rays T. Des Coudres had devised a method which indicated in a simple manner the propagation in time of the cathode particles. Cathode rays were produced by a high-potential battery of accumulators, and sent through a slit in a screen. A coil of a condenser circuit surrounded the rays near the origin, and the oscillating discharge widened out the beam into a fan, so that the rays only penetrated the screen at the instants of zero current. After traversing a length of the tube the rays penetrated another slit and then another coil of the same circuit. Now if their propagation were instantaneous, they would traverse the second coil before the current varied from zero, and would therefore not be deflected. But as a matter of fact they were, and knowing the oscillation period of the condenser circuit their speed could be roughly deduced. The method, however ingenious, does not seem to have been very successful. In the course of further experiments it was found that the cathode rays may be deflected by the current which produces them, and that even a single wire conveying a current across the path of the cathode rays, is capable of deflecting them.

[Des Coudres, *Verh. Phys. Ges. Berlin* 16, No. 10.]

Optical Rotation by Oscillating Discharges.—Vallari's supposed discovery of a lag in the Faraday effect in glass has given rise to a good deal of useful and suggestive criticism and to further test experiments. Lodge showed that electromagnetic rotation thinks nothing of 70,000 reversals per second. T. Des Coudres carries this a good deal further, and shows that periods of a millionth of a second are easily followed. He uses a coil of 20 turns, taken from a Kohlrausch ammeter designed for 200 amperes. Using a condenser of capacity 1,400cm., and a spark gap of 2·5mm., CS_2 gives between crossed Nicols a distinct brightening of an arc light. The effect is not stopped by raising the resistance 100-fold by the insertion of carbon rods. Even with benzol and saline and acid solutions in water the effect is well shown. What is essential is optical perfection: clear Nicols, uniform liquids, unstrained terminal plates, intense light source, and avoidance of wall reflections. The inductance of the circuit was not over 3,000cm., and the frequency was about 6 million per second in the actual experiments. The difficulties encountered in the case of strongly magnetic bodies are somewhat greater. The only substance whose negative magnetic rotation can counteract the positive rotation of the solvent is ferric chloride. Solutions in creosote are particularly good. But they are very opaque. Ferric chloride in methyl alcohol may be taken 6mm. thick. This requires very short coils. The author succeeded in making a coil of a single layer with 25 turns in 1·2cm. The brightening was very intense, much more so than in the case of CS_2. This shows that even the magnetic substances are capable of following several million reversals per second.

[Des Coudres, *Verh. Phys. Ges. Berlin* 15, No. 7.]

Distribution of Free Magnetism.—Following up Mascart's method, L. Holborn has investigated the situation of the poles in a magnetised iron cylinder under various circumstances. The poles in this case are the "centres of gravity" of the free magnetism, and are found by means of two coils, one of which is very short, so that all the lines of force pass through its ends without loss, while the other is so long that all the lines of force penetrate the turns of the coil. The effective length of the magnet is then obtained from the induction impulses in the two coils produced by a magnetisation of the cylinder. The results for total magnetisation show that the distance between the two poles of a cylinder or rod 15cm. long varies between 10·8cm. and 13·7cm., or between 0·72cm. and 0·91cm. of the total length. As the magnetising field increases the length decreases at first, but it steadily increases afterwards. The minimum coincides with the maximum of magnetic susceptibility. The change is least in wrought iron, where the susceptibility is high. This connection proves that the popular assumption of a magnetisation which first attacks the outer layers, and penetrates the inner layers as the field strength increases, is erroneous. Ellipsoids are magnetised uniformly throughout, as required by theory.

[Holborn, *Berl. Sitzungsber*, X., 1898.]

Standard Resistances.—W. Jaeger and K. Kahle write on "The Foundations of the Electric Unit of Resistance for the Physikalisch-Technische Reichsanstalt." They give a description of the calibration of the tubes containing the mercury, of the purification of the latter, of the comparison of the tubes among themselves and with manganin resistances. One difficulty dealt with is the expansion resistance (Ausbreitungs-widerstand) where the end of the standard tube enters the larger vessel containing the electrode. This resistance is different from that of an infinite conductor, and is not easily calculated. The work is facilitated by seeing that the end of the standard tube is within the spherical surface of the bottle forming the terminal vessel. If filled in a vacuum, the resistances of several successive fillings need not differ by more than a few 100,000ths of an ohm. As regards secular changes, recent measurements of older standards have shown a diminution of about three 100,000ths in four and a-half years. This is about the same as in the case of the manganin resistances.

[Jaeger and Kahle, *Wied. Ann.*, No. 3, 1898.]

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THE COMMERCIAL AND BUSINESS ASPECTS OF MUNICIPAL ELECTRICITY SUPPLY.

BY ALFRED H. GIBBINGS.

(Continued from page 785.)

The Wiring and Fitting of Private Premises by the Corporation.

General Remarks.—As a rule municipal electricity departments have not as yet extended their operations to include the wiring and fitting of private premises for the electric light and the supply of electrical goods generally. Many corporations are of opinion that to do so would be in fact travelling beyond their proper sphere, and that entering into direct competition with private enterprise is contrary to the spirit of municipal ownership and control. There are indeed very plausible reasons both for and against such a movement, and later on we will deal with these reasons somewhat fully. Such a department as a branch of a municipal concern can of course be worked with profitable results, and this is no doubt a very important consideration to many small townships where the electricity undertaking is at present carried on at a loss. Local circumstances must, however, very largely affect the decision as to the advisability or otherwise of the Corporation itself undertaking the work of private wiring contractors. In some localities, for instance, the amount of wiring work to be done would not be sufficiently extensive to enable a good firm to open a branch of their business for the purpose, with a qualified staff of workmen. The wiring contracts under such circumstances are left to local tradesmen, plumbers, ironmongers, carpenters, &c., who probably have had no experience whatever of the distinctive features of good-class wiring work, and who can employ only casual and incompetent workmen. The following letter from Mr. J. E. Stewart, the borough electrical engineer of Derby, will exemplify how such a condition of affairs retards and handicaps the progress of the municipal undertaking itself:—

"I shall be glad to hear from fellow works managers who have been in the same difficulty as I am in, and how they overcame the same. We have in Derby two people who do electric lighting work, but wait until it comes in their way; and it is hardly credible that one of our largest consumers had to write to me asking to know who were (if there were any) electric light contractors in the town. Derby is certainly a place for some enterprising man to start in."

The difficulty which Mr. Stewart has experienced will doubtless soon disappear as far as Derby is concerned, as it is a large and important town. There are, however, many small towns with populations varying from 10,000 to 50,000 where the local authority, if also the owner of the electric light undertaking, might with advantage all round lend themselves to the work of the wiring contractor. One of the advantages would be that no cheap and inefficient work would be undertaken, which, in the long run, is a matter of no small importance. In answer to the author's inquiries, the opinions of the electrical engineers, &c., to those corporations who have adopted the system are herewith given. The townships and vestries which do wiring work are—

1. Corporation of Bolton.
2. Corporation of Leicester.
3. Vestry of Shoreditch (London).
4. Liverpool.

Mr. Arthur Ellis, electrical engineer to the Bolton Corporation, says:—

"We do not trouble about canvassing, although we do 95 per cent. of the work. We charge a fair price for our work, and it is guaranteed to be of the best. In Bolton we have no wiring firms of any standing, and the work they do is of the lowest quality and price. In consequence of our doing this work, we find that the other contractors do not canvass. This is the only disadvantage in my opinion, but it does not make much difference to us considering we have put on over 13,000 lamps during the past 12 months. If the business gets slack then I shall consider the advisability of canvassing. Up to the present time we have kept 18 men and assistants fully employed in work, and at present we have more work in hand than we can cope with.

"Another advantage gained by wiring is that should anything go wrong our customers have only one party to deal with, viz., the Corporation. In cases where outside firms have done the work and trouble ensues, the consumer does not know to whom to apply. The wiring contractor will probably tell him that the Corporation are to blame, while, on the other hand, they come direct to us, and in many cases we find the fault lies with the wiring contractor. We have no cases at present on the hire purchase system, although, if requested, we spread the payment over five years. We get good prices for our work, so that other contractors cannot say that we cut their prices. We made £328 profit after the first year's working and £600 profit after last year's working, and we anticipate a much larger profit again this year (ending March 31, 1898)."

The profit made by the Corporation of Leicester from their wiring department is as follows:—

Year.	Profit from electric light fitting department.
1894	£258
1895	£534
1896	£382
Half-year, June 30, 1897	£183

Vestry of Shoreditch.—The basis upon which wiring contracts are carried out is that of the actual cost of labour and material with 10 per cent. added for supervision. This 10 per cent., therefore, is practically the percentage of profit made on each installation fitted up by the Vestry. The department has not been in existence for a sufficient length of time to give any figures relating to the profits made.

City of Liverpool.—The method and basis of contracting is much the same as in Shoreditch. The reason that a town of such size as Liverpool has adopted this system is because the municipality purchased the undertaking from the Liverpool Electric Supply Company, the business of wiring contractors having been started with the Company. No published figures are available.

Hire-purchase System.—None of the foregoing electricity supply undertakings have adopted the hire-purchase system. Such a system involves a large element of risk, and agreements would have to be made with the owner or owners of the premises as well as the tenant. The possibilities of free-wiring, hire-purchase and letting out on hire will be fully dealt with later on under their respective headings.

Equipment and Management.—The equipment of this department must include the following:—

1. Stores, which must be distinct from works stores.
2. Staff, including estimating clerk, superintendent, storekeeper, carpenters, and wiremen.

The price of material varies with market fluctuations, but contract forms, tests and specifications should be drawn up for all material which is bought in considerable quantities. The wages of a good storekeeper will be from 35s. to 40s. per week; for wiremen from 6½d. to 8d. per hour; and carpenters about 8d. per hour. Wages vary considerably in different parts of the country. The books necessary to keep in the department, and as tending to a perfect system of accounts, will include day book, ledger, contract and specification book, fittings invoice book, carriers book (inwards and outwards), stores (inwards and outwards), cables stock book, lamps stock book, time book, and wages book. In addition to these it will be advisable to have a foreman's order book on the storekeeper, a stores order book, and a prime cost book. The following are examples of some of the books referred to.

Methods and Systems of Wiring.—There are several methods of wiring, of which may be mentioned: (1) wires carried in wood casing; (2) concentric lead-covered wire, in which the lead is used as a return conductor; (3) twin lead-covered wires; (4) wires carried in insulated iron pipes; (5) "Cosmos" patent wiring system; and (6) armoured wires. A comprehensive description of each method is given in "Electric Wiring" by Russell Robb. In this volume will also be found full details of the various systems in use, such as the distribution system, the tree system, and the three-wire system.

Capital.—The capital outlay required will necessarily vary under different conditions. At Bolton a capital of £1,000 forms the actual working capital, and it has, in fact, been found sufficient. This amount is specially appropriated from the monies borrowed for electric lighting purposes generally, and is refunded annually, or that proportion of it which has been actually expended in wiring. This financial expedient is resorted to instead of obtaining advances from a bank, or of raising the money by levying a special rate for the purpose.

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Stores Inward.

Date.	Order No.	Description.	Rate.	£	s.	d.	Date.	Order No.	Description.	Rate.	£	s.	d.

Stores Outward.

Date.	Reg. No.	Description.	For work at.	Rate.	£	s.	d.	Date.	Reg. No.	Description.	For work at.	Rate.	£	s.	d.

Cables. Stock Book.

Date.	Order No.	Quantity.	Drum No.	Length.	Description.	Date.	Reg. No.	Quantity.	Drum No.	For work at

Lamps. Stock Book.

Date.	Order No.	Quantity.	Suppliers.	Date.	Reg. No.	To whom supplied.	Date.	Order No.	Quantity.	Suppliers.	Date.	Reg. No.	To whom supplied.

The present position of municipal authorities with regard to borrowing powers is explained in the following paragraph. The Local Government Board, in the exercise of its control, will not grant borrowing powers to a municipal authority for such a purpose as carrying on the business of wiring contractors, and this refusal necessarily involves all such other similar schemes as "free wiring," "hiring out of arc lamps and motors," &c. Power to raise capital for these objects would, however, be of immense value to the development of electricity undertakings, and it is to be hoped that Parliament will be petitioned to give further facilities in the direction of borrowing powers so as to include the schemes referred to.

Borrowing Powers.—The question raised in the preceding paragraph with reference to the borrowing powers for purposes of municipal wiring and hiring out of electric motors, &c., is not, so far as the author is aware, covered by any legal decision, and therefore at present depends upon the practice of the Local Government Board under the general Acts. Local authorities have, by virtue of the Electric Lighting Acts and the Public Health Acts, power to borrow money, with the consent of the Local Government Board, for the purposes of their undertaking generally; but one of the conditions imposed by Section 234 of the Public Health Act, 1875, is that the loan shall be available only for "permanent works." This term has been somewhat liberally construed by the Board, who, broadly speaking, consider that any work which may be expected to last for ten years or more is legitimately included under the denomination. Dynamo machines for generating the supply have therefore been treated as within the provisions; but loans for such objects as supplying "motors on hire," "wiring," &c., have not been allowed. Not, however, let it be again stated, that these loans have been definitely and distinctly ruled out on the ground that the work is not "permanent," but that the supply of motors, &c., does not fall within the general powers so far as they are governed by the Electric Lighting Acts and Provisional Orders.

Whether the decision of the Board as to the limits of these "general" powers is correct may probably be fairly open to question. The powers given by Section 10 of the Electric Lighting Act, 1882, are very wide, and might be construed, though not necessarily so, to include all works referred to in the preceding paragraph entitled "Capital."

In construing the words "meters and any fittings for the gas" which occur in the Gas Works Clauses Act, 1847, the Court of Appeal decided that the words included gas stoves, reversing the decision of a judge who had held the contrary. This decision, of course, enables municipal authorities to borrow money for the subsidiary business of letting on hire gas stoves and fittings.

A few years ago a protest was made by tradesmen at Leicester against the Local Authority undertaking wiring contracts and supplying fittings, and the matter formed the subject of discussion at a meeting of the Town Council, which was duly reported in *The Electrician*. This discussion, however, significantly enough, did not indicate any intention on the part of the Corporation to desist from trading in this way. The matter appears now to await some legal decision upon the terms of Section 10 of the Electric Lighting Act, 1882.

(To be continued.)

PORTABLE ELECTRIC DRILLING MACHINES.

We recently had an opportunity of inspecting some useful types of electric drilling machines made by the Thames Ironworks and Shipbuilding Company, and of witnessing

A Portable Electric Drilling Machine, made by the Thames Ironworks and Shipbuilding Company.

some applications of these tools in the drilling of holes in work difficult or impossible of being otherwise reached, except by hand labour. The accompanying illustration shows one form of these drills. Cased up within the hand truck seen on the left is fitted a shunt-wound overtype bipolar motor of about 2 H.P., together with the necessary starting resistance, speed-reducing gear and switch. Coupled to this motor through the coupling shown, is the drilling machine proper, seen on the right, the power being conveyed to the drill spindle (which is vertical) by a bevel wheel and pinion. The two stout legs on which the machine stands are the limbs of a U-shaped electromagnet, which serves to grip the work and resist the thrust due to the feed of the drill. The cores of these magnets are 8in. diameter, and the coils are run in

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parallel off the supply circuit. In the examples we saw the supply pressure was 100 volts and the current through the magnet coils 4 or 5 amperes. The direct pull given under these conditions, and serving to give the requisite grip, is 2,800lb. The magnet coils are entirely protected from injury and damp by strong copper sheathings. The coupling between the motor and the drill may be either an ordinary flexible shaft or, as is found preferable, the form shown in the illustration, which is a telescopic or extensible shaft, furnished at the ends with "Hooke" universal couplings. The ratio of reduction of speed may be readily altered by the substitution of a different set of gear wheels at the motor. Thus, by the provision of change wheels, is obtained a large range in the size of holes which the machine can drill. The motor arrangement is also made supported, not as in the illustration, but on trunnions giving a universal motion.

Another form of drill is made for use in situations where weight and size in the tool have to be a minimum. In this form the motor, gearing, drill and gripping magnet are in one compact and cased-in arrangement. The motor itself, in the "standard" size of this design, is a shunt-wound Manchester-type machine of 2 H.P. capacity at a speed of about 2,000 revolutions per minute; it takes 15 amperes at 100 volts pressure. The gearing reduces the speed to about 80 revolutions on the drill spindle. We saw many of these drills at work on the British battleship "Albion," and on the Japanese battleship "Shikishima," and in positions which gave us the strong impression that such tools were indispensable for such work. The makers say that the performance of the machines is most satisfactory, as by their use one man and a boy have drilled ⅝in. tapping holes 1¼in. deep in tough cast steel at the average rate of rather more than 100 per working day of 8 hours; these figures being taken from the weekly record sheet, the time including all shifting and setting up, grinding drills, &c. The extensive use of the drilling machines by the Thames Ironworks Company themselves is, however, the most undeniable evidence of the utility of these tools, which are manufactured in a variety of sizes and designs.

AN ELECTRICALLY-DRIVEN CYCLE FACTORY.

Lovers of intricate mechanism and ingenious mechanical contrivances will find plenty to delight them in the machine shops of a modern bicycle factory, but the interest is intensified when it is found that every machine is driven electrically. Although, from an engineering point of view, the operations in such a factory are individually of the lightest description, such good use is usually made of the floor space that in quite a moderate-sized shop a considerable amount of power may, in the aggregate, be required. The electric driving of a cycle factory, therefore, is a by no means unimportant undertaking; and, when the magnitude and rapid extension of the cycle manufacturing business are taken into consideration, the cultivation of this branch of electric driving is well worthy of the attention of electrical engineers.

In planning their new and commodious "Stellite" cycle works at Aston, near Birmingham, Messrs. R. F. Hall (Limited) decided upon the adoption of electric driving throughout the workshops, wherever mechanical power might be required. Several reasons led to this choice of power. In the first place, it enabled gas engines to take the place of steam engines, with considerable economy of fuel and wages for attendance; secondly, it provided a convenient and flexible means of distributing power throughout the factory; thirdly, it combined the arrangements for lighting and for power supply; besides which it offered numerous advantages over the ordinary methods of mechanical driving.

The power house at the "Stellite" works is situated, at a distance of some 20 yards or so from the main building, in an open space at the rear. It consists of a substantial building, one portion of which contains the machinery, a smaller portion being devoted to the purposes of the hardening shop, where gas fuel is used. A few yards from the power house the Dowson gas-generating plant, with the usual scrubbers, coolers and gas-holder, have been erected, underground pipes conveying the gas from the holder to the power house. Within the machinery room there are at present erected four Crossley horizontal gas engines, the largest being rated at 100 H.P., the next at 80 H.P., and the other two at 50 H.P. These engines are belted to four continuous-current dynamos, viz., one G. E. dynamo and one Crompton dynamo, each developing 600 amperes at 110 volts, and two Crompton dynamos, each developing 350 amperes at the same pressure. From the switchboard in this room the power is distributed in independent two-wire circuits to the various workshops and offices in the main building, all the outdoor conductors consisting of covered cables laid underground.

Fronting on the street is the building in which are the offices and show-rooms, and from the rear of this building there extend four three-story wings, in which are the workshops and stores. The magnitude of the structure may be gathered from the fact that the floor-space is 88,500 sq. ft., and there is accommodation for 4,000 workpeople. At the extreme rear end of each workshop wing there is a ventilating chamber, in which a 4-H.P. shunt motor drives a centrifugal fan, from which air, after passing through cleaners and warmers, or coolers, is led to the various workshops. These electrically-driven ventilators require practically no attention.

During a recent visit to these works we noticed that more than one method of electric driving had been adopted. There are engineers who advocate the abolition of line shafts and belts, each machine tool having a separate motor; while other engineers prefer that each workshop should be driven by one main motor. Messrs. R. F. Hall (Limited) have adopted both these methods of driving, doubtless with a view to give each a fair trial. In the polishing shop, or, again, in the mopping shop, each pair of buffs, or mops, is attached at the ends of the spindle of a 1 H.P. enclosed motor, the control of the motor being entrusted to the operative, who stops or starts it by means of a simple handle. In the polishing shop there are nine and in the mopping shop eight of these extremely compact and handy sets, and the entire absence of the customary shafts and belts and striking gears points to a decided advantage in this arrangement. On the other hand, a multiplicity of motors is costly, and placing them under the control of inexperienced and sometimes rough workpeople may be deemed undesirable in the majority of conditions. The conductors for the motors in these shops are well protected, being brought down from the ceiling inside the cast-iron columns supporting it, from which latter the wires are led through gas barrel to the cast-iron pedestals on which the motors are mounted. Electric power is also used in the plating shop, intermediate between the two shops just referred to; and here a motor-generator transforms the power from 110-volts to the pressure required for the copper or nickel-plating.

The shops in which the main-motor system of driving has been adopted are, curiously enough, those in which the individual machine tools are larger and more powerful than in the shops where separate-motor driving has been arranged for. Thus in the crowded automatic machine shops and tool shops, or, again, in the spanner and press shop, the practice has been to drive each entire shop by means of one or two 25 H.P. motors. In these cases the motors are placed on the floor, near the middle of the shop, and drive the overhead line-shafts by means of a belt. The motors for this class of driving are provided with regulating resistances, in addition to the on-and-off switch. Only in one or two instances has the principle of independent driving been adopted, in these main machine shops, where, we believe as a matter of experiment, small ½ H.P. Greenwood and Batley motors have been built into the frames of a few of the machines.

The electric driving of the "Stellite" cycle factory has been in operation for too short a time, as yet, for us to be able to give our readers any exact information as to the cost of this method of driving: but we understand that in respect of economy in working cost, no less than in convenience, cleanliness and safety, Messrs. R. F. Hall (Limited) are satisfied as to its superiority over older methods.

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ELECTRIC CRANES.*

BY J. G. STATTER.

In bringing this subject before you, I do so with the intention of inviting you to consider, from first principles, the question of lifting and transporting loads by means of electrical energy; that is to say, I do not propose to assume that an ordinary commercial motor is necessarily the best means to employ to convert electrical energy into mechanical work for this particular purpose. An electric motor driving a machine tool, or any piece of textile machinery, is not usually being continually started and stopped; it is subject to a variable load, perhaps, but it is allowed to revolve for a considerable time without being stopped; and therefore the apparatus required for stopping and starting, though not unimportant, is not of that paramount importance that it is in an electric crane where no clutches are employed. Tramway work offers a practical parallel to crane work, but it does not require its power so intermittently as a crane. The problem of starting, stopping and accelerating, and its converse, has been fairly well solved in the case of tramway work by the use of specially well-constructed switch gear. The details of this do not concern us at present, except that it may be stated that a magnetic device for blowing out the spark is used, which device is worth importing into the design of crane switch gear. The motors used for tramway work and the general scheme of their connections are also worth attention. Certain very excellent jib cranes for ships' use have been made, and provided with a couple of tramway-type switches, one for the lifting motor and one for the slewing.

An ideal electric crane lifting a load from rest should start it into motion slowly, accelerate it rapidly, and carry it for the major portion of the lift at full speed, then slow the motion quickly and stop. If the crane slews or traverses the same cycle must be gone through, and it is still more important that both starting and stopping should be gradual to prevent surging the load. In cranes as at present constructed this cycle is, practically speaking, only attained by that class of crane in which a separate motor is provided for each movement, and where the control is by switch-gear. I will call this type "Switch-controlled Cranes." In such cranes almost any form of gearing, if efficiently and well arranged, will answer the purpose, but worm gear is the best from the handling point of view, on account of the small amount of inertia of this class of gearing.

Cranes which derive their movements from one motor do not fulfil the conditions of a steady start with a rapid acceleration so well, but very good results are nevertheless obtained with the one-motor crane which I will describe as "clutch-controlled cranes." Perhaps the best results are given in this class by those employing open and crossed belts as transmitters. Friction gear also gives good results, and a particularly nice drive is given by a gearing which combines both belt and rolling contact-transmission, and which has been brought out and used with considerable success by Messrs. Wimshurst and Hollick.

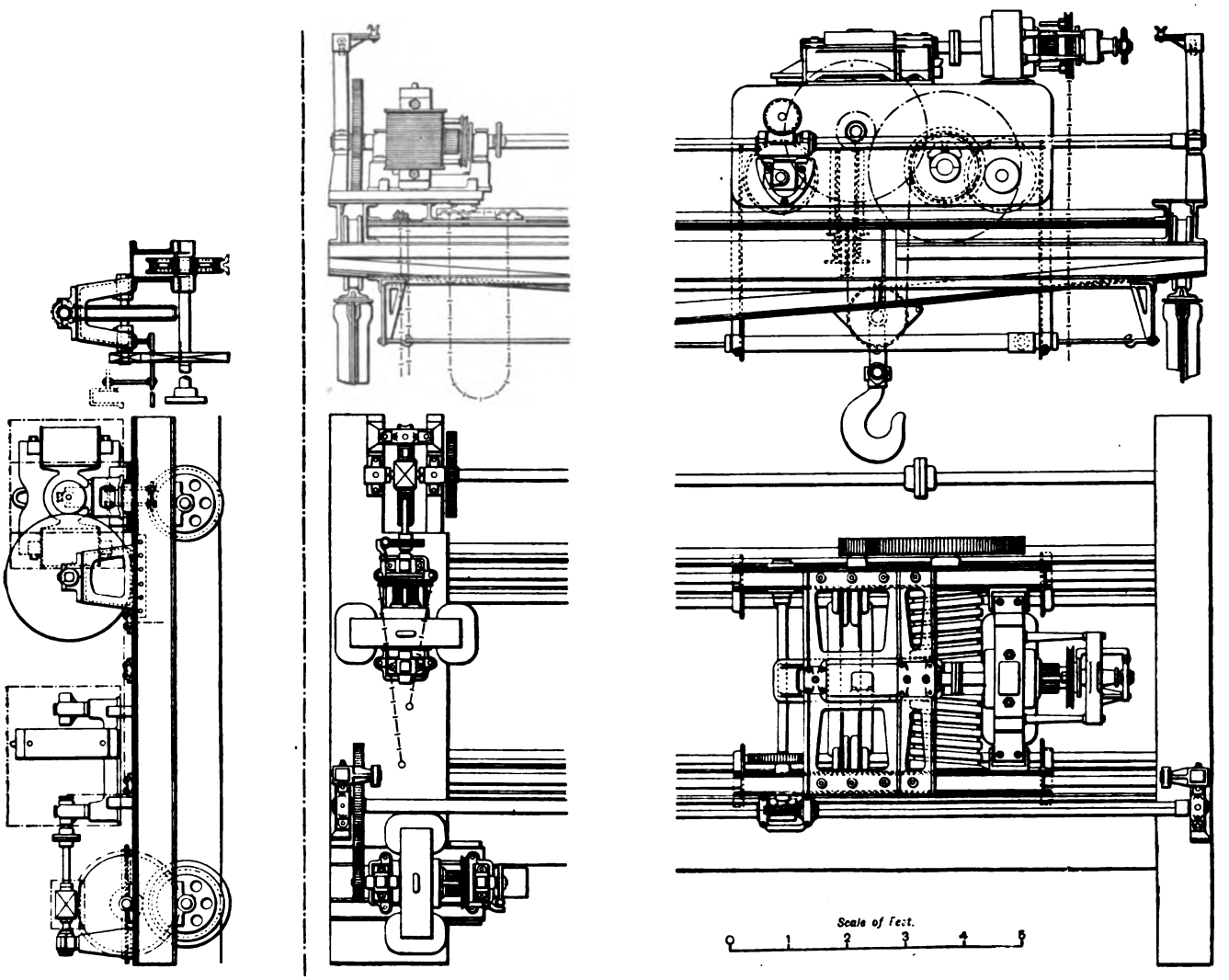

FIG. 1.—Constant-current 10-ton Travelling Crane.

I will now add a third type which, as far as I am aware, is novel; it is a switchless-clutchless type. As with the switch-controlled type it has one motor to each movement, which motor is started, stopped and reversed as required. This type can be constructed to work either with constant E.M.F. and variable current, or with constant current and variable E.M.F. The first variety of switchless crane has little commercial value. It is possible to conceive a few cases of small hoists to which the system might be applied with advantage; but, generally speaking, it may be regarded as an interesting toy. The regulation of the current is effected by always permitting relative movement to take place between armature and field magnet by the rotation of either the one or the other; it is, in fact, the equivalent of two motors, with their armatures arranged in series, and each of which is capable of absorbing the full E.M.F. of the supply circuit. With such an arrangement it is obvious that if we stop one of the armatures by main force the other will increase its speed and take up the full E.M.F., and will, if running light, permit so little current to flow through the armature that has been stopped

* Abstract of a Paper read before the Northern Society of Electrical Engineers.

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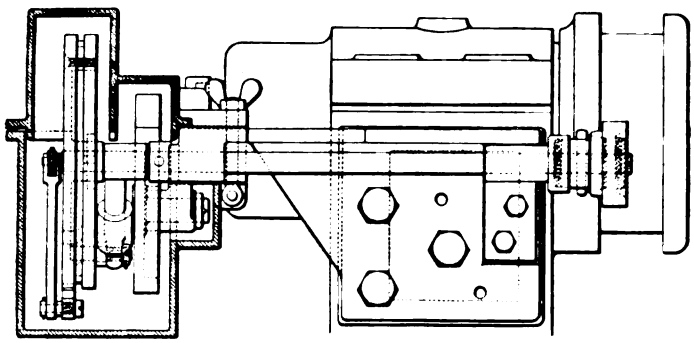
that it can be easily rotated in the direction opposite to that in which it was previously running. In attempting to construct a useful crane of this type, one would use a multipolar field and a light large diameter armature. If the latter were very lightly constructed, and, say, about 2ft. in diameter by 6in. wide, and revolved within a light cast steel multipolar field, such an arrangement with a lifting barrel geared to the field-magnets might in some cases answer a useful purpose. Armature and field-magnet might also be designed to have the same diameter, and multiphase motors are applicable. This system, when worked with one motor, cannot be reversed; and can, therefore, only be used for a hoist in which the load overhauls the winding drum. It is, however, possible to arrange for reversal by coupling two motor armatures mechanically to a drum by means of differential gearing, and electrically in series and arranged to run in opposite directions. The effect of such a combination is this: when the drum is at rest each armature runs light and absorbs half the total E.M.F. of the supply circuit; if we apply a brake to No. 1 armature No. 2 takes charge, accelerates as the other is retarded, and finally reaches practically twice its former speed. The drum is then revolving. If we wish to reverse the drum we let No. 1 armature go, and apply a brake to No. 2, the speed of the drum falls, and when the two armatures are revolving at the same speed it stops and then commences to revolve in the opposite direction and reaches full speed when No. 2 armature has been brought to rest. The graduation of the speed and the complete control of the drum is excellent, but the plant efficiency is bad; and therefore commercial applications of this system are not likely to be extensive.



I will pass on to the practical form of switchless crane, viz., that in which the motors are fed by a constant current. Messrs. Chamberlain and Hookham completed, early in 1897, a 10-ton travelling crane upon this system. This crane has since then been in successful operation in a steel foundry. It is the first of its kind, and is in consequence by no means mechanically or electrically perfect. In point of handling it is, however, superior to any crane that the writer has yet seen, and the practical experience gained demonstrates fully that no trouble is experienced by sparking at the commutator. The crane (Fig. 1) has a span of 30ft., the crab is carried by two built up fish-bellied girders of steel, supported by end carriages built of deep channel sections plated over. A light chequer-plate platform runs alongside one of the girders to give ready access to the crab for cleaning, &c. The three motions are derived from three independent motors, all directly geared, and started, stopped and reversed as required. These motors are standard open type constant-current motors, of which the makers possessed the patterns at the time of taking the contract. Enclosed motors would, of course, be employed for further cranes. With respect to gearing, all three motors are geared alike with a worm and worm-wheel, and afterwards with one further reduction by spur gear. With this arrangement the worm-wheel can be driven at a fairly good pace, and in the case of the lifting motor it is double threaded, a combination which gives a very fair efficiency. The following are the particulars of the three motors: the lifting motor, when lifting 5 tons at the normal speed of 8ft. per minute, absorbs about 85 volts at 75 amperes; the cross-traversing motor absorbs about 50 volts at 75 amperes when travelling at about 40ft. per minute, its normal speed The longitudinal motor absorbs the same energy and gives the same speed, viz., 40ft. per minute. This unusually low speed for the longitudinal traverse was arranged to meet the requirements of the foundry.

The chief work done in the steel foundry is that of casting shells; the shell moulds are cast-iron chills placed in rows longitudinally down the foundry. Usually two such rows are prepared with, say, 50 chills in each row, and the chills are pitched about a foot apart. The crane takes up a ladle containing about six to seven tons of molten steel from a furnace, and carries it to the end of the two rows. One row having been plumbed by the cross traverse, a tap hole is opened in the bottom of the ladle by means of a lever, and the first chill is filled. The tap hole is then closed, and the longitudinal traverse is applied to move the ladle 1ft., and so to plumb the second chill. The tap hole is now opened again, and the chill filled, and so on down the whole length of the first row and back again up the second. It will be seen, therefore, that to get over a distance of little more than 100ft. the crane has to be stopped and started 100 times, and that accuracy of movement is of great importance, and high speed is not desirable. The whole crane must be moved a foot at a time as quickly as may be, but without causing the ladle to surge, and the head box of the chill must be accurately plumbed or the metal splashes. During the operation, which takes place three or four times every 24 hours, the crab and its motor are exposed to the heat and ascending fumes from 12 sq. ft. of glowing molten steel at a distance of 3ft.

The current is supplied by a continuous-current transformer receiving E.M.F. at 120 volts, and giving out a constant current of 75 amperes at varying volts, according to the requirements of the circuit. The armature of the generator is of the gramme type, and is so proportioned with respect to the field strength that it pushes the field before it—the neutral point follows the brushes, with the result that there is very little sparking; with carbon brushes which are employed upon this transformer the sparking is usually not visible, but a little does occur, though not enough to affect the wear of the commutator.

The regulation of current depends upon an automatic gear for moving the brushes. This is represented in Fig. 2, and consists essentially of a rocking shaft driven off the transformers' own shaft, and armed with a pair of pawls. A segment of a spur-wheel is

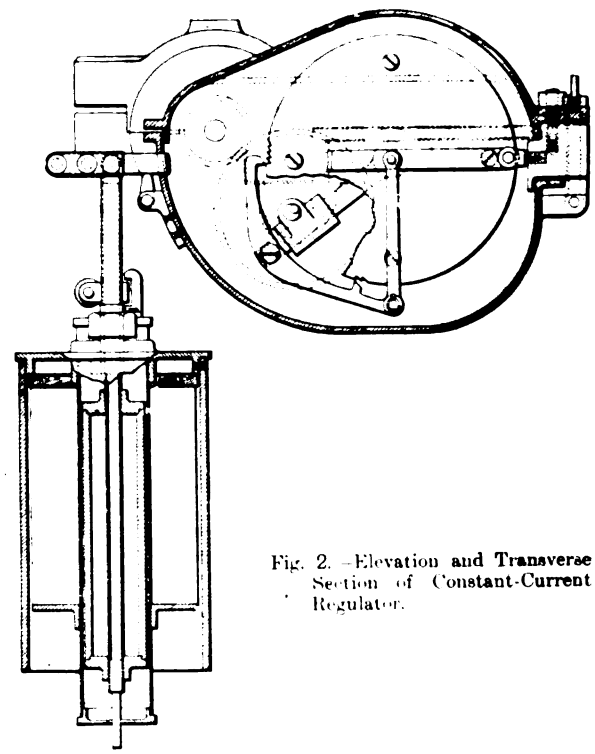


Fig. 2.—Elevation and Transverse Section of Constant-Current Regulator.

screwed to the brush-rocker and connected by gearing to a pair of ratchet-wheels with teeth cut in opposite directions. Into one or other of these, one of the pair of pawls is carried by the rocking shaft gears, and so can give motion to the brushes either forwards or backwards. The engagement of either pawl is determined by a series-wound solenoid carrying the main current. At normal current both pawls are lifted out of gear, but a very slight variation is sufficient to make either one or other pawl engage with the ratchet wheels and so move the brushes upon the commutator to a position of greater or less difference of E.M.F. A constant current having been thus obtained it is led to the crane through a fuse and a minimum cut-out, and supplied by the usual type of bare collecting wires. It passes through the cross traversing and longitudinal traversing motors, on to a second pair of stretched bare wires between the girders between which the lifting motor is inserted, and after passing the lifting motor the current returns to the line.

The control of the motors is effected merely by altering the position of the brushes on the commutator. All motors are worked by chains from below, since it would be impossible for a man to live, if perched up near the girders, owing to heat and fumes. With the brushes at right angles to a line drawn midway between the polar gaps there is no tendency in the motor's armature to rotate either way, the effect of one-half of the turns upon it exactly

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balancing the effect of the other half. In order to obtain a movement the brushes are displaced by a pull upon a chain passing over a chain-wheel which forms the brush-rocker. With the two traversing motors a displacement of about one-third the maximum is sufficient to cause either motor to rotate and traverse the crane, showing that these motors are very much over their work and can produce a sufficient twisting moment even when a part of the winding on the armature is neutralised. With the lifting motor, readiness to revolve depends upon the load to be lifted ; the size of this motor should be such that it will just accelerate with full load. This effectually protects the crane against over-load. In order to reduce the E.M.F. required to circulate the current when all motors are at rest, and also to make them stop quickly, a short-circuiting device is employed which acts when the brushes are at the position corresponding to that of rest of armature. The same cam also gives a determined position for the chain-wheel corresponding to rest, and informs the attendant that the motor is standing. The action of this short-circuited armature coming to rest in an excited field gives all the brake power needed and renders the brakes unnecessary, except for the lifting motor. The 5 H.P. constant current motor is shown in Fig. 3.

Having now described this crane and its action, I will give some description of typical cranes of the other two classes.

Clutch-controlled Cranes.—In order of date, preference must be given in this class to a crane designed by Messrs. R. E. Crompton in the early eighties. The energy of the motor is transmitted by the friction of a papier maché pulley forced against a wheel which makes one revolution to 4·3 revolutions of the motor. A second reduction takes place by spur gear in the ratio of 5 to 1, and from this line of parts all the three motions of lifting, slewing and traversing are taken. This is a good design for a small slow-working crane, but with the amount of gear and number of parts employed, the wear and tear must be considerable. The crane will deal with weights up to two tons, and the motor is wound for 110 volts and 45 amperes continuous ratings. A crane on very similar lines was supplied by the writer's firm, in 1895, for timber stacking.

The principal dimensions and the capacity of another jib crane, made for Messrs. Glover, are as follows :—

Length of jib (*i.e.*, length of cord, jib being swan-necked, for the better handling of skip of deals)		40ft.
Maximum radius		36ft.
Minimum „		15ft.
Maximum height of jib head	(from ground)	70ft.
Working load		15cwt.
Speed of lift	(per minute)	125ft.
Speed of slew	„	300ft.
Speed of traverse	„	80ft.

In this case four separate motions—three of which have to act in both directions—are required ; and since none of them require a great power, it was decided to drive them all off one motor, using a coil clutch for the heavier load, and ordinary friction cones for the lighter motions. The motor is a standard "Statter," B type, built for an output of 100 volts and 90 amperes. The motor is geared directly to the shaft carrying the lifting barrel by a worm and worm wheel running in an oil bath, and the other motions are also driven by this shaft. The barrel is engaged and disengaged, as required, by means of the coil clutch, and is controlled by a powerful strap brake. A flexible steel wire rope is used for hoisting. The whole of the motions are controlled by four upright levers, and a foot-brake is placed in front of the driver, and the direction of the slope of these levers gives the cue to the driver for the direction of movement. In all cases when a lever is vertical its corresponding clutch is disengaged. By pressing forwards, say, the slewing lever, the crane slews to the right, while pulling it backwards makes the crane slew to the left. On all lever quadrants are brass plates indicating the movement effected and the direction. A fifth lever, placed at the driver's right side, controls the speed of the motor, and enables the driver to graduate the speed if required. The motions for slewing and travelling are driven off the worm-wheel shaft, which is always revolving by cone clutches of the reversible type, in a similar manner to the arrangement used for those purposes in Crompton's crane ; but whereas, in the latter, the lifting barrel has to be disengaged by stopping the gear and drawing out a jaw-clutch for lowering, in the former the barrel can be engaged and disengaged at any time as required while the shaft is revolving. The derricking motion, being seldom required, is put in gear by a jaw clutch.

A number of photographs of single-motor cranes were then exhibited in the lantern by the author.

Cranes Partly Clutch-controlled and Partly Switch-controlled.—Good examples of this judicious compromise are two 3-ton cranes constructed by Messrs. Stothert and Pitt, of Bath, and motored and equipped with switch gear, &c., by the writer's firm. The particulars of these cranes are : lift 3 tons at 100ft. per minute, or 2 tons at 200ft. per minute, slewing at 500ft. per minute. The rated capacity of the two motors is 200 volts and 225 amperes for lifting, and 200 volts by 50 amperes for slewing. The actual currents required are about 160 amperes for full load of 2 tons at 200ft. per minute, and 15 to 20 amperes for slewing with load. In regular work—unloading steamers of the Clyde Steamship Company—the loads were dealt with at the higher speed, and averaged about 1 ton in weight. For this work the lift usually required between 60 and 70 amperes, and for 10 hours' continuous work about 50 Board of Trade units were consumed—an average of five units per hour. Slewing and lifting were always performed simultaneously. The lifting gear of these cranes was by clutch and switch action, and the slew entirely by switch control.

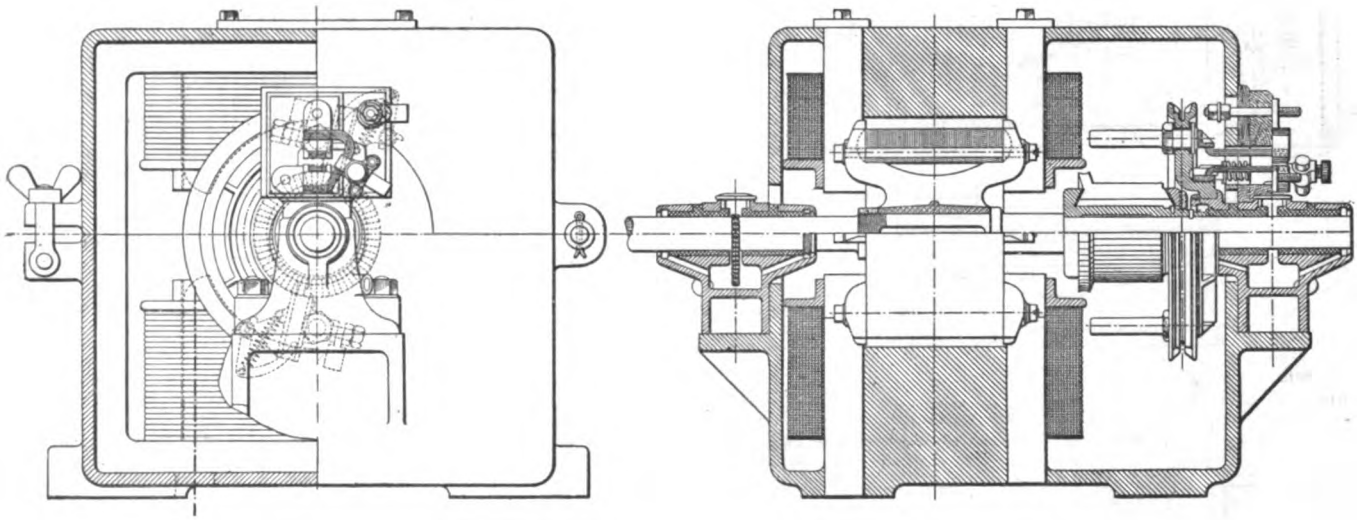

FIG. 3.—5 H.P. Constant-current Motor.

The writer's reason for adopting the double method lay in the difficulty of making switches to bear being switched off and on 50 times an hour, and worked sometimes for 36 hours at a stretch. The clutch is a coil clutch, and can be thrown in and out of gear while the motor is revolving at full speed. But when working at 200ft. per minute it is not desirable to pick up half a dozen fire grates loosely slung together. The driver therefore slows the motor by a switch placed above his left arm, and engages the clutch with his right. The moment that he sees all has been picked up safely, and that the load is not going to surge under the hatchways, he pushes over the switch to full speed and immediately after lowers his left hand on to the slewing switch, and commences to slew while the left is still on. For this class of work switches alone can be made to do the work, but they require to be of large size, as will be seen later. The combination above referred to was so successful that the same arrangement was adopted for the lifting movement of a crane built shortly after, by the writer's firm, for the South Western Railway Company of Russia (Fig. 4). The capacity of this crane was as follows : lift 1½ tons, at 200ft. per minute ; 2½ tons, at 100ft. per minute. Slew, 400ft. per minute.

The arrangement of the two motors is very much the same as in the last mentioned crane, but the lifting motor has two windings upon the armature to give two speeds and powers of lift, with one rope and hook. In the former crane the two speeds were given by

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inserting a snatch-block for the low speed—a troublesome and time-wasting matter. In the Russian crane the change was effected by turning over a switch, which placed the windings of the armatures either in parallel for the high speed or series for the low. This gave the desired ratio of two to one for the speed of light load and full load. With the heavy load, however, the armature is required to produce 50 per cent. more twisting moment than that required for light load. This is attained in the following manner: a series winding is placed upon the field magnets and only included in the circuit when the armatures are run in series. It is possible, therefore, to work with a greater armature reaction than before. The turns being double the current should be halved for the same reaction, but for the work we require more current and more torque. Experiments showed that it was possible to work with the same current with armature windings in series as when in parallel, sparking being prevented by the extra excitation

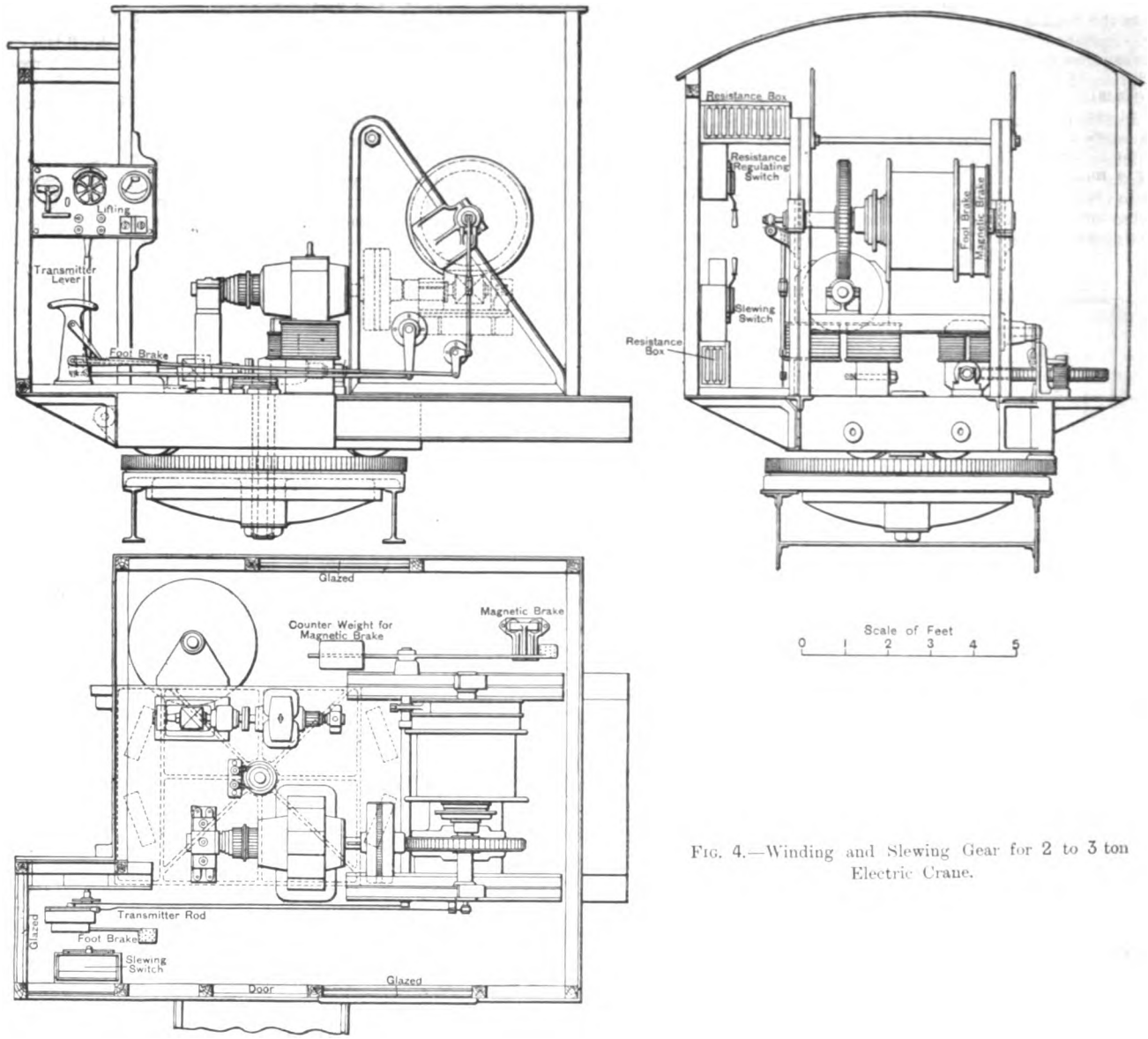

FIG. 4.—Winding and Slewing Gear for 2 to 3 ton Electric Crane.

in the field. Heating effect is of no consequence, since the heavy load lifts are not often required. The rating for parallel working is the continuous-working rating. Experiments were made to determine the torque with a spring balance on a radius arm, and the reduced results are as follows :—

Current.	Armatures in series.	Armatures in parallel.
	Net pull in lbs.	Net pull in lbs.
30 amperes	38	18
50 ,,	52	39
70 ,,	63	43

giving very closely the required ratio, viz., 3 to 2.

The lifting motor was built for 200 volts at either 700 or 320 revolutions per minute (the increased field reducing the speed as well as the altered armature turns). It had an armature core 14½in. diameter by 10in. long, slotted to receive the conductors, and wound with two distinct windings, the first wound gramme-wise, and the second a drum winding. The slewing motor was wound for 200 volts by 20 amperes at 12,000 revolutions, and had a slotted drum armature core 6½in. diameter by 4½in. long. The actual current required to slew averaged 9 amperes.

The following is a description of the cranes upon the after-deck of the North German Lloyd steamship "Bremen," which were constructed by the Union Electricitäts Gesellschaft. The "Bremen" carries 4 cranes, each capable of lifting 3 tons, and 12 cranes, each capable of lifting 1½ tons. A 7 H.P. motor is used for slewing, and a 25 H.P. motor for lifting for both sizes, the smaller weight being lifted at twice the speed of the 3-ton load. If the control of a crane is to be entirely by switch gear no greater mistake can be made than that of cramping the switch. It however emphasises the fact that the cost of the switch gear upon this type of crane is by no means an insignificant proportion of the total cost of the electrical equipment. For the sake of simplicity both the controllers are the same size, and are linked together by an ingenious arrangement of bevel gears, both operated by one lever. This lever is directly attached to a central ring shown, and communicates movements to either a vertical or horizontal quadrant by means of drivers. If, therefore, the lever is depressed it moves the left-hand quadrant only, and if swung round horizontally only the right-hand quadrant, but if depressed and displaced horizontally in one movement both quadrants are moved, and both lifting and slewing take place simultaneously. This is a very useful arrangement and a very neat piece of designing.

The last crane that I propose to describe to you is a 3-motor traveller of the switch-controlled class, produced by Messrs.

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Vaughan and Sons, of West Gorton. The particulars as to its actual performances are as under:—

—	Empty.	With 5-ton load.	With 10-ton load.
Longitudinal traverse	270ft. per min., volts 100, amperes 23.	220ft. per min., volts 105, amperes 30.	185ft. per min. volts 100, amperes 45.
Cross traverse	186ft. per min., volts 100, amperes 10,	160ft. per min., volts 100, amperes 20.	124ft. per min., volts 105, amperes 26.
Hoisting.....	6⅔ft. per min., volts 100, amperes 18.	4½ft. per min., volts 100, amperes 28.	3⅓ft. per min volts 100, amperes 40.

Total weight of traveller 19 tons. Crab being 4½ tons.

Relative Advantages and Disadvantages of the Three Systems of Crane Control.—First, as regards efficiency, both clutch-controlled and switch-controlled cranes lose power at the moment of lifting or starting up any movement. To consider lifting only as being the most important, switch-controlled cranes starting to lift a load absorb power wastefully in the starting resistance, and clutch-controlled in the slipping of the friction gear or clutch. These quantities should (frictional losses in gearing being the same in both cases) be practically equal. Then there are what I may call the "standing losses." In clutch-controlled cranes we have one motor always running light when the crane is not actually doing work, and in switch-controlled we may have the shunt losses of two or three motors, if shunt-wound motors are employed, and these losses amount to about half those entailed by the clutch-controlled crane motor running light; there are no standing losses at all if series-wound motors are employed. In the switchless constant-current crane we have no losses at all in starting up a load, all the energy developed is consumed usefully; it is purely a matter of counter electromotive force. But we have the standing losses in the field-magnets, which are preferably always excited, although the armature is short-circuited when any given motor is not at work. We have also the losses in the conductors, due to the current in them always being of the same value, but in most cases this is not a serious amount. It is impossible to draw a hard and fast line, but constant-current and switch-controlled cranes should run one another very close for first place as to efficiency, while the clutch-controlled will be slightly less efficient, owing to the regular running of the motor when no useful work is being done.

Next, as regards handling: although I have seen very accurate work done by clutch-controlled cranes, there can be little doubt that the most accurate work is done by the switch-controlled cranes. And the control is even better when the control is by displacing the brushes of a constant-current motor.

In point of durability: comparing, as before, clutch-controlled and switch-controlled, cranes first, as, being the two types now in regular use, the palm must be awarded to the clutch-controlled by a very narrow margin indeed. The switchless constant-current crane has decided advantages in this respect. It has no switches and no clutches and it does not waste energy; it therefore does not waste itself. The lost energy of the clutch-controlled crane expends itself in grinding up its friction wheels or clutch surfaces; and that of the switch-controlled seeks every opportunity of damaging our switch contacts or of electroplating in our liquid resistances. Fig. 3 shows a constant-current crane motor. It is reversed by pulling the chains shown by the dotted lines. The brush-rocker is a chain wheel and can be revolved through 160deg. The brushes always working in a constant field, work extremely well. The area of the carbon brushes is little over ½ sq. in. They carry 50 amperes with the greatest ease, and the commutator is bright and shows no sign of wear. Under ordinary conditions of commutation such carbons would not carry more than 25 to 30 amperes. We have, however, to consider the generator in the case of a constant-current crane. This is an ordinary dynamo—so far as wear and tear are concerned—with an additional piece of apparatus for automatically moving the brushes over the commutators. This piece of apparatus (Fig. 2) works in an oil bath and is very durable. The oldest I have at work was made in 1890, and I do not think that one penny has been spent upon it yet. In point of durability, therefore, the constant-current crane will, I believe, prove to be the best of the three types. But up to the present we have not enough experience to state this definitely.

Initial Cost.—All cranes requiring two or more power-driven movements can be more cheaply constructed on the clutch-controlled system than upon any other, and for many purposes they are most suitable. For shop travelling cranes, however, I give a general preference to those with three motors, either switch-controlled or worked by constant current. A comparison of cost of switch-controlled *versus* constant-current cranes is a simple matter. The motors on the crane cost about the same for either class. The brushes and their rocker bar exist on both types of motor, and there is very little extra cost for the movable gear of a constant-current motor—the brush-rocker being merely made in the form of a chain-wheel. On the constant-current crane, therefore, we make a saving of three sets of switch gear, and provided that a generator has to be supplied for driving the crane or cranes, the constant-current system is not more costly than the switch-controlled 3-motor crane, allowing for the fact that a constant-current generator with automatic brush-shifting gear is more expensive than an ordinary 100-volt direct-current dynamo. In the case of the constant-current crane illustrated, the current had to be derived from mains carrying a constant pressure of 120 volts. It was therefore necessary to convert this to constant-current with varying pressure, and a transformer having independent armatures is employed, the one running at constant speed independent of load, and the other having movable brushes and capable of varying its terminal E.M.F. from 10 volts to 120, with a constant current of 75 amperes. In future I should use my constant-current transformer as a booster, so that its E.M.F. might be additive or subtractive, and give a total of 240 volts or zero. The determination of relative costs therefore depends upon the cost of constructing three sets of expensive switch gear against constructing one booster of a capacity equal to half the watts to be absorbed by the crane. The watts absorbed by a constant-current crane cannot be taken as the sum of the full output of the three motors. The motors may all be running at once, but certainly not all at full speed. For a 10-ton crane, therefore, 75 to 100 amperes at 100 volts is ample. Let us take the larger current, and call the required energy 10 kilowatts, then the extra apparatus required is a 5-kilowatt constant-current transformer, costing, say, £100. For a similar sized crane worked by switches, three sets of starting, stopping and reversing switches would be required of 100-ampere capacity. These I have no doubt could be produced for less than £100. But if really first-rate switches enclosed, in cases, are employed there will be very little change left out of the £100, and the wear and tear will be much greater. It is also not to be forgotten that for crane purposes a sufficiently good constant current can be produced from a separate generator driven by means of an ungoverned engine.

In conclusion, there can be little doubt that the constant-current crane is a very practical form of electric crane, which deserves a more extended application than it has so far enjoyed.

RIVETING BY ELECTRICITY.*

BY F. VON KODOLITSCH.

Most of the shipbuilding yards and bridge-building establishments are now seriously considering the question of introducing electric transmission of power into their works for the sake of driving each tool by a separate motor. Some of the factories already possess a hydraulic installation for riveting purposes which it would be impossible to convert to the new system. The only way of applying the new system to the existing plant would be to drive the compressor pumps by a separate electric motor. All the defects which belong to hydraulic installation in general would adhere to this, viz., a great outlay of capital, high working expenses, and an enormous cost in the up-keep. For the last two years I have been experimenting on electric riveting machines, and have finally succeeded in bringing out a type of riveting machine quite capable of superseding the two systems already existing, viz., hydraulic and pneumatic riveting. There are a good many firms in this country who have to decide which system of riveting they intend to adopt for the future, in order to keep pace with the rapidly-increasing competition of other firms at home and abroad, and this is the reason that I propose to read a Paper on this subject at the present meeting, especially as I have seen that some firms on the other side of the Atlantic are making great efforts to introduce the pneumatic system, and promise gigantic profits to those who decide to adopt it.

Before I proceed to describe the electric riveter in detail, I wish to point out, in a few remarks, why the electric system is, from the commercial and technical point of view, superior to all its rivals. I assume, of course, that the yard adopting the new system already possesses a central station and a system of wires for transmission of power, as is already the case in a good many establishments. If they are driving punching. shearing or boring machines, rolls or mangles, &c., by the electric current, it is certainly logical to utilise this existing current also for riveting. Anyone deciding to rivet by electricity has only to order such a machine and place it where he wants to do his riveting, connect two wires from the main to the riveter, and he can begin the operation at once.

Now let us suppose that hydraulic riveting has been decided upon. A pair of expensive compressor pumps have to be installed, a gigantic accumulator has to be put up, pipes must be laid, pipe connections between the riveter and the accumulator have to be made, and a hydraulic riveting machine must be bought and erected. In case of pneumatic riveting the same installations must be made, and almost the same outlay of capital is incurred. What has been

* Abstract of a Paper read at the Institution of Naval Architects.

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said above clearly demonstrates that the initial outlay is far less if the electric system be adopted. Everyone who works a hydraulic or pneumatic installation must know what a heavy item is the keep-up in the total working charges. In case of the electric system, this point only becomes a fraction of the expenditure. As regards the quality of the work, there is not the slightest difference, but as regards the quantity of work done, the electric system is considerably superior. The machine I am describing to-day has closed, for weeks and weeks, 1,200 rivets in a day of ten hours' duration, requiring the attendance of only three men and a boy.

The electric riveting machines which have up to the present been built can be carried about easily to any place in the yard, but are not made for being suspended from a crane. To the large jaw are attached two platforms at right angles, so that the riveter may be used horizontally or vertically. The system is so very simple that I need not occupy much of your time in describing it. One heavy disc is always rotating by electricity, whether the riveter is closing rivets or not. This disc can become, at the same time, an electro-magnetic coupling, so that when the current is passing this coupling a second disc, keyed on to a screw spindle, may be at once firmly attached to the revolving disc, thus the friction of the screw spindle can be regulated according to the operator's wish. The screw spindle moves a large nut at the end of a knuckle joint, which raises and lowers the die for making the rivet head. Between the two already-mentioned discs a conical friction roller can be inserted. By pressing in this roller, the motion of the screw spindle can be reversed, and the nut of the knuckle joint returned to its original position in order to be ready for a new stroke. The pressure on the die must be regulated in proportion to the diameter of the rivet, and this is done by producing more or less friction between the two discs, which difference in friction is obtained by more or less current being admitted to the electro-magnetic coupling. The type of the riveting machine which we are building now is made chiefly for shipbuilding purposes, and closes rivets up to 1⅛in. in diameter; the output is, as already stated, 120 rivets per hour. When so many hot rivets are required in a short time the question of heating the rivets becomes very important. When we started to rivet by electricity, we could not produce the number of hot rivets required by using a reasonable number of portable forges. For this reason we have made a small fan, driven by an electric motor, to supply air to a number of small furnaces, which considerably reduces the number of boys required for heating rivets.

ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Bedford (Municipal)	March 4	Leeds (Company)	April 8
Burton-upon-Trent (Municipal)	April 15	Northampton (Company)	April 15
Clerkenwell (Company)	March 18	Notting Hill (Company)	March 11
Dover (Company)	March 11	Oxford (Company)	April 1
Hanley (Municipal)	April 8	Richmond (Company)	March 4
Huddersfield (Municipal)	March 25	Scarborough (Company)	April 1
Kingston-upon-Thames (M'cip'l)	March 25	Wandsworth (Company)	March 18

The two electric supply undertakings, the accounts of which are analysed on the opposite page, furnish material for an interesting comparative study of metropolitan electric supply on a magnificent scale, and in highly favourable circumstances. The undertaking of the Charing Cross and Strand Electricity Supply Corporation (Limited) ranks somewhat below that of the Westminster Electric Supply Corporation (Limited) in respect of capacity and output, but this disparity is corrected by the more advantageous situation of the area supplied by the first-named concern, and for all practical purposes the two undertakings are on comparable footings.

Westminster Electric Supply Corporation (Limited).

The Authorised Capital of the Westminster Electric Supply Corporation (Limited) has been reduced from £500,000 to £499,500 by cancelling the Founders' shares, 100 in number, and, the balance of the Ordinary shares having been issued, the Share Capital received is represented by 79,000 fully paid £5 shares of this description. Of the authorised Loan Capital, £100,000 has been received, this being represented by £29,400 in Five per Cent. and £70,600 in Four and a-Half per Cent. Mortgage Debentures. Notice has been given of the redemption of the Mortgage Debentures bearing interest at the rates just named, and £250,000 in First Mortgage Debentures, bearing interest at 3½ per cent., has been created, some £200,000 of which has already been issued.

There are at the present time more than 300,000 lamps connected, the number at the end of last year being 290,561, as compared with 249,318 in the previous year. No less than 44 miles of roadway have been equipped with mains, making 180 miles of conduits and upwards of 152 miles of copper cable and strip. As will be seen by reference to the opposite page, the capacity of the generating plant has been increased from 3,765 to 4,533 kilowatts, and a considerable amount of capital has been expended during the year on new buildings and plant as well as on extensions of mains. The additions to the plant and buildings that have been going forward are now almost completed, and, in this connection, it is pleasing to note that the temporary inconvenience, owing to these operations, has not prejudicially affected the costs of working the stations. In respect of the amount of business done, the output has increased from 3,503,054 to 4,355,781 units sold, an increase of 24·3 per cent., which compares favourably with the 16·5 per cent. rise in the lamp connections, and the 21·6 per cent. increase in the maximum supply demanded, showing an improvement in the conditions of working.

The total revenue and the revenue from supply per unit sold have remained almost stationary, falling in either case only 0·02d. A better result than in the previous year, however, is shown in the working profit for the year, which now stands at 12½ per cent. of the capital expended. A liberal sum of £13,790, or nearly 2¾ per cent. of the capital expended, has been set aside for depreciation, in addition to £1,500 carried to a separate reserve fund. After deducting these and sundry other charges, and paying interest on loans, a sum has remained available for the handsome dividend of 12 per cent. on the Share Capital.

Charing Cross and Strand Electricity Supply Corporation (Limited).

The following table sets forth the Share and Loan Capital received by the Charing Cross and Strand Electricity Supply Corporation (Limited), together with the dividend or interest paid:—

Description of capital.	Nominal amount of shares.	Amount called up per share.	Total amount.	Dividend or interest per cent. per annum in 1897.
Ordinary shares ...	£5	£5	£150,000	7%
Preference shares..	5	5	100,000	4½
Debentures	100	100	70,000	5
Temporary loan ...	...	...	4,000	3½

The business of this undertaking is in a highly flourishing condition. During last year the lamp connections were increased 53·7 per cent., from 73,464 to 107,512: and the total output increased 33½ per cent., from 1,944,402 to 2,615,508 units sold. Some 6½ miles of additional mains have been laid down, and the generating stations and plant have been extended. The new station on the wharf at Commercial-road will shortly be completed. Situated as the mains of this undertaking are in the midst of a district crowded with theatres, restaurants and clubs, the circumstances are highly favourable to economical working. The number of units sold per lamp connected (averaging the connections throughout the year) was about 29.

Unfortunately, a fall of 0·34d. in the gross revenue per unit sold has not been quite compensated by the fall in the total costs, with the result that the net revenue per unit sold has decreased. A decrease from 7·63 to 7·24 per cent. of the capital expended is also to be observed in the annual working profit. The high expenditure per unit is wholly due to a rise in the cost of generation, both distribution and management costs having fallen appreciably. Thus, the works costs have risen 0·09d., while the distribution costs have fallen 0·033d., and the management charges, &c., have fallen 0·152d.

Of the £24,154 working profit for the year, which represents 7·24 per cent. of the capital expended, a sum of £5,247 has been set aside for depreciation, representing 1·57 per cent. of the capital expended. Although not so liberal as that of the companion undertaking, this is a very respectable sum to set aside for the purpose, and is far in advance of average practice. After deducting interest and other charges, and paying 4½ per cent. dividend on the Preference shares, a substantial dividend of 7 per cent. has been paid on the Ordinary shares, leaving £3,015 to carry forward to the next account.

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	WESTMINSTER.		CHARING CROSS.	
Undertaking Worked by	Westminster Electric Supply Corporation (Ltd.)		The Charing Cross and Strand Electricity [Supply Corporation (Ltd.)	
Date of Commencement of Supply	1890.		1890.	
System of Supply	Continuous-current three-wire with batteries.		Continuous-current, three-wire.	
Chief Engineer	A. B. W. Kennedy.		W. H. Patchell.	
YEAR ENDED DECEMBER 31st.	**1896.**	**1897.**	**1896.**	**1897.**
QUANTITIES—				
Units generated	4,069,184	5,046,500	—	—
,, **SOLD (TOTAL)**	3,503,054	4,355,781	1,944,402	2,615,508
,, sold to consumers	3,503,054	4,355,781	1,944,402	2,615,508
,, sold for public lighting, &c.	nil	nil	nil	nil
,, used on works	51,249	61,096	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	30·2	31·0	27·6	32·7
Maximum supply demanded	3,000 kilowatts	3,650 kilowatts	—	—
Number of public lamps	—	—	nil	nil
Connections to mains in 8-c.p. lamps	249,318	290,561	73,464	107,542
CAPACITY OF PLANT IN 8-C.P. LAMPS	115,900	140,500	70,000	80,000
CAPACITY OF PLANT IN KILOWATTS	3,765	4,533	2,250	2,540
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£500,000 / £133	£499,500 [c] / £110	£400,000 / £178	£400,000 / £157
Share	400,000 / 106	399,500 / 88·2	250,000 / 111	250,000 / 98·4
Loan (including Debenture charges)	100,000 / 26·6	100,000 / 22·2	150,000 / 66·7	150,000 / 59·0
RECEIVED (TOTAL)	440,000 / 117	499,500 / 110	280,000 / 124	324,000 / 128
Share	340,000 / 90·4	399,500 / 88·2	200,000 / 89·0	250,000 / 98·4
Loan (including Debenture charges)	100,000 / 26·6	100,000 / 22·2	80,000 [a] / 35·5	74,000 [f] / 29·1
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	60,000 / 15·9	nil / —	120,000 / 53·4	76,000 / 29·9
Share (unissued)	60,000 / 15·9	— / —	50,000 / 22·2	— / —
Share (uncalled)	nil / —	— / —	nil / —	— / —
Loan (including Debentures)	nil / —	— / —	70,000 / 31·1	76,000 / 29·9
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	14,649 / 3·89	16,687 / 3·68	— / —	— / —
DEPRECIATION FUND	30,576 / 8·12	43,192 / 9·52	8,000 / 3·56	13,000 / 5·12
EXPENDED (TOTAL)	478,871 / 127	560,388 / 124	309,604 / 138	357,770 / 141
Lands and buildings	111,820 / 29·7	153,621 / 33·9	155,064 / 69·0	160,871 / 63·4
Plant	127,437 / 33·8	144,795 / 32·0	45,836 [b] / 20·8	73,515 [g] / 28·9
Mains	195,624 / 52·0	211,588 / 46·5	91,865 / 40·4	103,883 / 40·9
Miscellaneous	43,990 / 11·7	50,384 / 11·1	16,839 / 7·49	19,501 / 7·68
BALANCE OF CAPITAL ACCOUNT	−38,871 [a] / −10·3	−60,888 [a] / −13·4	−29,604 [c] / −13·2	−33,770 [c] / −13·3
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£86,632 / 5·94d.	£107,366 / 5·92d.	£39,118 / 4·83d.	£48,915 / 4·49d.
Revenue from supply	81,214 / 5·57d.	100,561 / 5·55d.	38,105 / 4·70d.	48,027 / 4·41d.
,, meters, &c.	3,718 / 0·258d.	4,344 / 0·239d.	465 / 0·057d.	582 / 0·053d.
,, public lighting	nil / —	nil / —	— / —	— / —
,, sale of lamps, &c.	nil / —	nil / —	134 / 0·017d.	214 / 0·020d.
,, miscellaneous sources	1,700 / 0·117d.	2,461 / 0·136d.	414 / 0·051d.	92 / 0·008d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£33,000 / 2·26d.	£42,491 / 2·34d.	£18,976 / 2·34d.	£24,761 / 2·27d.
WORKS COSTS	20,055 / 1·37d.	25,681 / 1·42d.	13,701 / 1·69d.	19,337 / 1·78d.
Generation of electricity	*18,568 / 1·27d.*	*23,919 / 1·32d.*	*11,748 / 1·45d.*	*17,069 / 1·57d.*
Fuel (including cartage, &c.)	7,838 / 0·537d.	11,450 / 0·632d.	7,090 / 0·875d.	10,350 / 0·95d.
Oil, waste, water, stores	1,391 / 0·095d.	1,737 / 0·096d.	631 / 0·078d.	997 / 0·092d.
Wages at station	6,550 / 0·449d.	7,114 / 0·392d.	2,583 / 0·319d.	4,010 / 0·368d.
Repairs and maintenance at station	2,786 / 0·191d.	3,618 / 0·200d.	1,444 / 0·178d.	1,713 / 0·157d.
Distribution of electricity	*1,487 / 0·102d.*	*1,762 / 0·097d.*	*1,953 / 0·241d.*	*2,268 / 0·208d.*
Wages, &c.	681 / 0·047d.	1,183 / 0·065d.	1,180 / 0·146d.	1,101 / 0·101d.
Repairs, renewals of mains, &c.	806 / 0·055d.	579 / 0·032d.	773 / 0·095d.	1,167 / 0·107d.
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	12,996 / 0·891d.	16,726 / 0·923d.	5,272 / 0·650d.	5,422 / 0·498d.
Royalties	*nil* / —	*nil* / —	*91 / 0·011d.*	*nil* / —
Rent, rates, taxes	*3,721 / 0·255d.*	*5,002 / 0·276d.*	*2,335 / 0·288d.*	*1,929 / 0·177d.*
Management	*9,275 / 0·636d.*	*11,724 / 0·647d.*	*2,846 / 0·351d.*	*3,493 / 0·320d.*
Salaries	6,840 [b] / 0·469d.	8,226 [f] / 0·454d.	2,073 / 0·256d.	2,639 / 0·242d.
Stationery, &c.	270 / 0·019d.	359 / 0·020d.	231 / 0·029d.	218 / 0·020d.
Establishment charges	443 / 0·030d.	579 / 0·032d.	355 / 0·044d.	389 / 0·036d.
Law charges, &c.	1,722 [c] / 0·118d.	2,560 [c] / 0·141d.	187 [d] / 0·023d.	247 [h] / 0·023d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£53,632 / 11·6%	£64,875 / 12·5%	£20,142 / 7·63%	£24,154 / 7·24%
Sum carried to Depreciation Fund	12,100 / 2·62%	13,790 / 2·65%	4,854 / 1·84%	5,247 / 1·57%
Sum carried to Reserve or Sinking Fund	1,000 / 0·217%	1,500 / 0·289%	— / —	— / —
Net interest on loans (incl. Debenture charges)	4,743 / 1·03%	5,164 / 0·994%	3,580 / 1·36%	4,140 / 1·24%
BALANCE FROM LAST ACCOUNT	+1,339 / 0·290%	2,985 / 0·575%	+1,397 / 0·529%	+2,997 / 0·898%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	33,973 [d] / 7·37%	49,461 [g] / 9·52%	12,484 [e] / 4·72%	17,764 / 5·33%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	9% / —	12% / —	6% / —	7% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	38·1%	39·6%	48·5%	50·6%
Expenditure per kilowatt capacity	£8. 15s. 5d.	£9. 7s. 7d.	£8. 8s. 8d.	£9. 14s. 10d.
REVENUE PER KILOWATT CAPACITY	£23. 0s. 0d.	£23. 14s. 0d.	£17. 7s. 5d.	£19. 4s. 10d.
Expenditure per 8-c. lamp capacity	5s. 8¼d.	6s. 0½d.	5s. 5¼d.	6s. 2¼d.
REVENUE PER 8-C.P. LAMP CAPACITY	17s. 3½d.	15s. 3½d.	11s. 2d.	12s. 3d.
Price charged for lighting, per unit	6d. [h]	6d. [h]	6d.	6d.
Price charged for power, per unit	4d.	4d.		
Price charged for public lighting, per lamp	—	—	—	—

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SPECIAL NOTICE.

The present number of "The Electrician" completes Volume XL. With next week's number will be issued (Gratis) the Index to the Volume.

THE ELECTRIC DRIVING OF MACHINE TOOLS.

The electric driving of machine tools and other workshop appliances, which for some time has been extensively practised in America and on the Continent, is now making rapid strides in this country; and numerous engineering works, shipbuilding yards and many descriptions of factories for light and heavy work are already equipped with electric motors for this method of driving; while in several important works in the North the introduction of this system is being rapidly pushed forward. Commonly in foreign works that are electrically driven, and, we believe, in every instance in this country of works of any considerable size, it has been the custom to generate electric power within the works themselves; but in some instances power has been obtained from an external and independent supply. The local conditions in many foreign countries where water-power abounds often favour the latter method of obtaining power, a large source of water-power serving as a centre for distribution to numerous factories and other consumers. But in England, where fuel is cheap and where the prices asked by electric supply undertakings are relatively high, it has generally proved more advantageous, in a factory or works of more than the smallest size, to erect a suitable generating station upon the premises. When it is remembered that even for lighting purposes alone it is often advantageous to equip large buildings, such as hotels, with their own generating plant, it is not surprising that in the majority of English factories and shipbuilding yards

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where electric driving has been introduced the same plan has been adopted. For, indeed, electric supply concerns have offered little or no inducement to large businesses to consume current wholesale, whether for lighting or power purposes; and though in some instances special rebates have been offered for "taking a quantity," and in other cases there has been a lower price fixed for supply for motors, the advantages thereby held out have not been, as a rule, sufficient to tempt the wholesale consumer. On the contrary, in some instances electric supply concerns have by no means yearned for the wholesale consumer for motor purposes, fearing that his influence upon the voltage of the mains would be too terrible for the user of electric light. Experience, however, is showing that these fears are groundless, or, at any rate, that modern practice in electric generation and distribution is quite capable of rendering them antiquated; and there are indications that statutory supply of electric current for lighting and electric driving combined will, before long, be extensively practised in this country. To accomplish this end it will be necessary to offer electric energy at a much cheaper rate than the lowest price charged by existing undertakings at the present time, otherwise the installation of private plant will still be the cheaper method; but there can be no reasonable doubt that an undertaking favourably situated in the centre of an industrial district will be able to supply current much cheaper than individual manufacturing firms can generate it for themselves, and, since these latter have already demonstrated the superiority of the electric over other methods of factory driving, the prospect is decidedly encouraging.

Turning from the question as to the mode of generating the electric power, we may in passing observe that more than one electrical system of generation have been found successful in practice. On the Continent and in America the two-phase and three-phase systems have been extensively used, and in the United States the ingenious, but we fear somewhat unnecessarily complicated monocyclic system devised by Mr. Steinmetz has received extensive trial, not without considerable success. In England, however, we are aware of the existence of but one polyphase plant for this purpose, viz., the 2,000-h.p. Brown-Boveri installation at Messrs. T. Richardson and Son's engine works, at Hartlepool, and continuous-current plant hitherto has been generally adopted. It is not our present purpose to discuss the relative merits of these various systems of working, an interesting inquiry we reserve for a future occasion; rather would we direct attention to some of the mechanical features of electric driving in itself. It is, at the outset, a matter for considerable surprise that the class of works in which electric driving has received its earliest adoption in this country, has been one demanding large amounts of power and involving heavy strains upon the driving machinery. Nowhere has electric driving been so extensively and successfully practised as in the shipbuilding yards and engine works of the North-East Coast. Probably no class of machine tools throws heavier and more trying strains upon the driving plant than the large rolls, plate-bending machines and wall-planers used in such works. We have seen electric motors, of both polyphase and continuous-current types, drive with perfect regularity and success extensive workshops equipped with these descriptions of heavy machine tools, under conditions which amply demonstrate the suitability of electric driving for every-day work of the most severe description. Another example of electric driving under conditions of severe and sudden strain is furnished in the account given by Herr F. von Kodolitsch of electric riveting, in a Paper recently read before the Institution of Naval Architects. An abstract of this Paper is given in another column this week. Not only do the electrically-driven riveting machines turn out work equally as good as that done hydraulically, but they can be worked more quickly, thus increasing the output *per diem*; besides which they are cheaper in first cost and in working expenses than a hydraulic or pneumatic riveter, and have the immense advantage of ready portability. An operation incidental to riveting is the drilling of rivet-holes, and in this connection we may call attention to a handy little electric drilling plant, described in an article we publish this week, which is manufactured by the Thames Ironworks and Shipbuilding Company, and is in use in their works. In many shipbuilding yards rivet holes, instead of being drilled, are punched in the cold plate, an operation which throws an enormous momentary strain upon the driving plant; but experience shows that this strain is not too severe for the robust constitution of a healthy electric motor. Heavy strains are also to be met with in the daily operations of any large travelling crane. In a Paper on "Electric Cranes," recently read by Mr. J. G. Statter before the Northern Society of Electrical Engineers, this subject is ably discussed, and an abstract of Mr. Statter's Paper will be found in another part of our issue this week. As compared with square-shafting, rope-transmission or any of the older mechanical methods of propelling a travelling crane, there can be no doubt of the superiority in every respect of the electric motor; though, as a rule, it would probably not pay—at any rate in works generating their own electric power—to adopt electric driving for this purpose, unless such power were to be used for other purposes in the same works. Opinions differ in regard to the superiority of one-motor and three-motor cranes, both types being largely used. Mr. Statter advocates a system not commonly in use, requiring either a constant-current transformer or else that the generator for supplying current to the crane be driven by an ungoverned engine, so as to develop constant current. These complications must tell against the general adoption of the constant-current crane, which, however, has certain advantages over the constant-potential types. But we are inclined to think that double-wound armatures and series-parallel controllers would obtain the same advantages by a better and more direct method.

Not alone in works requiring the intermittent performance of heavy duties, on the part of the motors, but also in workshops where the work is of a lighter, more sustained and delicate nature has the electric motor proved its superiority. Instances of this might be multiplied, but it shall suffice if we call attention to the adoption of electric driving in a bicycle factory, some account of which we give elsewhere this week. The steadiness obtainable in the speed of an electric motor fits it for delicate duties not less perfectly than its power of developing a high starting torque enables it to tackle sterner work. No type of reciprocating engine or motor can attain so perfect a degree of steadiness in speed; and, though in this respect the electric motor may theoretically be rivalled by other forms of rotatory motors, it cannot be surpassed by them, while the relative inconvenience in the application of these latter severely handicaps them in practice. To obtain this steadiness in the highest possible degree in the use of an electric motor, the motor must be applied as directly as practicable to the work, and must not be separated from it by belting or other forms of gearing. For the most sensitive work, therefore, the separate-motor arrangement is the most suitable; but in the majority of engineering and other industrial operations the work is not of so delicate a nature as to demand perfectly steady driving, and choice between the rival systems of main-motor and

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separate-motor driving must be settled by other considerations. Each of these systems has attained a certain degree of popularity, and decided advantages are to be found in either of them; but, after a careful study of electric driving under varied conditions, we are of the opinion that practice is far from having arrived at a settled stage. Not that we would imply that one system must eventually eliminate the other, for the special advantages in either system must render it the more suitable for special circumstances; but the conditions under which each is superior are not yet clearly recognised. Apparently the two systems have been adopted in somewhat haphazard fashion, in many instances. Again, even when choice between the two systems has been decided, the details of the arrangements appear to be far from finality, in respect of their adaptation to the special conditions of working. Where there is a motor allotted to each machine tool it would surely be preferable that the motor should be an integral part of the tool than that it should be a stock motor—designed for any one of a hundred purposes—just coupled to the tool in a rough-and-ready fashion. Probably with the present small demand, motor tools would not justify the extra cost; but when this form of electric driving is more extensively practised, motor-builders will have to specialise in self-contained motor-lathes, motor-planers, &c., as they are now doing in motor-cars and motor-ventilators. Nor, in the system of driving a workshop by one or two main motors and overhead shafting is there much less room for special adaptation. It will probably be found advantageous to build motors so that they may readily be used as shaft-hangers, wall-brackets, or pedestals, the line-shafting being coupled at each end of the motor spindle. Here, again, however, evolution can only proceed at a pace regulated by the demand for special types. And, for the present, it is satisfactory to discover evidence all around that the common types of electric plant now in existence can answer so well the purposes of electric driving for workshops and machine tools.

REVIEWS.

Archives of the Röntgen Ray. February, 1898. Edited by W. S. Hedley, M.D., and Sydney Rowland, M.A. (London: The Rebman Publishing Co.).

Biologically speaking, the cell wall of a new scientific society is often difficult to define. Where shall its sphere be said to begin and where end: just what subjects should it include, and what shut out—questions of considerable importance to those concerned in its organisation and management. The peculiarly isolated character of work associated with high vacua research, and its nevertheless extensive application and interest, may account in some way for the need that was felt for a "society" especially devoted to the discussion of matters relating to that branch of physics. There is little doubt that the great refinement of experiment necessary, together with the disheartening inability to obtain quantitive results, helps to add to that isolation. At any rate, early in 1896 came word from Berlin that meetings were being held there by some German specialists in scientific photography—meetings at which X-rays and optical physics in general were discussed; and last year St. Martins Town Hall held a large concourse of people, attending to inaugurate the formation in London of a Röntgen Society.

Nucleated with a strong committee, the "cell" has rapidly developed, and the progress of this new society is to be regularly reported in "The Archives of the Röntgen Ray," a quarterly journal, the February number of which now lies before us.

Mr. Swinton's important Paper, read before the Röntgen Society, on "Adjustable X-ray Tubes," occupies the first seven pages, although an excellently-written editorial at the very beginning should not pass unnoticed. The articles are illustrated clearly and well, and the paper is good. Mr. Ernest Payne hopes to stir up others to follow his example by discussing "Contact Breakers"; and the medical aspect of the subject is represented by articles on "Radiography of the Hip-Joint," by Mr. Fortesque, a case of "Versical Calculus" by Dr. Joynt, and other interesting articles by Drs. Carl Beck, Hedley, and Mr. Thurstan Holland. Mr. W. Webster's Paper before the Röntgen Society on "Practical X-ray Work" is given *in extenso*. His enthusiasm over the work of Crookes and Jackson brings from him a dramatic and unfortunate analogy: "But I venture to say that the Union Jack can be placed entirely over the discovery"—which is more suggestive of a slow march and a decent burial than the idea his words were presumably intended to convey.

A page or two of notes and some very carefully-executed plates bring us to the close of the journal—quite the best amongst periodicals devoted solely to X-rays that so far we have seen.

Elektrische Licht und Kraft-Anlagen. Gesichtspunkte für deren Projectierung. By Dr. Ludwig Fischer. (Wiesbaden: C. W. Kreidel, 1898.)

More than half of this book is filled with full-page illustrations, and the remainder consists chiefly of "padding" of the worst description. For instance, the following sentence is made to form a paragraph by itself:—"If there is as yet no generating station at all, it is of the greatest importance to determine its position." And another example:—"When directly coupled to the driving motor, the number of revolutions of the dynamo is the same as that of the motor. . ."; and again, "The conductors constitute the connecting link between the current-generators and current-consumers." There is no denying such facts; but surely these "Gesichtspunkte" must already be known to all readers of a book of this sort. We are told in the preface, however, with profusion of spaced type (the German equivalent for italics), that the work does not aim at being an *exhaustive* exposition of everything to do with the projecting of electric light and power stations; neither is it intended to be a *guide* to the projecting or even to the carrying out of the installations. After this general disclaimer we are told what the book is really intended to be:—

> . . . But to lead broadly into the *spirit* of the subject, by means of a short synoptical compilation of the *most important considerations* (*Gesichtspunkte*) influencing the projecting engineer—*that is the object of this publication*, which appeals, therefore, less to the practically *experienced* electrical engineer than to *students* and *intending engineers*. . . . It also appeals to those who, though not technically trained, occasionally come in contact with projects for electrical installations, or are obliged to form general opinions on such projects; thus to *mechanical engineers, architects, owners of electrical installations*, or those who *wish to possess* an *installation*. In order not to unnecessarily increase the size of the work a knowledge of electrical machines and apparatus is assumed, as well as of their working and of the general principles of their construction. . . . Here the following question alone is dealt with: *From what general considerations (Gesichtspunkte) must one choose and combine the machines and apparatus to attain a fixed object?* . . .

This preface, which we think can hardly tend to recommend the book, may perhaps be considered sufficient to explain the number of omissions and the want of practical descriptive matter. There are, on the other hand, few inaccuracies; the most noticeable is possibly the use of the term "Arbeitswert," instead of "Leistung" or "Effekt," for power measured in watts. The illustrations are mostly from photographs of existing plant, some of which are good, others indifferent.

Die Benützng Einer und Derselben Elektrischen Leitung für Verschiedene Betriebe, unter besondere Berücksichtigung der bei Eisenbahnen einschlägigen Schwachstrom-Anordnungen. By Oberingenieur Kohlfürst. (Stuttgart: Ferdinand Enke, 1898.)

This little work forms one of a series of papers on various electrical subjects, published under the editorship of Prof. Ernst Voit. It is a collection of the different systems of simultaneous telegraphy, telephony and railway-signalling on the same wire. A great number of methods are described, and illustrated with diagrams, and, wherever the descriptions are not complete, references to other works are given. For those who can read German, the book will be a useful companion to Langdon's "The Application of Electricity to Railway Working."

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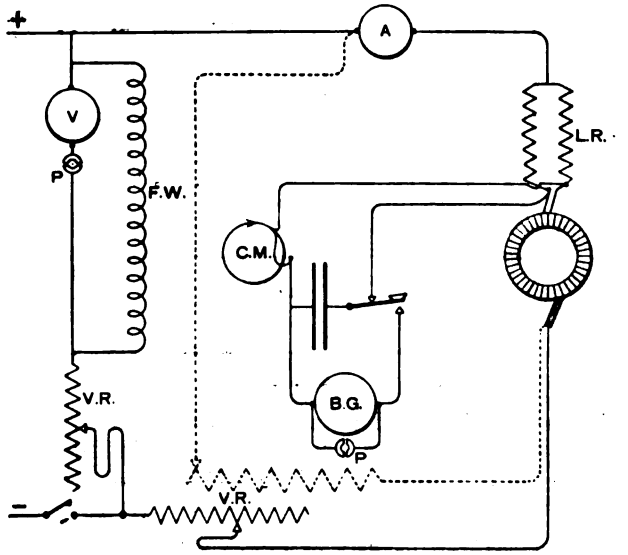
EXPERIMENTS ON COMMUTATION IN DYNAMOS AND MOTORS.

BY W. H. EVERETT, B.A., B.E., AND A. H. PEAKE.

The theory of commutation in dynamos and motors has been treated fairly fully by various writers; but there seems to be room for further verification and help from experiment. We therefore give here a short account of some work in this field, on which we have from time to time been engaged. The experiments have been carried out in the electrotechnical laboratory of University College, Nottingham, where Prof. W. Robinson has kindly afforded us every facility.

Our work so far has been confined to a Crompton two-pole, compound-wound dynamo, with ring armature, designed to give up to 45 amperes at 110 volts when running at 1,610 revolutions per minute. It has 60 sections in the armature winding, each of six turns of wire 0·09in. in diameter; the commutator segments being $\frac{7}{32}$in. thick on the face, and separated by $\frac{1}{32}$in. of mica. The resistance from brush to brush is 0·12 ohm, or 0·008 per section. The overall diameter of the armature is $7\frac{3}{4}$in., and the net cross-section for the magnetic flux is 12 square inches. Throughout these experiments separate excitation, generally at about 100 volts, has been employed, without the series winding.



V., Voltmeter; A., Ammeter; B.G., Ballistic Galvanometer; C.M., Contact Maker; F.W., Field Magnet Winding; V.R., Variable Resistance; P., Plug Key; L.R., Known Low Resistance.

FIG. 1.—Diagram of Connections.

Referring to any direct-current dynamo or motor: the current is reversed in each section while passing under either brush, and thus the curve connecting current and time, for a given coil, consists (practically) of a straight line above and parallel to the time axis, followed by a straight line at the same distance below. The current cannot change abruptly, and hence these two straight lines must be joined by a curve, giving the current in the coil at each instant while it is passing under the brush. It is to this curve that we have given most attention.

Passing over various pioneer experiments, it will be enough to describe the arrangement we are now using (Fig. 1). We employ a special split brush, consisting of two copper plates, 0·036in. thick and 1·6in. wide, separated by vulcanised fibre, the overall thickness being about equal to that of the face of a segment. These plates are joined by a non-inductive resistance of 0·007 ohm, to the middle of which the positive main is connected. The negative brush is an ordinary one, covering about one segment and a-quarter. From the ends of the resistance wires are brought to the terminals of a condenser, and in this circuit is included a revolving contact-maker, which completes the circuit at any desired instant in every revolution of the armature. The condenser is thus charged to the voltage existing between the ends of the resistance for any selected position of the armature coil under the brush; and this voltage is found by discharging the condenser through a ballistic d'Arsonval galvanometer. The contact-maker consists of a vulcanised fibre disc having two points in its periphery joined by a wire sunk in the fibre. This disc is fixed on the shaft and revolves under two contact springs, connected to the ends of the circuit containing the voltage leads and the condenser. The holder of the two springs can be clamped at any point on an arc concentric with the shaft, and accurate adjustment, when desired, can be effected by a tangent screw. The position of the coil under the brush, when the contact-maker closes its circuit, is found by inspection for any simultaneous positions of contact-maker and brush. The resistances of the various parts of the brush circuit were found to be as follows: inserted resistance, 0·007 ohm; brush contacts, 0·0022 ohm; armature section, 0·0082 ohm; total, 0·0174 ohm. These tests were made with a current of 15 to 20 amperes. The total with the ordinary brush was about 0·0088 ohm, or say half of the other.

It is necessary to consider the effects, on the commutation current-curve, of the modifications present in our split-brush. Any features due to contact resistance of the brush should be shown nearly unaltered in our curve; for such resistance is mainly operative only when a segment is just coming under the heel of the brush or just leaving the toe, and the middle part of an ordinary brush is therefore, in this respect, comparatively idle. The diminished thickness of the brush probably has the effect of slightly smoothing down the first and last parts of the curve, since it diminishes the range of commutation. As regards the insertion of resistance in the brush, one effect of this is to decrease the time-constant, thus making the slopes in our curves, on the whole, steeper; but, in any case, so far as this point is concerned, the curves hold good for a similar armature wound with wire of half the present gauge.

The general character of the curves admits of a simple explanation, and agrees with the predictions of Mr. Housmann in his suggestive remarks on Mr. W. B. Sayers' first paper (*Journal* of Inst. E.E., 1893, p. 400). In a motor, as a coil approaches the neutral axis, the E.M.F. is in such a direction as to oppose the current—that is, to aid its reversal; and when the coil has passed the neutral axis the E.M.F. tends to oppose reversal. Hence, to obtain reversal the brush should be moved to such a position as will bring the neutral point near the toe. It follows that the slope of the curve is greatest at first, and afterwards decreases. In a dynamo the field required for reversal (since the current is in the opposite direction to that in a motor) lies in front of the neutral axis, and consequently the neutral point should be near the heel. This will give curves of the character shown. It should be remembered that the neutral axis is not fixed, but tends to move with the brushes if the lead is altered, though not to the same extent. Whatever current there is in the coil just before leaving the brush must be altered to half the armature current by the increase of contact resistance between brush and segment. Any excessive inaccuracy of finish will give rise to sparking.

Since at the neutral point no E.M.F. is acting in the short-circuited coil, the current must there be diminishing, for an instant, at a rate—

$$\frac{di}{dt} = -\frac{R}{L}i,$$

where R is the resistance in the coil circuit and L is the inductance. Inserting approximate values for R and L, the neutral point can be found by inspection in each case. Generally it is near a horizontal part of the curve.

The curves shown in Figs. 2, 3 and 4 are each the average of four or five taken in succession, the average being taken as follows:—Each individual curve was drawn rigidly through the points found; eight equidistant points were then taken in each curve, and the averages of the respective ordinates taken and plotted to give the curve shown. The scale in each case is so chosen that half the armature current is represented by the same ordinate. The brushes were always adjusted to avoid sparking. Figs. 2 and 3 show commutation curves for the machine used as a motor. The three curves in Fig. 2 show the effect of

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varying the current only; the brush position, speed and excitation being kept constant. As the current is increased the curves become flatter, and the first drop is not so great. This is what would be expected. Curve E in Fig. 3, compared with curve B in Fig. 2, shows more gradual reversal of the current due to weaker field. Curve F in Fig. 3, compared with curve B in Fig. 2, shows the result of moving the brush forward by half a segment. The first drop in the curve is not so great, the rise begins earlier and a greater change in the current has to be produced by the increase of contact resistance as the segment leaves the brush. Although this change is about 10 amperes, only very slight blue sparks were noticeable at the toe of the brush, showing that the current must have been raised almost to the half armature current before the circuit was broken.

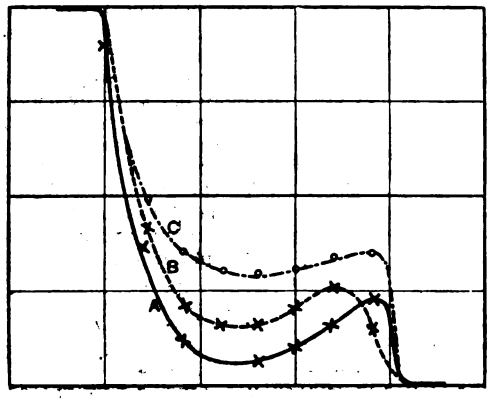

Fig. 2.

It was found that a large change in the speed had little effect on the curves.

In Fig. 4 are shown three representative commutation curves for the machine driven as a dynamo. Curve P shows the increase of current at first, which is obtainable at light loads, and also excessive reversal. Curve R shows the gradual falling off in the rate of reversal as the current approaches the value demanded by the E.M.F. It also shows a change of

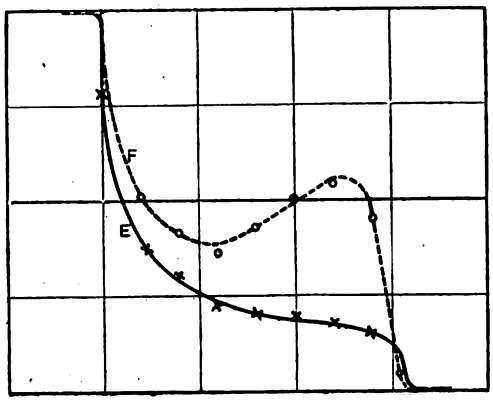

Fig. 3.

current produced by contact resistance. This change must have been complete, for no appreciable sparking was produced; in fact, the experimental brush stood the heavy current of 45 amperes quite as well as the other brush.

Collected Data for the Curves.

Curve.	Armature Current.	Voltage on field.	Revs. per min.
A	6·5	100	420
B	12·0	100	430
C	17·5	100	600
E	19 0	50	650
F	12·0	100	440
P	6·6	100	820
Q	11·0	100	470
R	45·0	100	820

With a field excitation of 43 volts, a speed of 760 revs. per minute, and an output of 20 amperes, a curve was obtained very similar to curve R. This excitation gives about 45 per cent. of the flux with 100 volts. The reciprocal of the speed, since there are 60 commutator segments, is the fraction of a second in which the commutation is effected, and this is represented by the abscissa of the curve.

We hope to examine the subject of commutation further, as time permits. Instead of our present brush, we think of using a triple brush having three resistances meeting at a point; this, though not so simple, would remove the restriction as to brush thickness. Again, it would be instructive to find commutation E.M.F. curves, say by means of thin coils over the armature winding, using instantaneous contact.* Experiments

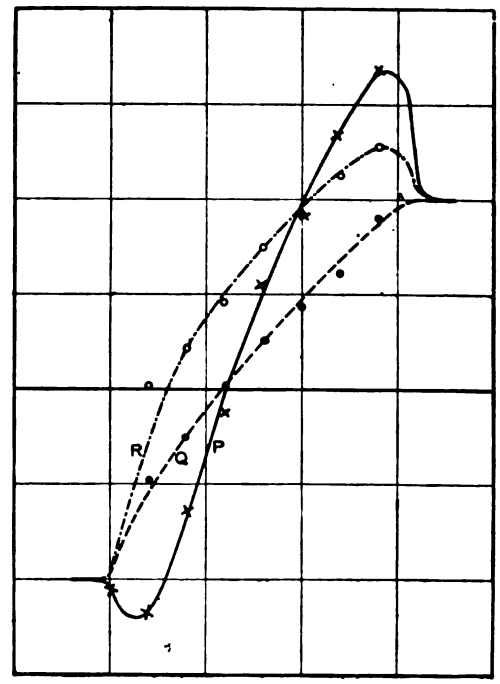

Fig. 4.

with the machine used as a rotary transformer (for which purpose six slip rings are already fitted) would likewise be of interest. And we hope also to study commutation in a machine with toothed armature core.

COMMERCIAL FORMS OF ELECTRICAL RESISTANCES.†

BY LL. B. ATKINSON.

MATERIAL OF WHICH THE ELECTRICAL RESISTANCE CIRCUIT IS COMPOSED.

The following table shows the resistance of one centimetre in length of various metals and alloys, carbon and liquids, the cross-sectional area of the specimen being one square centimetre and the temperature 0°C.

Table of Specific Resistances.

—	Resistance per cubic centimetre.	Percentage variation per deg. Centigrade.
Silver	1·504 microhms	0·377
Copper	1·598 „	0·388
Iron	9·716 „	0·453
"German silver"	20·93 „	0·03
Platinoid	51·0 „	...
"Manganin"	52·0 „	practically nil
"Eureka"	50·0 „	do.
"Rheostene"	100·0 „	do.
Carbon	1,200-40,000 „	−0·2
"Relugite"	3·2 to 3,200 ohms	−0·2
Solution of soda, 10 % solution	11·5 ohms	...
Do. zinc sulphate density, 1·405	28·3 „	...
H_2SO_4 density 1·10	1·37 „	−1·7

* Since this paper was in type we observe that two such E.M.F. curves have just been published by Mr. H. N. Allen (*Journal* of Inst. E.E., April, 1898).

† Abstract of a Paper read at the Northern Society of Electrical Engineers, April 18, 1898.

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This table is only to be used as a guide, since, except pure silver and copper, all the materials are of somewhat undefined composition, and the resistance of alloys and carbon varies greatly with their chemical and physical condition. It will be observed that several of the materials used are special alloys, for the most part of nickel and manganese, which, in addition to having a very high resistance, have a very small temperature coefficient, which is important, as resistances are often worked to a temperature of 200°C., causing a very considerable variation of resistance. An interesting example of this is in the use of iron wire when it is approaching a red heat, in which case it will be found that the resistance rises so rapidly that a very large increase of E.M.F. will only cause a very small increase in the current, because as the E.M.F. is raised, causing a small increase of current, this raises the temperature so that the resistance rises almost as fast as the E.M.F. The writer some years ago used this property for arc lamp resistances, when even if the lamp was cut out the permanent rise in current was quite small.

The metals, solids and liquids shown in the table are those which are most frequently used for making resistances. The usual form of the metals and alloys is in the shape of wire or strip, the former generally wound into coils. Carbon may be used either in rods, in which case the ends should be electro-coppered, and the connections clamped and soldered to the copper, or the carbon may be used in the form of flat plates piled on one another. The material "relugite," shown in the list, is a new material, now being put on the market by the Electric Insulation Syndicate, of Cardiff, and having an incombustible base, such as asbestos, in which is deposited conducting carbon, and the specific resistance of which can be made as required within the limits given. This material also may be used either in strips, the current passing from end to end, or in plates or layers, through which the current passes. Liquids are used generally where high resistances are required, and are on the whole an unsatisfactory form of resistance, as the solutions creep and cause loss of insulation on the circuits to which they are attached whilst the liquids also leak or evaporate.

Carrying Capacity of Resistance Materials.—It is important to determine what is the carrying capacity of the wires, strips or plates of which a resistance is composed; this being defined in relation to some particular allowable rise of temperature. The rise of temperature to be allowed is probably the point on which the greatest difference of opinion seems to exist among manufacturers. It is somewhat curious that the fire insurance offices, who define to a nicety the insulation of the circuit and other quantities, are exceedingly vague on what is probably one of the chief fire risks that are run, most of the offices satisfying themselves by merely stating that the resistance should be constructed of and mounted upon incombustible material, and that no combustible material should be within a foot of the resistance. Since most organic matters and fabrics char at a temperature of 200°C., the writer thinks that that limit, at all events, should never be passed, and probably the rule defining that the maximum temperature of the hottest part at the maximum working load should not exceed 150°C. would be a safe rule. The principal methods of dissipating heat from resistance are by radiation, air currents, and, in certain cases, by circulating liquids such as oil or water. The amount of heat radiated at the temperatures discussed is not large, and the use of liquids for cooling is not common, so that practically speaking cooling by air or currents is the usual method. It is obvious therefore that the designs should be such as to allow a free circulation of air through those parts where the heat is being produced.

Wire Resistances.—For this reason where wires are used, it is advantageous that the diameter of the wire should be small, so as to give a maximum surface for a given cross-sectional area, and to carry the requisite current a sufficient number of wires should be placed in parallel. Again, where wires are wound into coils, these coils should be open, and there should be a space between successive turns of the coils of two or three diameters to allow an effectual passage of air. In the case of long coils placed vertically, the upper parts of the coil become far the hottest, as the air heated by the lower coils is the only cooling medium. It is almost impossible to give any general rule as to the carrying capacity of wires in coils.

One of the most effective forms in which wire can be used is in the form of wire gauze, and the best class of gauze is that in which the longitudinal wires carry the current, the wires all being in parallel connection, whilst the cross threads carry away the heat, and in this case the load to be carried by a given wire is double that given in the table. A great difficulty occurring with wire resistances, particularly where alloys, such as german-silver, are used, is that the wires become brittle or rotten, and break, causing short circuits and danger of fire. In the case of resistances enclosed in boxes, so that only the outside surface will dissipate the heat, the carrying capacity of the wires is much less; and the ultimate carrying capacity of the resistance will depend on the surface of the casing exposed to the air, and for a temperature of 150°C. the total external surface should be about 10in. per watt to be dissipated. The surface for this purpose may be increased, if of metal, by casting ribs or fins upon the casing, so as to increase the surface.

Some resistances are only required for a short time at intervals, such, for instance, as resistances for starting motors; and here the element most to be considered is not the surface on which depends the power of steadily dissipating heat, but the total specific heat of the parts on which depends the rise of temperature, with the given load in the time for which it is to be used; and in this case materials having a high specific resistance with large bulk may be used to advantage, or if fine wires are used they may be imbedded in materials such as enamel or sand or asbestos, which will absorb, by conduction, the heat from the wire itself.

Carbon Resistances.—A common form of carbon resistance consists in the use of ordinary lighting pencils, with the ends coppered and connected up by clamps. These resistances for testing purposes can be run at a very high temperature, but they dissipate heat badly; they are very liable to come broken, and are not often used for resistances, which may have to be transported. Carbon resistances made up of plates placed in a frame are often used, and they have the advantage that the resistance may be varied by screwing them up more or less tight by a clamping screw. In this case a very large part of the resistance is due to the resistance at the surface of contact between the layers, and due also to the fact that the current travels in the plane of each layer from the points of contact at the surface, of one set of plates to those of the next set; these, in most instances, not coming opposite to one another on the plates. In other words, except when the plates are screwed up quite tight, the current is travelling by a zig-zag course through the pile of plates, and it is principally this which enables the resistance to be varied. The material previously mentioned, viz., "relugite," is used in the same way, and with the same results, but it has a great advantage over the carbon resistances in that the material being flexible and elastic, a much wider range of the screw is obtained, so that the resistance can be varied more gradually, whilst the tendency with solid carbon resistances for the plates to actually break contact and so set up an arc, is got over. The chief difficulty with carbon resistances is that they present a very small cooling surface. This difficulty has been obviated in the case of "relugite" resistances by interposing metal plates between the plates of material, which metal plates are larger than the plates of the material, and thus serve to conduct the heat from between the plates, and to present a large surface for the air to pass through to cool them.

Liquid Resistances.—The commonest form of liquid resistance is a wooden tub filled with water in which is sulphuric acid, common salt, washing soda, or other metallic salt, to render it more or less conductive, and in which are immersed plates leading in the current. Such resistances cannot, of course, rise above the temperature of boiling water, and they absorb a large amount of heat due to the large latent heat of steam. Such an arrangement is, of course, a very rough one, and only used for temporary purposes. For permanent installations iron or earthenware jars or pots are used, containing solutions, and having electros of various forms which can be moved in relation to one another.

MATERIALS FOR SUPPORTING RESISTING WIRES OR MATERIALS.

In the early days of the use of electric power, resistance wires or coils were usually strung in wooden frames, and the writer believes he was the first to introduce into the market standard patterns of resistances, in which the supports were wholly composed of incombustible material, that is to say—iron frames carrying slate or porcelain insulating parts to which were attached the resisting wires. A class of support previously mentioned is the use of enamel on a base of iron. In this case the iron is first enamelled, to give it an insulating coating; the wires, which are very fine, are then placed on the enamel, and covered with thick coating of enamel, which is then fused, so that the wires are formally imbedded in it. The resistances known as the Carpenter resistances, and the resistances in most heating and cooking apparatus, are arranged in this manner. In this case the enamel carries the heat from the wire to the iron supports, which then distributes it, and forms the cooling surface. In the case of the "relugite" resistance material, this is carried in iron frames, generally on pillars or bolts passing through it, the insulation being enamel, and in certain cases mica or asbestos sheets are used where flat surfaces are to be insulated.

The author then described briefly a number of forms of adjustable resistances, most of them well-known. Among the various forms of liquid resistances, he mentioned that shown in Fig. 1. The current enters at the bottom of one tube and leaves at the bottom of the next tube, a wire fork or bridge being raised or lowered in the tubes. A curious phenomenon occurs with such an arrangement, the complete explanation of which the writer is unable to give, viz.: That using lead plates at the bottom of the tubes and a copper or iron bridging piece, the resistance and heating effect is not equally divided between the tubes but is largely concentrated in one of them.

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ADAPTATION OF RESISTANCES FOR SPECIAL PURPOSES.

Resistances for Regulating Dynamo and Motor Shunts.—Almost any of the forms which have been described are suitable for this purpose. As to capacity, the maximum amount of power to be dissipated is reached when the resistance is equal to the resistance of the shunt, and when the current comes down to half its original value. Resistances working by compression, and therefore giving a perfectly steady graduation between maximum and minimum, have the advantage of allowing the E.M.F. to be regulated very exactly, an advantage where dynamos are being run in parallel.

Arc Lamp Resistances.—These form an important class, as very large numbers of them are used. The usual form consists of a porcelain cylinder, having a spiral upon it, in which is wound a german-silver wire. The resistance is regulated by a movable clamp placing more or less of the wires in circuit. Some years ago the writer designed three forms of arc lamp resistances, in each of which the base was an iron cylinder covered with asbestos, on which the resistance was wound. All these forms of resistance have the disadvantage that, as the wire is heated and cooled it is subject to very considerable strains, and the wires are frequently fractured. This difficulty is diminished in the forms designed by the writer as the asbestos gives a little, and so releases the strain on the wire. A form of arc lamp resistance used a good deal on the Continent consists of two earthenware discs, having a groove on the periphery, round which a wire coil is stretched (*see* Fig. 2). The adjustment is made by a movable contact sliding over one of the coils. Fig. 3 shows the form of arc-lamp resistance in which "relugite" is utilised as the resisting material, and the resistance is adjusted, as required, by tightening or slackening the end on the top. An important advantage possessed by this latter form of resistance is that as the coefficient of temperature variation is negative, the resistance is higher when first the current is switched on than it is when the arc has been burning a short time and the resistance becomes warm, thus assisting in keeping the current to its normal value, whilst the arc becomes of a proper length.

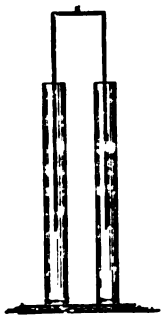


FIG. 1.

FIG. 2.

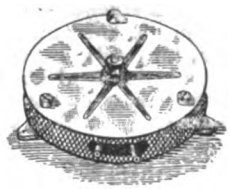


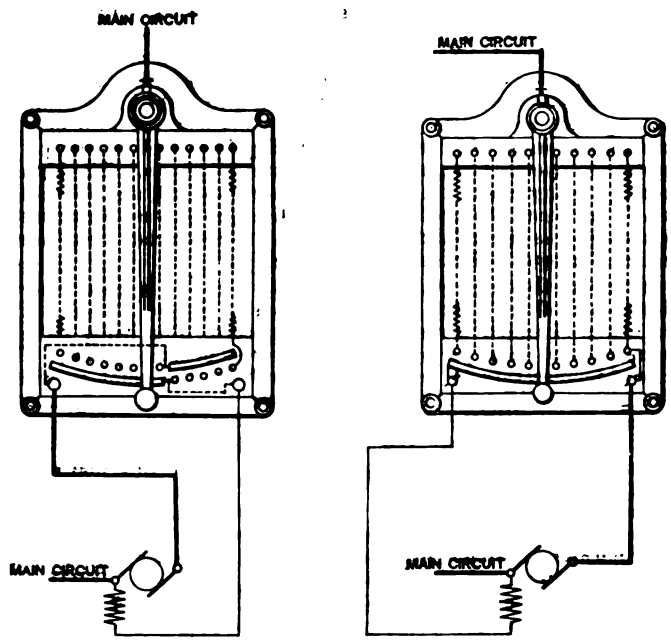
FIG. 3.

Resistances for Lowering Lamps.—These are mostly used for stage effects, and if made with switches should have a large number of contacts to make the graduation imperceptible, or liquid resistances and resistances worked by pressure variation should be used. Owing to the peculiar nature of the fire risks in the theatre, special care should be taken that the rise of temperature should be small. In the case of resistances designed by the writer for the Drury Lane Theatre, the specification was that the resistances should not rise more than 80°F. above that of the atmosphere.

Motor Starting Resistances.—It has frequently been a subject of complaint that the resistances for starting both continuous current and multiphase motors, particularly for small powers, cost almost as much as the motor itself. This has been largely due to want of standard designs specially suited for the purpose. In general the resistance is not required for more than say one minute, but should be capable of carrying the full load of the motor for that time. Some forms recently introduced will only carry the load for 20 seconds; this is not safe.

The author described several types, one of which embodied also a main switch and cut-out—a point of importance, as some of the fire insurance companies make a rule that there must be a switch independent of the regulating switch. In this the switch arm is controlled by a spring, so that the only points at which it will remain are the position when the circuit is broken, and the position when the resistance is short circuited, when the arm is held by a catch. The moment it is released from this catch it travels back over the contacts and breaks the circuit, thus preventing a careless attendant leaving the switch in an intermediate position, when the resistance would be overheated and damaged. Another switch had a similar arrangement, except that two automatic safeguards were provided; the first of these was that in place of the catch holding the switch arm at the "on" position, an electromagnet is substituted, this magnet being excited by a shunt coil; the result being that if the current is taken off the motor, either by the main switch or by the failure of the supply, the switch arm being released inserts the resistance and then opens the circuit. A second electromagnet is adjusted so that if the current exceeds a determined value the armature is raised, and breaks the circuit of the holding-on magnet; so that the switch-arm flies back and breaks the circuit. Another automatic cut-out is designed to prevent motors being left on the circuit when the resistances are cut out if the current supply fails, and in this case there is a series winding on a magnet coil, and so long as the current passes through this coil the switch is held closed. When the current fails the catch is released, and a weight falls and opens the switch. In another form the resistance is gradually removed by the motion of the motor after starting.

For the purpose of regulating the speed of motors the resistances must be made larger, and must be capable of carrying a load depending on the range of regulation, but if this is a wide one practically the full-load of the motor must be provided for. The simplest way of regulating the speed of a shunt motor is shown in the right-hand diagram of Fig. 4, where a resistance is placed in circuit with the armature of the motor, the full line pressure always being on the shunt coil. The left-hand diagram of Fig. 4 shows a modified arrangement, in which part of the speed regulation is effected by varying the strength of the current in the magnet coils. In this case the method of working is to have in the first instance the full line pressure on the magnet coils and resistance in the armature circuit. The resistance is gradually taken out of the armature circuit, and resistance is then inserted in the magnet circuit, thus weakening the field and allowing the speed to rise. If this form of regulation is to be adopted the magnet windings should be specially arranged for the apparatus to have a low resistance, so that the motor is considerably over-excited at starting. Water resistances are also well adapted for motor starting, and pressure resistances filled with either carbon or "relugite" are also used for this purpose. In order to avoid the possibility of a motor being switched into circuit rapidly, it is preferable to fit such resistances with a screw motion, but, if this is done, arrangements must be made by a separate switch or otherwise, so that the circuit can be broken instantaneously in the case of accident or emergency.



Starting Resistance with Shunt Regulation.

Starting Resistance without Shunt Regulation.

FIG. 4.

An important point in connection with regulating resistances, particularly where the variation in resistance from point to point is considerable, is the question of the switch contacts, as considerable sparking occurs on the contact, which from this cause becomes dirty or roughened, and causes considerable trouble. In a form of switch pillar for starting and regulating the speed of motors, designed by Messrs. Royce, independent quick break contacts are fitted at each resistance point, and the final break is effected by a carbon contact. In a form designed by Pochin, the switch arm itself carries a small wiper which takes the spark, and it may be renewed as required. In the case of pressure resistances these precautions are unnecessary, and even in the case of resistances with multiple contacts and filled with "relugite" material, owing to the fact

that such resistances are inductionless, the spark on the contacts is practically eliminated.

CONCLUSION.

From a manufacturer's point of view, it is greatly to be desired that engineers designing plants will endeavour to avail themselves of manufacturers' existing patterns and standards rather than to specify for particular arrangements, as it is only in this way that the cost of accessories of the electric light and power plants can be brought to a point which will have the effect of greatly stimulating the use of electrical appliances in many cases where at present the admitted advantages do not outweigh the expenditure necessary.

WATER-POWER UTILISATION AT DARJEELING.

The *Indian and Eastern Engineer* gives a description of a water-power installation at Darjeeling, owned by the Municipality. The generating station is 3,500ft. below the level of Darjeeling and some three miles distant from it. From the reservoir, which is 100ft. long by 40ft. broad and 10ft. deep, the water is carried in a 24in. cast-iron pipe a distance of 400ft. to the pentrough, which is a small tank on the same level and of the same depth as the reservoir. From the pentrough two steel pipes 15in. in diameter with flanged joints are carried down side by side to the turbine house some 300ft. below the pentrough level; these pipes are each about 750ft. long. Each of these pipes supply water to a Girard turbine coupled direct to a Crompton-Brunton alternating-current dynamo, the horse-power developed by each turbine is 100, and the output of each alternator is 65 kilowatts, sufficient for lighting 2,000 lamps. The turbines are fitted with a particularly sensitive form of hydraulic governor for regulating the speed, and the alternators have the usual field resistances for electrical regulating purposes. Each alternator carries its own continuous-current exciting dynamo on a prolongation of the armature spindle. The whole combination, working on one spindle with no side strains whatever, forms a very compact and workmanlike piece of machinery.

The effective head of water is 276ft., and 150 cubic ft. of water per minute passes through the turbine when working at full load. A noticeable feature in these turbines is that they are equally efficient at quarter load; this is an important matter in connection with an electric supply station where the load factor is low and the hours of running are long.

The alternators generate electricity at a pressure of 2,300 volts, and the energy is conducted to Darjeeling through two bare copper mains made of No. 7 standard wire gauge hard-drawn high-conductivity copper, carried on oil insulators fixed to posts of the Indian Telegraph Department pattern, and suspended some 20ft. from the ground. Where these mains cross public roads they are made of strandard copper cable insulated heavily with vulcanised india-rubber, and suspended from a steel wire by means of porcelain clips; the steel suspending wire is also insulated. The electrical energy is carried at the above pressure to three transforming stations in Darjeeling where it is reduced to 240 volts, at which pressure it is distributed throughout the streets of Darjeeling for lighting purposes. By means of the three-wire system this pressure is in turn reduced to 110 volts for the house supply. The third wire is earthed and is carried along the top of the poles, forming a most efficient lightning conductor for the whole system.

The street lighting of Darjeeling consists of 200 incandescent lamps of 16-c.p., and two arc lamps of 3,000-c.p. The incandescent lamps are carried in neat waterproof fittings with saucer-shaped reflectors at the back of them. They are spaced generally about 50yds. apart, and both in lighting-power and in appearance are a marked contrast to the old oil lamps carried in square lanterns of the usual Indian type. The street lighting wires, consisting in most cases of two No. 12 copper wires, are hardly noticeable, and are not nearly so unsightly as the usual line of telegraph wires.

Electric Traction on a French Railway.—The Northern Railway Company of France is having three patterns of motor-cars constructed for use on its lines. The first has one single compartment, seating 12 passengers. It is on the accumulator system, and is intended for the conveyance of postal despatches at hours when the passenger traffic in inconsiderable. A second type is of the same size, but is worked by steam on the Serpollet system. The third type is an accumulator capable of carrying eight first-class, 12 second-class, and 30 third-class passengers. It will be used chiefly on small branch lines, on which there is only a temporary traffic during certain seasons. Some of the Serpollet steam cars are already running, but the electric cars are a new experiment on the part of the Northern Railway Company.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April 8, 1898.*

American Bell Telephone Company.—The report of this Company for the year ending December 31, 1897, contains some interesting facts regarding the telephone business of this country. Touching the subject of underground lines, the report says that it has been found that with the best class of cables built for the purpose, transmission can be accomplished by this means over distances of only a few miles. So far as the development of the art has gone, therefore, it is still impracticable to employ underground lines for what is known as toll or long-distance service. The underground system is now in use in 130 of the exchanges, and 282,684 miles of exchange wire, nearly 50 per cent. of the total mileage in the United States, is now carried in underground conduits. The output of telephones and the increase in the number of exchange subscribers are unprecedented in the history of the business. This growth is attributed to the increase in population and business throughout the country, the greater efficiency of the service, and the growing recognition of the telephone as a valuable agent for the transaction of business and a convenience of home life. Improvements in the method of equipment have removed the difficulties which formerly attended the operation of party lines. The system of measured service continues to grow in popular approval. The subscriber pays for the specific number of outgoing exchange connections for which he contracts, or as many more as his needs require, and is at no expense for inward calls. For those who have only occasional use for the telephone, over 18,000 public pay stations are distributed over the country. The unlimited service subscribers continue to increase in number year by year. During the year the long-distance company's lines have been extended to reach Omaha to the West, Minneapolis to the North, and Southerly to Petersburg and Norfolk, Va. On January 1st this year there were in operation 8,778 miles of long-distance pole-line and cable, and 116,116 miles of wire, connecting 238 offices, a gain during the year of 1,433 miles of pole-line and cable, 8,706 miles of wire, and 55 offices. The number of exchange lines operated under the licences of this Company is 884,230; this equals, within a few thousand, the aggregate number of exchange lines in all Continental Europe. [Next to this country comes the German Empire, which had 122,362 lines in 1896, and next Great Britain, with at present 89,222.] In the United States conversation is now had by subscribers over distances of 1,800 miles, which is twice the length of wire anywhere else employed for telephonic use. During the year 1897 $8,712,915 was expended in new construction by companies with which the Bell Company has contract relations. Of this sum $4,865,817 was expended upon exchange construction and equipment, and $3,847,596 on toll lines. The entire expenditure for construction, including real estate, to the close of 1897, has been $97,946,102. The financial statement shows an increase in gross earnings in 1897 over 1896 of 16·1 per cent.

Preparations for War.—Active preparations for the possible war with Spain continue to be made by the United States Government, and the natural result of this is an increase in activity in the lines of business called upon to supply the materials to carry on war. In my letter of recent date the deficiency in the military service as regards methods of signalling between stations and military posts was pointed out. The necessity for a means of quick communication between such points has at last been brought home to the Government, and active preparations are now being made, and, indeed, plans have been carried out to establish governmental telegraph and telephone lines between distant points, so that these points can be communicated with instantly from headquarters without utilising the lines of private companies. Considerable work has been done, too, in preparing submarine mines and torpedoes for the principal harbours on the Atlantic coast. For this purpose there has naturally arisen a demand for submarine cable, and it was reported a few days ago that the General Electric Company's stock of cables had been entirely

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taken up by the Government, and that its output for the next two months had also been contracted for. Other cable manufacturing companies have enjoyed an increase of business for the same reason, and it is stated that pretty much the entire stock of cable has been bought up by the Federated Authorities. Submarine and aërial telegraph lines have also been laid, connecting the different military posts and forts in New York Harbour and vicinity.

Volunteer Engineer Corps.—It is authoritatively announced that Capt. Griffin, of the General Electric Company, who was formerly an officer in the United States army, has proposed to the war authorities to organise a volunteer corps of electrical engineers. The scheme has received the hearty support of the Secretary of War, and is well advanced. More than 1,000 men are enrolled and ready for service. Capt. Griffin has asked for recruits from the whole of the electrical industry and the response has been ready and enthusiastic.

Electric Cars on the Brooklyn Bridge.—Since the inauguration of the electric car service on the Brooklyn Bridge, the regular bridge cable railway has suffered a severe loss of business. As a consequence of this, the operating force has been greatly reduced, and altogether 70 persons have been dismissed from the service. The number of trains has also been reduced and the headway increased. The elevated railways in Brooklyn are now at work effecting connection between their lines and the bridge railway line, and by June 1st next it is expected that the elevated trains from Brooklyn will deliver their passengers at the New York end, thus avoiding the annoying change of cars at Brooklyn.

CORRESPONDENCE

COMMUTATION OF CONTINUOUS-CURRENT DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Sayers's letter in your issue of the 8th inst, I would say that although I cannot claim a monopoly of knowledge of "practical" armatures, I have found by a considerable experience of armatures—mostly of the slotted type—that my views are consistent with fact. It is usual, however, in sketching out a theory, to begin with simple cases which are sufficient to indicate the line of reasoning by which the more complex cases may be dealt with.

Now the whole of my argument is based on the supposition that the completion of the process of commutation restores the armature field to its original condition, so that the net effect is that one coil or pair of coils has advanced one section, cut a certain field and reversed its current. The field cut may vary during the process, but the average E.M.F. in the coil is unaffected thereby so long as the original condition is restored at the end. The finite number of sections in a "practical" armature has thus no effect on the reversing E.M.F. required, although for other reasons a large number of sections is favourable to the suppression of sparking.

In the case suggested by Mr. Sayers, if the number of sections is 50, the armature field would vary 4 per cent. and back again during commutation. Is he quite serious in suggesting this as an important point?

With regard to his inductor alternator I am equally at a loss to understand the importance he attaches to it; for assuming the period of commutation to correspond to a complete cycle of the alternator (and if it does not, what does?), how can this either increase or diminish the average reversing E.M.F. required? You might as well expect an alternator to charge a battery! There is, however, no evidence of any ripples in the curve of E.M.F. due to one section, and theory does not lead us to expect any, except just at the edge of the pole-piece, since the coils rotate with the iron projections.

Will Mr. Sayers kindly explain his views on this subject?—Yours, &c., R. H. HOUSMAN.

Birmingham, April 15, 1898.

TELEGRAPHY ACROSS SPACE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If Mr. J. W. Wilkins, who writes on p. 832, would only have taken the trouble to read for himself the Paper which I read at the Society of Arts (*vide Journal* of Society of Arts, April 1, 1898, p. 453), instead of directing his attention and yours to something which I am "stated to have said," he might not only have spared himself the trouble of writing but would have found some accurate information. So far from jumping to the conclusion that transatlantic space-telegraphy was rendered certain once and for all by Hertz waves, I expressly said that I was *less certain* that it could be accomplished by waves than by other methods. Let me quote but one sentence of my Paper: "I doubt very greatly whether the wave-method can be made applicable at all to these so-distant parts of the globe." After that it is very unkind, nay very unnecessary, nay even foolish, of Mr. Wilkins to lecture me about the rotundity of the earth, and the "tangential ray," and the "prescience of the difficulty to be encountered," and the "advocates of this sort of thing who nowadays only jump to conclusions." Please, Mr. Editor, it was not I that jumped.—Yours, &c., SILVANUS P. THOMPSON.

April 19, 1898.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From reading your report of my lecture in your issue of the 8th inst. it might be inferred that the experiments at Bournemouth and the Isle of Wight had been carried out by the Post Office. Such was not the case—all work in that vicinity was done under the superintendence of Mr. Marconi.

This is a minor correction, but I should be glad if you would record it.—Yours, &c., J. N. C. KENNEDY, Capt. R. E.

Junior United Service Club, London, S.W.,
April 13, 1898.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the correspondence which has been appearing in your columns and to the discussion on Capt. Kennedy's recent Paper at the Royal United Service Institution anent the new method of selection of Hertzian or wireless telegraph signals by means of rated or harmonic reeds or pendulums, may I be allowed to point out that this combination was definitely and completely described and claimed by Mr. G. R. Neilson and myself in our Patent No. 28,955 of 1896.

A considerable series of experiments was made on the method at the time, with the result, among other things, of transmitting a musical note. It was found that the lower rates, however, as was to be expected, were much more efficient for selective purposes—which selection is easily and certainly accomplished by means of a combination with our harmonic pendulum system already worked out in detail for other purposes.—Yours, &c., A. C. BROWN.

Winchester House, Old Broad-street,
London, E.C., April 21, 1898.

LITTLE'S CONTINUOUS INDICATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the article you have printed in your issue of the 8th inst., describing the continuous indicator manufactured by me, I see it is stated that a knowledge of the number of revolutions per minute made by the engine is a requisite factor in the caculation of I.H.P. Will you allow me to point out that as the record on the dial of the instrument at the end of one minute is actually equal to one-tenth of the aggregate areas which a diagram indicator of the same dimensions, &c., would make at each revolution during the same time, no observation of, or division by the number of revolutions of engine made in that time is needed, as is stated in your notice. The formula is therefore simply H.P. = CR, where C = the engine constants, &c., and R = the record on the dial at the end of one minute. For a longer time it is therefore H.P. $= \frac{CR_T}{T}$, T being the time in minutes, and R_T the

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record in that time. For the calculation, however, of M.E.P., where the average record (*i.e.*, area) per revolution of engine must be known, the simple formula would be $M.E.P. = \frac{CR_T}{T \times revs.}$

With regard to what is said in your editorial as to a dynamometer answering the same purpose, I may point out that, whereas the continuous integrator makes a cumulative record of the work done in the cylinder, the dynamometer does not, and the two instruments are therefore hardly comparable in this respect.—Yours, &c.,

W. G. LITTLE.

Bexley, April 15, 1898.

LEGAL INTELLIGENCE.

Vestry of St. Mary, Battersea, v. the County of London and Brush Provincial Electric Lighting Company (Limited).

Yesterday (Thursday), in the High Court, Sir Francis H. Jeune (sitting as a Judge in Chancery) resumed the hearing of the action brought to test whether the defendant Company, who hold a Provisional Order to supply electric current within the district of Wandsworth, were entitled to lay their pipes in Trinity-road, Battersea, part of which was admittedly in the parish of St. Mary, Battersea, within the area of supply of the Battersea Electric Lighting Order. The case was opened before his lordship on March 9th, when Mr. Reginald Bray, Q.C., and Mr. Chapman appeared for the Vestry; and Mr. Cripps, Q.C., for the defendant Company. Counsel for the Company argued that under their Order they had all rights along Trinity-road, Battersea, north and south, except the small portion in dispute, to avoid which, he was instructed, would cause a deviation of 1,440 yards, at a cost of some £5,000. His lordship, when the matter was previously before him, said it raised an interesting point of law, but he thought the Company might very well recognise the rights of the Vestry, and take a licence from them, or something of that kind. It would never do for parties at their own will and pleasure, and for the purpose of making money, to lay pipes and wires, and set a local authority at defiance. Mr. Cripps said his clients were ready to recognise the rights of the Vestry, and meet them accordingly in any reasonable way, but Mr. Bray said that any matter of arrangement would have to be submitted to the Vestry, and had consented to an adjournment. The matter was then on March 10 adjourned by consent for a month.

On Thursday Mr. CRIPPS notified that it was not possible to come to an arrangement. It was a case in which he thought that the parties might very well have come to an understanding or arrangement, and the defendants were anxious to carry out the suggestion of his lordship, but the Vestry would not consent to this.

Mr. BRAY said the Vestry had their views, and they wanted a decision on the matter.

His LORDSHIP said that he was entirely in Counsel's hands, but he was still of opinion that it was a case in which an amicable arrangement could well be made.

Mr. CRIPPS then continued his argument on behalf of the defendants, and submitted that anyhow it was not a case for a mandatory injunction but for damages. Whatever the defendants had done it could not be considered more than a technical trespass. The defendants' case was that they would never require to disturb the *locus in quo* again.

His LORDSHIP said he could not get away from the fact that this was a continuing trespass. The only question was whether there should be damages or a mandatory injunction.

Mr. BRAY having replied, his LORDSHIP said he should have been glad if the case could have been settled between the parties. As a matter of fact, public bodies as well as private individuals were entitled to have their rights adjudicated upon, and then afterwards, if they thought proper, could make such arrangements as they thought fit. He should proceed to deal with the case purely as a matter of law. The only thing he had to consider was what was the remedy to which the plaintiffs were entitled. That the defendants were wrong in what they did was to his mind beyond question. The Act of Parliament approving the Order under which the defendants worked clearly defined their rights and powers, and it was equally clear to his mind that the plaintiff Vestry had vested in them—whatever those words might mean—the area in which the wires had been laid by the defendants. The defendants were clearly wrong in what they did, and he was bound to say he thought their conduct was about as wrong as the principle under which they had acted because it appeared that some time before the particular act complained of in the case was done, they had acted in a precisely similar manner and had apologised. They afterwards applied for leave to place their wires in the area, but that leave being refused and finding they could not get it they took the law into their own hands, and at ten o'clock on a Sunday night proceeded to invade the district and put down the wires, and after that act was challenged by the plaintiffs they said they were prepared to defend what they had done. He thought the case was governed by the case of Goodson v. Richardson, which was a decided authority in the plaintiffs' favour, the only distinction being that in that case the plaintiff in whom the soil was vested was a private owner. In one of the decided cases which had been cited, however, it was laid down that in such cases there was no real distinction between public and private owners. The defendants could, if they had wished, have made arrangements with private owners for the laying of their wires. He came to the conclusion that the defendant Company ought to be called upon to remove the wires in question, and that there ought to be judgment for the plaintiffs for a mandatory injunction, and a declaration as prayed, with costs.

Upon the application of Mr. CRIPPS the operation of the injunction was suspended for three months, in view to an appeal.

Parsons Steam Turbine Patent.

On Monday the Judicial Committee of the Privy Council (consisting of Lords Watson, Macnaghten and Davey, and Sir Richard Council) heard the petition for the extension of the term of letters patent (No. 6,735, dated April 23, 1884), granted to the Hon. C. A. Parsons for "Improvements in rotary motors actuated by elastic fluid pressure and applicable also as pumps."

Mr. Moulton, Q.C., and Mr. A. J. Walter were counsel for petitioner; the Attorney-General and Mr. Sutton for the Crown.

The invention related to machines known as steam turbines, and prior to the date of the petitioner's letters patent no steam turbine was, so far as petitioner was aware, in practical use within the kingdom. Various attempts had been made to employ the velocity of steam generated in a boiler for the purpose of causing constant revolution in one direction of moving parts without the use of the reciprocating apparatus in engines actuated by steam, but so far as petitioner knew, no practical machine had, at the date of the patent, been invented which would enable steam to be used in this way. When petitioner first devoted attention to the subject of steam turbines no one had worked out the conditions essential to the manufacture of a practical turbine which would be capable of working with an efficiency in any way comparable to the efficiency of steam in engines of the reciprocating type. The petitioner, after many experiments and exhaustive research, produced a practical steam turbine. The high speed at which, in order to obtain the best results, it was necessary to run the moving parts of petitioner's engine rendered it essential that bearings of a novel description should be invented, the bearings being provided with a certain amount of elasticity so that the moving parts would rotate around their centre of gravity or principal axis, instead of around their geometrical centre or axis, so as to prevent vibration and shaking. The petitioner had also been able to eliminate one of the great difficulties attaching to steam turbines known as the thrust. In introducing the invention great opposition was encountered from engineers, engine builders, and others; it was then generally believed in the engineering world that no steam turbine could be constructed whose efficiency would approach the efficiency of the ordinary reciprocating engine. Many steam turbines were, however, now in use for driving electric lighting and other machinery, and the public appeared to have recognised the merits of the invention. Evidence was given as to the merit of the invention. It was shown that one of the machines had been fitted to a vessel 100ft. long, which attained a speed of 34½ knots—a speed which it was believed would be increased if the machines were fitted to larger vessels. Lord Kelvin, who was called in support of the petition, said there was no practical steam turbine before the petitioner's, which gave for the first time a practical steam turbine. There was a great future for steam turbines. The petitioner's invention had given very good results, and for many purposes it was going to supersede the reciprocating engine, and its application to ships was a very great step indeed.

Lord WATSON announced that their Lordships would humbly recommend her Majesty to grant an extension of the patent for five years, and they would state their reasons for coming to that conclusion on a later day.

Flack v. National Telephone Company.

At the City of London Court last week, before Mr. G. Pitt-Lewis, Q.C., and a jury, Alfred Flack sought, under the Employers' Liability Act, to recover £150 as damages for injuries caused to his right eye through the alleged negligence of the National Telephone Company's servants. The plaintiff said that on August 18th he was sent by the defendants, in whose employment he had been for nine years, to cut down certain wires and put up new ones. He had (he alleged) complained to the foreman of the dangerous character of the work, but the assistance which he asked for was not given to him. His eye was very much hurt, and he had to remain in the hospital for three weeks. He now found that the other eye was in sympathy with the eye which had been affected. The accident happened owing to a piece of wire flying up into his eye immediately after being cut. The defendants asserted that the plaintiff made a mistake in cutting off the wire too far from the insulator. If he had cut it off close up to the pole as instructed no injury would have befallen him. No order was given him as to how many wires he was to cut at once, and it was entirely his own fault that he had been injured. The jury adopted this view, and found for defendants, who did not ask for costs.

BOOKS RECEIVED.

"*Journal* of the Institution of Electrical Engineers." No. 133, Vol. XXVII. Edited by W. G. McMillan. (London: E. and F. N. Spon.) Price 3s.

"The Official Gazette of the United States Patent Office." No. 1, Vol. LXXXIII. Published by authority of Congress. (Washington: Government Printing Office.)

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TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Bibliography of X-Ray Literature and Research, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free; abroad, 6s. 6d. Digest post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty Elementary (or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. Vol. II., in preparation.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"Electric Motive Power," by Mr. Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied price 12s. 6d.; post free, 13s.; abroad, 13s. 6d.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Armature Windings of Electric Machines."—By H. F. Parshal. and H. M. Hobart. This work has been compiled from Notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad, 13s. 6d. Prospectus post free.

"Signalling across Space without Wires by Electric Waves." Being a Description of the Work of Hertz and his Successors.—By Dr. O J. Lodge, with many original illustrations. Enlarged edition, 2s. 6d. net 2s. 9d. post free.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade. *In the Press.*

"The Electric Arc."—By Mrs. Ayrton. *In the Press.*

"Electrical Testing for Telegraph Engineers."—By J. Elton Young. *Ready in May.*

"The Electrician" Electrical Trades' Directory and Handbook.—This Directory and Handbook for 1898 is *now ready.* Many new features of interest to the profession are included in the new edition, and all the usual important tables, articles, &c., which have made the book indispensable to the industry, are brought up to date and amplified where necessary.

Tenders Invited.—The Corporation of Sunderland require tenders for the supply of a high-speed 225-kilowatt steam dynamo and Lancashire or Galloway boilers. Further particulars are given in our advertisement columns, and specifications can be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street. Tenders (addressed to the Chairman of the Lighting Committee) must be sent to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon on Friday, the 29th inst.

——— The Aberdeen Town Council require tenders for supplying and laying about 10 miles of 0·67 single-core feeder cable, about 5 miles of 0·2 three-core network cable, and about 3½ miles of arc lamp series cable. Specifications, &c., can be obtained from the City electrical engineer (Mr. Alfred Blackman), Corporation Electricity Works, Cotton-street. Our advertisement columns contain additional particulars.

——— From an advertisement elsewhere it will be seen that the Aberdeen Harbour Commissioners invite tenders for supplying and erecting 62 arc lamps on cast-iron posts, also 3 leading lights, each consisting of 4 arc lamps mounted on 80ft. posts. Lamps must be either of the Brockie-Pell or Crompton-Pochin type. Specifications, &c., can be obtained from the Corporation Electricity Works, Cotton-street.

——— The Urban District Council of Colwyn Bay and Colwyn invite tenders for the supply and erection of plant for the lighting of their new promenade by electricity. Further particulars are given in an advertisement elsewhere, and specifications, conditions, &c., can be obtained from Messrs. Lacey, Clirehugh and Sillar, consulting engineers, 78, King-street, Manchester. Tenders must be delivered to the clerk to the Council (Mr. Jos. H. Roberts), Council Offices, Colwyn Bay, by 4 p.m. on Monday, May 9th.

——— The Electric Light Committee of the County Borough of Salford invite tenders for the supply of electric cables. Specifications, &c., may be obtained from the electrical engineer (Mr. Chas. L. Turner), Walness-road, Broughton. Tenders, addressed to the Chairman of the Electric Light Committee, must be delivered at the office of the town clerk (Mr. Samuel Brown), Town Hall, Salford, by 9 a.m. of Friday, May 6. The official announcement will be found in our advertisement columns.

——— The Technical Instruction and Free Library Committee of the Corporation of Hyde invite tenders for supplying and fixing generating plant, wires, fittings, &c., for the electric lighting of the New Technical School and Free Library. Copies of the specification, &c., may be obtained from the organising secretary (Mr. S. Ashworth), Technical School, Hyde, and plans of the building may be obtained from Messrs. Lacey, Clirehugh and Sillar, consulting engineers, 78, King-street, Manchester. Tenders must be sent to Mr. Ashworth by noon of Thursday, May 5th. Some additional particulars are given in an advertisement elsewhere.

——— From an advertisement elsewhere it will be seen that tenders are invited for supplying and installing various electric motors, with all cables, switches and starting resistances. Particulars from Mr. Alexander Sparks, electrical engineer, 4, Belmont-street, Aberdeen.

——— The Bootle Corporation require tenders for the supply and erection of arc and incandescent lamps, lamp-posts and accessories. Tenders to the town clerk (Mr. J. H. Farmer) by 5 p.m. of 25th inst.

——— The Winchester Town Council require tenders for the lighting of the streets of that city for three or five years from Nov. 1. Tenders to the Town Clerk by 30th inst.

——— The Dudley, Stourbridge and District Electric Traction Company require tenders for the erection of a power station, car-shed, &c., at Brierley Hill. Tenders to the Company, 95, Colmore-row, Birmingham, by May 12.

——— The Urban District Council of Waterloo-with-Seaforth invite tenders for wiring the Town Hall, Waterloo. Tenders to Chairman of Finance Committee by 26th inst.

——— The Glasgow Corporation invite tenders for providing and erecting a temporary wrought-iron chimney (100ft. high and

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about 5ft. 6in. in diameter) on the site of the new electricity works at Port Dundas. Tenders to the town clerk (Sir J. D. Marwick), City-chambers, Glasgow, by 26th inst.

Tenders Accepted.—The Darwen Town Council have accepted the following tenders:—

Steam dynamos with Belliss engines, Siemens Bros. and Co.
Steam pipes, J. Spencer.
Accumulators, Tudor Accumulator Company.
Switch gear, Thomas Parker (Limited).
Mains, Callender Company.
Arc lamps and pillars, W. Lucy and Co.

——— At their last sitting the Brighton Town Council accepted the tender of Messrs. Willans and Robinson, to supply and erect two steam dynamos at the electricity station at £9,591.

——— The Electric Lighting Committee of the Bath Town Council recommend the acceptance of the tender of the Wheeler Condenser and Engineering Company for a 1,000-H.P. surface condenser, an air and circulating pump for 1,500 H.P., a feed pump for 1,500 H.P., a feed-heater for 3,000 H.P., a hot-well and filter tank for 3,000 H.P., a feed-water filter for 1,200 H.P., with all necessary piping, for £1,870,

——— The Lighting Committee of the Shoreditch (London) Vestry have ordered a 30-kilowatt transformer from the Electric Construction Company at a cost of £502 for their Hackney-road sub-station and also four switch-board panels from the same Company in connection with the vestry's arc light extension scheme.

Electric Lift Contracts.—The City and South London Railway Company has placed the order for the whole of the electric lifts required on their new Islington Extension with the United Ordnance and Engineering Company (Limited), of London and Erith, with whom Easton, Anderson and Goolden (Limited) are now incorporated. Each lift will be fitted with patent gear, will be capable of carrying about 70 passengers, and the average stroke will be 72ft. The current required for working will be supplied from the generating station of the railway company. The same firm has also adopted one of the hydraulic lifts on the Stockwell section of the line, so that it is now worked by electricity. Amongst other work of this class which the firm has in progress may be mentioned five electric lifts for the New Brighton Tower, three serving to the 80ft. level and two to the top of the structure (over 500ft. high), the speed of the latter lifts being 300ft. per minute, and each carrying 30 passengers. They are also supplying a large electric platform lift to raise two tons for the Royal Agricultural Hall, Islington, London.

Electric Tramway Contract.—An inclusive contract for the electrical equipment of the Dudley and Stourbridge tramways has been placed with the British Thomson-Houston Company (Limited), the work is to be commenced immediately.

Spanish Submarine Cables.—According to a recent dispatch from Madrid, a Royal Order has appeared in the *Gazette* that, as no acceptable offer has been received for the laying of a national submarine telegraph cable, a second auction will be held under the same conditions in 40 days from March 24.

Appointments Vacant.—From an advertisement elsewhere it will be seen that an engineer of Government vessels is required by the Government of Lagos, West Africa, the engagement to be for one year, with Government option to extend to three years. Salary £300 per annum, with free quarters, or allowance in lieu thereof. Applicants must have sufficient electrical knowledge to enable them to take charge of the electric light installation and store in the absence of the electrical engineer. Applications will be received by the Crown Agents for the Colonies, Downing-street, London, S.W., up to the 30th inst.

——— The Glasgow Corporation require a resident engineer and a mains superintendent for their electricity supply department. Salary about £200 per annum in each case. Applications to the town clerk (Sir J. D. Marwick) by the 28th inst. Some further particulars will be found in our advertisement columns.

Plant for Sale.—In an advertisement on another page Mr. Henry Hendriks notifies that he will (on behalf of the debenture holders in Winfields Limited, and with the approbation of the Court under a judgment of Mr. Justice Romer) in conjunction with Messrs. James and Lister Lea and Sons (acting for the mortgagees) sell at 2:30 p.m. on Thursday, May 12, at the Estate Sale Room, 43, Waterloo-street, Birmingham, the valuable goodwill and old-established connection (including contracts, patents, trade mark, patterns, pattern books and registered designs of electric light fittings, &c.), of Winfields Limited, Cambridge-street Works, Birmingham. Full information as to cards to view and other particulars are given in the advertisement referred to.

Business Notice.—M. Jules Richard, of Paris, will next week be on a visit to London, and will be pleased to see any trade friends by appointment, if communications are sent to him care of his London agents, Messrs. J. Levi and Co., 97, Hatton-garden, E.C.

Liquidations.—A meeting will be held at 6, Old Jewry, London, E.C., on May 23, to receive an account of the winding-up of the Electrical Traffic Syndicate (Limited). Mr. M. Jenks is liquidator.

——— Mr. W. J. Cohen, 13 and 14, Abchurch-lane, E.C., liquidator of the Apostoloff Automatic Telephone Parent Syndicate (Limited), has declared a first dividend of 10s. in the pound. The liquidator states that there will be more than sufficient to pay the full 20s.

Bankruptcies.—The following are creditors in the recent failure of Trehearne, Son and Crump, electrical engineers, 155, Fenchurch-street, London, E.C.:—General Electric Company, £146; Barclay and Sons, £132; Electrical Power Storage Company, £120; Simon, Berry and Co., £86; International Electric Company, £47; Downie and Adams, £35; Bilbie, Hobson and Co., £21; Fowler-Waring Cables Company, £21; Telegraph Manufacturing Company, £19; Chard and Co., £18; Gülich and McIntyre, £17; J. Stott and Co., £16; I. Frankenburg, £16; Keeling, Teale and Co., £15; Crompton and Co., £11; Crystal Electric Lamp Company, £10; and Improved Electric Glow Lamp Company, £10. The liabilities are returned at £1,066. 14s. 11d.; assets, £413. 19s. In the separate estate of S. G. Trehearne the liabilities are £283. 8s.; assets, £65. 9s. 11d.

——— The first meeting of creditors in the failure of James Fletcher and John Arthur Hirst, trading as electrical and mechanical engineers under the style of Fletcher, Hirst and Co., at Burnley, was held on Tuesday at Manchester. The statement of debtors' affairs showed liabilities expected to rank £2,184, assets £424. It was stated that debts to the amount of £1,131 had been proved. Debtors made an offer of 6s. in the pound, to be paid—3s. within seven days of the creditors' acceptance of offer, and 3s. after six months. The creditors present were willing to accept the offer, but it was pointed out by the Chairman (Mr. A. B. Potter, Assistant Official Receiver) that it was neither within their power nor that of the Court to do so. The lowest composition that could be accepted and approved was 7s. 6d. The meeting was adjourned for a month to give debtors an opportunity of making a further offer.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 8 to 19, with the ports of destination:—

Argentina—Buenos Ayres, £580 (including £350 telegraph material). *Australasia*—Albany, £80; Auckland, £29; Geraldton, £118; Melbourne, £169; Rockhampton, £9; Sydney, £150; Townsville, £67; Wellington, £3,172 (including £2,846 telegraph material). *Belgium*—Ostend, £30. *Burma*—Rangoon, £30. *Ceylon*—Colombo, £308. *Chili*—Valparaiso, £167. *China*—Shanghai, £1,190; Tientsin, £11. *Denmark*—Copenhagen, £55. *Egypt*—Alexandria, £34. *France*—Boulogne, £139. *Germany*—Hamburg, £110; Stettin, £150. *Gibraltar*, £28. *Holland*—Amsterdam, £200 (including £30 telegraph wire); Rotterdam, £16 (telegraph material). *Hong Kong*, £35. *India*—Bombay, £50; Calcutta, £337; Madras, £657. *Italy*—Genoa, £70. *Japan*—Yokohama, £437. *Portugal*—Beira, £1,155 (telegraph material). *Russia*—Batoum, £180 (telegraph apparatus); St. Petersburg, £250. *Siam*—Bangkok, £122, *South Africa*—Cape Town, £2,160; Delagoa Bay, £500; Durban, £423; East London, £255; Port Elizabeth, £1,808. *Spain*—Barcelona, £41; Santander, £38. *Sweden*—Stockholm, £255. *Straits Settlements*—Singapore, £14,575 (including £14,425 telegraph material). *United States*—New York, £150. *West Indies*—Jamaica, £23. Total £30,363, against £3,731 on April 14 and 15 last year.

Electrical and Engineering Supplies.—Messrs. Ball, Wylde and Co., of 9 and 10, Fenchurch-street, London, E.C., forward several useful lists of American-Ball engines and direct-connected generators manufactured by the American Engine Company, for whom they act as agents in this country. The lists are well illustrated and show several new features recently introduced into this Company's make of generating machines. Messrs. Ball, Wylde and Co., are also agents for Mr. Eugen Seeligmann, of Cologne, and stock supplies of lamp-holders, lamp-holder fittings, switches, shades and reflectors, electric light fittings, insulators and general electrical apparatus manufactured by Mr. Seeligmann.

Almanacs and Calendars.—We have received from Sir Joseph Causton and Sons a useful mercantile almanac, and also a hanging board calendar for 1898. The latter is a fine example of the lithographic work of this well-known London firm.

Royal Alfred Aged Merchant Seamen's Institution.—Funds are earnestly needed in aid of the objects of this admirable institution, which has in past years provided pensions and a home for the class of submarine cable workers represented by the able seaman. The secretary (Mr. A. Bailey Walker), 58, Fenchurch-street, London, E.C., will promptly acknowledge any sums forwarded.

Aberdeen.—The Gas and Electric Lighting Committee having considered the recent report of Prof. A. B. W. Kennedy on the extension of electric lighting to the west end of the City, recommend the Council to adopt the third method set out in our issue of the 25th ult., viz., Direct system, with a drop of 110 volts at full load. The extension is estimated to cost £5,700.

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Argentina.—Confidence in the trade outlook for this country is stated to be steadily reviving, and foreign capital is again coming into the country, one strong evidence of reviving trade being the improved results of railway working. An electric tramway has recently been opened in Buenos Ayres, and a large electric power installation has been put down at Casa Bamba, in the province of Cordova. The installation consists of 5 turbines of 17,000 H.P., with electric generating plant equal to 1,100 kilowatt capacity. Water power is available at Casa Bamba up to 6,000 H.P., and in the near future 20,000 H.P. will be obtainable. Two new electric lighting companies will shortly be in a position to supply current in the city of Buenos Ayres, and there is talk of a third being established. The electrical plant and apparatus is, we learn, chiefly supplied by American and German firms.

Bath.—At the last meeting of the Electric Lighting Committee the consulting engineer (Mr. Robert Hammond) submitted a lengthy and exhaustive statement of the position of the electric lighting undertaking to date. The actual and prospective expenditure is £58,535. 19s. 5d., of which the Local Government Board has already sanctioned £54,128. The Council has actually authorised the expenditure of £61,750. It is now proposed to obtain powers to borrow a further £5,000. Mr. Hammond's proposals for certain extensions of the mains, &c., and his report generally have been adopted by the Electric Lighting Committee.

Belfast.—A report from the city electrical engineer (Mr. Victor A. H. McCowen) to the Electric Committee last week stated that the output of the electricity works for the first quarter of the present year was 55 per cent. greater than for the corresponding period of 1897. There was a discussion as to the lighting of some of the leading thoroughfares electrically as soon as the new station is in working order, and the engineer was instructed to submit a statement of the comparative cost of electric and gas lighting.

Blackburn.—Such progress is being made with the electric tramways in this town that it is anticipated that electric cars will be run for the Royal Lancashire Agricultural Show, to be held in July.

Bradford.—The Gas and Electricity Supply Committee recommended at Tuesday's meeting of the City Council the adoption of a sliding scale of charges for electricity for motive power and the reduction of the charge for lighting from 5d. to 4½d. per unit. The recommendations were agreed to, and the revised scales are to come into force on July 1. The Council also decided that the two new tramway routes—portions of Bolton-road and Horton-road—should be lighted by electric arc lamps at an estimated cost of £500 per annum.

We have received a copy of the report of the special deputation recently appointed to visit the Continent for the purpose of inspecting and reporting upon electric traction stations, particularly with reference to the supply of electricity for lighting and traction from the same plant. The deputation visited the stations at Brussels, Hamburg, Berlin, Dresden and Leipzig. The conclusions of the deputation were given in our issue of the 8th inst.

Buenos Ayres.—The *Review of the River Plate* states that the Municipal Council has accepted the tender of the Compañia General de Electricidad de la Ciudad de Buenos Ayres for the electric lighting of the streets. 300 8-ampere arcs are to be installed. The charges are as under:—120 lamps, burning all night, at $27 each; 180 lamps, burning up to 1 a.m., at $20.25; total $6,885 per month. The actual cost of electric light and gas in the area affected by the proposal is equal to $1,471 gold per month. The suppression of 990 gas lamps at $7 each equals $6,230, so that the monthly saving will be considerable. The first contract will be for one year only.

Burton-on-Trent.—At the meeting of the Town Council last week a report was read from Mr. Frank Bailey, dealing with the high-tension mains and as to the present condition and future development of the electricity supply works. It was decided to authorise Mr. Bailey to prepare the necessary plans, specifications and estimates for the system of disconnection and re-connection of the high-tension mains as suggested in his report. The manager (Mr. F. L. Ramsden) has also been authorised to prepare plans and specifications of the additional machinery required for the electricity department. Mr. Alderman Lowe, Chairman of the Gas Committee, said that the Committee had received an additional report from Mr. Bailey upon the subject of the cables and mains, which was very full and elaborate; but at present the Committee were of opinion that the matter should wait a little longer before the views of the members of the Council were invited upon the whole subject.

Cairo.—The report of the British Chamber of Commerce of Egypt for the past year states that on account of the heat of the climate electric lighting is making considerable progress. The local gas company, which possesses an exclusive concession for electric lighting, have offered to light the whole of the city by electricity in lieu of gas, and this offer has been accepted by the Government. Alexandria should speedily follow the example of Cairo and adopt the electric light.

Cape to Cairo Telegraph.—Telegraphic communication was opened on Wednesday between Blantyre (Nyassaland) and Umtali (Mashonaland), a distance of about 250 miles.

City of London.—A report by the City Engineer (Mr. D. J. Ross) on the works and improvements which have been executed in the city during the past year states that the number of arc lamps in lighting at the end of the year was 494. The question of lighting the side streets by electricity is still under consideration. The lengths of telegraph and pneumatic tubes, and electric lighting conduits, &c., laid in the subways under the control of the City Corporation amount to a total of 7¾ miles. The electric light and telegraph conduits contain about 424 miles of wires and cables.

Country House Lighting.—Warnham Court, Horsham, is being wired for the electric light by Messrs. Drake and Gorham. Three hundred lights are to be supplied from the farm by a combined system of gas and petroleum engines, the power being also utilised for pumping and driving farm machinery. A "D.P." battery of 106 cells will be provided.

Curacao.—In a report recently forwarded to the Foreign Office by Consul Jesuren it is stated that the streets of this Dutch colony are lighted by electricity, but that owing to the number of lamps being too few the light has proved insufficient. A charge is made to private consumers of 3s. 4d. per 16 c.p. lamp per month.

Dublin.—A special meeting of the Corporation was held last week for the purpose of considering the proposals of the Dublin United Tramway Company for the electrical equipment of the tramways within the city. The scheme, with some minor alterations as to route, &c., was approved.

The question of the erection of a new electricity generating station and of the suitability of the Pigeon House Fort as a site has been referred to a committee of the whole house. The committee are also to consider and suggest the best method of raising the necessary moneys for the building and equipment of such a station as will generate current sufficient to electrically light the entire city.

Dumfries.—The Town Council have instructed the Lord Provost's Committee to take into consideration the advisability of establishing electricity supply works.

Ealing.—The Clerk reported at the meeting of the District Council last week that at the end of the third year's working of the electric light undertaking an equivalent of 15,209 8-c.p. lamps had been applied for, and of these 14,900 had been connected. It was generally agreed that the results of the undertaking were satisfactory.

East Grinstead.—Mr. Steer has succeeded in inducing his fellow members on the District Council to unanimously assent to application being made to the Board of Trade for a Provisional Electric Lighting Order for this district.

East Ham.—A committee of the House of Commons have passed the Bill of the District Council of East Ham for authority to purchase the tramways in the district and to introduce mechanical traction.

Edinburgh.—The Town Council on Tuesday unanimously adopted the recommendation of the Electric Light Committee to increase the salary of the resident electrical engineer (Mr. F. A. Nowington) from £500 to £600 per annum.

Some discussion arose on a report by the Cleaning and Lighting Committee advising the extension of the arc-lighting system in four additional streets. Bailie Mackenzie said the proposal was to add 70 additional arc lamps to the number already sanctioned on the understanding that a reduction of charge should be made on the whole from £15 to £14 per lamp per annum. On Jan. 25 the Council authorised the erection of 91 additional lamps on the understanding that the charge should be £15. The present proposal, including the suggested addition of Colebridge-road, took 70 additional lamps and displaced 219 gas lamps. Seventy electric lamps at a charge of £14 came to £960, and 690 lamps, formerly sanctioned at £15, if reduced to £14, would mean a saving of £690. The cost of each gas lamp per year was 30s., including upkeep. Taking the saving at 25s. for each lamp displaced, they had a sum of £272, which, added to the sum of £690, gave a total saving of £962, against the proposed expenditure of £980, so that the present proposal would add nothing to the estimates for the year. Along with the engineer he had gone very carefully into the whole matter, and their belief was that the extension of the street lighting would have such an effect in increasing the private lighting as to warrant the electric light department in reducing the charge per lamp to £14, which was far and away lower than any other place in the kingdom. The extension was agreed to.

Electric Lighting in Venice and District.—A report of the British Consul at Venice states that the electric light for street illumination has recently been introduced at Udine, Bassano and Vicenza. At Venice and Treviso the electric light is obtainable for the use of shops and buildings, but is not utilised for street lighting. The principalities of Belluno, Feltre, Mestre and Chioggia have in principle approved the introduction of electric

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lighting for public and private purposes. The street lighting at Bassano is effected by 16 c.p. incandescents, 180 of these lamps being used ; 503 16 c.p. incandescents are used in lighting Udine.

French National Bureau of Commerce.—By a law dated March 4th last an institution is established in France intended to supply exclusive information to French manufacturers, merchants and exporters, in reference to the trade outlook in foreign markets, and to foster the extension of French trade in foreign markets and in French colonies and possessions. The extensive library of the Paris Chamber of Commerce is placed at the disposal of the new institution, whose offices will be situated at 3, Rue Feydeau. A provision of 70,000fr. per annum is made by the Minister of Commerce in the Budget estimates as a subsidy to the Chamber of Commerce in recognition of its providing office accommodation, &c., for the new institution. The new bureau is to publish the *Moniteur Officiel de Commerce*. Correspondents are to be appointed in all French towns, in the French colonies and in foreign countries, these correspondents having the honorary title of Councillor of Foreign Trade ; their services, which are for a period of five years, are given gratuitously. The Minister of Commerce for the time being acts as president of the new bureau, and the President of the Chamber of Commerce of Paris is vice-president, the chief departmental Chambers of Commerce throughout France being represented on the general committee.

Glasgow and West of Scotland Technical College.—At the annual meeting of the Governors of this College, on Tuesday, the Committee on Teaching and Staff reported that negotiations were in progress for modifications of the conditions of tenure of the Pender International Submarine Telegraph Memorial Bursary. A letter was read from the Marquis of Tweeddale, Chairman of the Memorial Committee, intimating that the latter had been in negotiation with the Glasgow University, and it had now been decided that a sum of about £1,600, the balance of a memorial fund to the late Sir John Pender, should be handed to the Senate of the University, on the understanding that only students holding the diploma of the College, who afterwards enter the University to continue their studies, should be eligible for the bursary to be annually provided from the interest of such sum. The Clerk of the Senate of the University submitted the regulations for the bursary, which are :—That the holding of a diploma of the Glasgow and West of Scotland Technical College be a condition of appointment to the bursary ; that the appointment to the bursary be made by the authorities of that College ; that the bursary be tenable for one year ; and that the bursar be required, during his tenure, to attend in the University three full courses, or their equivalent, from among those that would constitute in his case a qualifying curriculum of study for the degree of B.Sc. in engineering. It was suggested that the words "in electrical engineering" be put after the word "diploma" in the regulations. It was also agreed to recommend as an additional regulation—"That, in the event of there being no candidate deemed worthy of appointment in any year, the interest be held over to provide a second bursary in a subsequent year."

Hackney (London).—The most absorbing question in municipal and local circles at present is the proposal of the Electric Light Committee to transfer the Provisional Order to a company. Animated discussions have already taken place on the matter, and an exciting debate, lasting over five hours, was the feature of Wednesday's Vestry meeting, when eventually it was decided to further adjourn the discussion.

Last week, a meeting of ratepayers protested against the proposal of the Vestry to transfer its Provisional Order to a company.

Hanley.—Mr. Joseph Lobley (borough engineer and surveyor) has forwarded a copy of his report to the joint Works and Sanitary Committees on the proposed refuse destructor for the town. The report deals with the question of the value of destructors for steam-raising purposes for the generation of electricity.

Hastings.—An animated discussion took place at Wednesday's meeting of the Town Council on the proposal to apply for authority to construct electric tramways in the town. The resolution was passed by 24 votes to 14, but as a two-thirds majority was requisite for the application the matter will have to remain in abeyance.

Huddersfield.—There are at present 650 customers of the electricity department, representing an equivalent of 44,047 8-c.p. lamps, an increase of 18 customers and 752 lamps for the month of March.

Las Palmas.—Electric lighting in this Spanish colony is stated to be in a fair way to be accomplished, a contract having been signed for a complete installation. Belgian capital is at the back of the scheme, which embraces both public and private lighting. A recent report on the general outlook for this island states that in view of the large trade in fruit which the growers on the island are establishing, and the difficulties in transit, there is an excellent opening for the employment of capital in the construction of a light railway round the island. Already a steam tramway has proved a great financial success, all its liabilities having been paid off and a handsome dividend being realised.

Light Railway Inquiry.—An inquiry into the application for authority to construct a light (electric) railway in Chatham, Rochester, Gillingham and district is being held to-day (Friday) at Chatham, by the Light Railway Commissioners.

Loughborough.—The Town Council have decided to apply for a Provisional Order, and the Gas and Electric Lighting Sub-Committee have been authorised to incur an expenditure of £50 inobtaining professional assistance if necessary.

Lourenco Marques.—The *Financial Times* states that a French company is busy laying down electric light cables for lighting the streets of Lorenço Marques and suburbs.

Ludlow.—The Town Council recently advertised for electric lighting schemes, and have now, on the recommendation of the Public Lighting Committee, awarded the prize of £20 to the scheme sent in by Mr. J. S. Enright.

Lynn.—The Electric Lighting Committee having considered the recent report by Prof. H. Robinson, on the question of the erection of electricity supply works, presented a report at the last meeting of the Town Council, in which they recommended that Prof. Robinson be invited to state the terms upon which he would be prepared to design and carry out the works, and that application be made to the Local Government Board for sanction to borrow £30,000 for carrying out the project. The Committee have also approved the site selected by Prof. Robinson for a station.

Magnolia Metal Patent.—We are informed by the Tandem Smelting Syndicate (Limited) that the appeal against Mr. Justice Romer's judgment and order for the revocation of the letters patent No. 8,655, of 1890, for the manufacture of magnolia metal has been abandoned, and that the action has been dismissed with costs and the void patent struck off the register.

Manchester.—At the adjourned meeting of the City Council on Wednesday, Ald. Higginbottom introduced the recommendation of the Electricity Committee to make application to the Local Government Board for sanction to borrow the further sum of £150,000 for electricity supply extension purposes. In moving the adoption of a resolution approving the Committee's recommendation, Mr. Higginbottom said the money was required for works in the city and for extensions to Moss Side, Levenshulme and Withington. The following was a summary of the estimated cost :—Manchester, £73,300 ; Moss Side, £15,600 ; Levenshulme, £8,970 ; Withington, £48,920 ; total, £146,790. This would leave a sum of £3,210 for "sundries and contingencies." Sir John Harwood moved an amendment that application should be made for sanction to borrow £200,000, and this was ultimately agreed to.

Moscow.—The British Consul at Moscow reports that the Municipal Authorities propose to convert the present horse tramways into electric lines. The two existing tramway companies are in communication with German syndicates, who have submitted proposals to the Mayor (Prince Galitzin). The matter is, it is stated, at present being considered by a Special Commission, which will draw up a report and furnish the Consul with particulars of the municipality's requirements. We may supplement the Consul's statement by saying that it is within our knowledge that large orders for electric cables and other accessories have already been placed with British and Belgian manufacturing houses to Russian municipal requirements.

Municipalisation in Germany.—In a report by the United States Consul at St. Gall it is stated that the municipalities of Barmen, Bremen, Cassel, Darmstadt, Düsseldorf, Elberfeld, Hanover, Cologne, Königsburg, Lubeck and Pforzheim own and manage electric light and power supply works, and with the exception of Hanover these towns also own the gas works. In Aachen, Chemnitz, Frankfort-on-the-Main and Strasburg the electricity works are operated by companies on leases, while in Altona, Dessau, Gera, Hagen, Heilbronn, Leipzig, Mülhausen, Stettin and Zwickau private companies have established works under certain conditions, including future right of purchase by the Municipal Council.

Newcastle-on-Tyne.—The Electrical Committee seek powers from the Town Council to enter into negotiations for the purchase of the undertakings of the two electric supply companies in this city.

Port Elizabeth (South Africa).—The Town Council have decided to introduce a Bill in the next Session of the Cape Parliament for power to supply current for private lighting.

Private Bill Legislation.—Official notice is given that the West Ham Corporation propose to make application to amend their Bill now before Parliament, so as to empower the Corporation to purchase, supply, sell, let, and deal in electric wires, fittings, lamps, and apparatus for the supply and utilisation of electricity for any purpose in any premises within the borough, and also to amend the provisions of the West Ham Corporation Act (1893), the West Ham

Corporation Electric lighting Order (1892) and any other Act or Order relating to the Corporation which may affect the legality of the proposed amendment of the Bill now before Parliament.

Singapore.—Particulars of a combined electric lighting and tramway scheme have been submitted by a local company, and the Finance Committee of the municipality are dealing with the matter.

St. Helens.—Major P. Cardew, R.E., held an inquiry here on Tuesday into the application of the Corporation for sanction to use electricity as the motive power on the local tramways, and to borrow £25,000 for the purpose of equipping the existing lines. The town clerk (Mr. Jeeves) said that the Corporation had come to the conclusion that it would be an advantage to the district to introduce the overhead trolley system. The Corporation would undertake the electrical equipment, but would not supply the rolling stock. The present application referred to the existing lines, but the Bill before Parliament dealt with a number of extensions and also with the question of the motive power. There was no opposition to the application.

Shanghai.—At the forthcoming annual meeting of the Municipal Council the question of the construction of a system of electric tramways in the streets of the settlement will be discussed.

Sunderland.—In the report recently presented by the borough electrical engineer (Mr. J. F. C. Snell), recommending various extensions of the electric light plant and mains, evidence is given of the constant and steady increase in the demand for current for lighting and power purposes in this town. The following table shows the annual growth since 1896 to Dec. 31:—

Year.	No of consumers.	Equivalent 8-c.p. lamps fixed.	Increase.	Max. load E.H.P.	Increase.	Capacity of station E.H.P.	Capacity E.H.P. deducting stand-by.
1896	113	11,289	—	294	—	345	210
1897	170	19,177	7,888	499	205	480	345
1898	—	23,750	4,573	630	131	715	480

In order to meet future requirements Mr. Snell recommended that the Local Government Board be asked to sanction a loan sufficient to meet all expenses for extensions for three years, so enabling additions to the plant being made as required, and without having to wait on each occasion for special sanction. Below we give Mr. Snell's figures of the estimated results of the working of the department to the end of 1901:—

Year.	E.H.P. required	Units estimated to be sold	Capital outlay to end of year.	Working and sleeping costs.	Sinking fund and interest	Total costs.	Revenue.	Net pr'fit
1898-9 ...	630	418,550	£46,300	£3,580	£2,370	£5,950	£6,055	£105
1899-1900	800	529,470	56,000	3,860	3,180	7,040	7,800	760
1900-1 ...	1,000	660,960	69,000	4,360	3,700	8,060	9,430	1,370

The total estimate for all requirements to end of 1901 is £12,728, made up as follows:—

1. Buildings, flues, trenches, roof, underground tank, engine foundations £2,050
2. Three boilers, feed-pump, water-softener and pipework 3,950
3. Two steam dynamos, with piping, cables, &c.; two balancing transformers, extensions to switchboards, &c. 6,550
4. Lathe, drilling machine and other tools and instruments 178

The sum of £7,800 was, however, calculated to meet immediate requirements. Mr. Snell concludes by recommending: (1) That the Local Government Board be asked to sanction a further loan of £26,000 to carry out the foregoing scheme; (2), that subject to the sanction of the Board, the Council be asked to grant leave to borrow £10,000 for immediate requirements; (3), that he be empowered to draw up specifications and call for tenders for two Lancashire or Galloway boilers, and all piping and accessories, one new Weir's pump, one new steam dynamo, and two motor transformers; (4), that he be authorised to take steps so that the change to the 440-volt system may be effected in the spring of 1899, subject to approval of Board of Trade. As stated in our last issue the Town Council have approved the Electric Light Committee's report, which endorsed Mr. Snell's recommendations.

Shoreditch (London).—At Tuesday's meeting of the Vestry a report was presented by the Lighting Committee from Messrs. Kincaid, Waller and Manville on the subject of extensions to the electric generating station, &c., at an estimated cost of £13,200. The Committee recommended the approval of the suggested extensions, and in the course of the discussion which followed Mr. Kershaw, the energetic chairman of the Committee, stated that the past three quarters' working of the electricity works had yielded a profit of £1,700, and that refuse equivalent to the combustion of 30,000 tons per annum was being dealt with in the destructor. The extensions to the station would include putting down five dry-back boilers at a cost of £5,000, steam piping £500, destructor battery extensions £1,500, and additional transformers £2,300, the balance being expended on structural alterations and extensions. It was his opinion that the Shoreditch station would show the lowest works costs in London, and, perhaps, even in the whole country. The proposal was almost unanimously adopted. The Committee were further authorised to instal an electric ventilating fan in the engine-room at the works.

Fifteen tenders were received by the Vestry for the execution of the arc lighting extensions, and these the Lighting Committee have under consideration.

Tariff Changes.—Under the New Chilian Customs Tariff wire, with or without covering, physical, mathematical, telephone and telegraph instruments, apparatus, &c. (excepting wooden cross pieces for posts), electric light plant and machinery, arc and incandescent lamps are to be admitted free of duty.

Taunton.—At a special meeting of the Town Council, on Wednesday, the Electric Lighting Committee recommended that sanction to borrow £11,500, instead of £10,000, as previously agreed upon, should be applied for, in order to provide for the renewal of the electric lighting plant. A report from Messrs. Kincaid, Waller and Manville was also submitted, recommending the introduction of up-to-date plant. This report was adopted.

Telephone Trunk Line Extension.—Buckie, Newmarket and Coldstream, N.B., are the latest towns to which telephone trunk line communication has been extended.

The Telephone in Wurtemburg.—Owing to the recent considerable extension of the telephone system in this division of the German Empire, the gross receipts, which in 1893-94 amounted to £21,424, are estimated for the financial year 1898 at £41,250.

United States Exports of Electrical Machinery.—According to the *Iron Age*, the value of the electrical machinery exported from the United States in the latter half of 1897 was $917,453.

Wolverhampton.—Extensions to the electric light mains, at an estimated cost of £470, have been authorised.

Weston-Super-Mare.—The District Council have received a proposal from "Mr. W. L. Madgen, for the Municipal Electric Supply Company, of Brighton," to take a lease of the Council's Provisional Order. The offer provides for taking a lease of the Order upon the condition that at the end of 10 years (and at any time thereafter), by giving two years' notice in writing, the Council shall be entitled to purchase at a valuation to be fixed by independent valuers. The Company would pay all costs and expenses incurred in connection with obtaining the Order, and all fees paid or due to the consulting engineer (Mr. W. C. C. Hawtayne). The Company would undertake to establish supply works forthwith, and would supply electric current not only in the compulsory area but also in several additional streets. The Company state that they would adopt the scheme recently proposed by Mr. Hawtayne, who would have the opportunity of approving their plans and specifications. The communication concludes with the statement that "the Company is not connected with makers of engines, boilers, dynamos, mains, &c., and is thus quite free from any trade bias in favour of particular machinery. The acting proprietors are Mr. Henry Reason and Mr. W. L. Madgen, both of whom have had a wide experience as electrical engineers, and they would be pleased to furnish references as to their professional ability, and also with bankers' references as to their financial standing." The Clerk was instructed to reply that, "should the Council determine to dispose of the Order, the Company's offer shall receive the consideration it deserves."

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicaters of inventions, or where complete specifications accompanies application an asterisk is suffixed.*

March 18, 1898.

6,605. W. AITKEN. London. Improvements in telephonic inter-communication system.

6,607. E. J. CLARKE. London. A new or improved separator for the plates or electrodes of secondary batteries or accumulators.

6,619. L. M. ERICSSON. London. Improvements in microphones.*

6,633. F. W. COOKE and T. IRELAND. London. An electrical charge indicator.

6,637. C. E. ACKER. London. Improvements relating to the electrolytic production of metallic alloys and to apparatus therefor.*

6,649. C. W. ATKINSON and W. H. JOHNSON. London. Improvements in dynamo electric generators and motors.

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March 19, 1898.

6,667. H. GODSALL. London. Improvements in electrical coherers.
6,672. A. F. EVES. Dublin. An improved receiver for electromagnetic waves.
6,695. R. E. B. CROMPTON and S. W. ASHLEY. London. Improvements in electrical regulating apparatus.
6,704. H. F. PARSHALL. London. Improvements in switchboards for the control of high voltage electric circuits and apparatus.*
6,714. E. M. FRENCH. London. Improvements in electric switches.
6,720. W. GRUNOW, JUNR. and Z. GOODSELL. London. Improvements in depressible rail systems for electrical railways.
6,758. A. M. G. SÉBILLOT. London. Improvements in electric furnaces.
6,762. W. E. SIMPSON. London. Improvements in the means of and apparatus for transmitting pictures and the like by electric currents.

March 21, 1898.

6,773. J. E. STEWART. Derby. Improvements in and relating to street lanterns for the reception of incandescent electric lamps.
6,831. W. O. WOOD. London. Improvements in electric miners' lamps.*
6,834. C. H. WORDINGHAM. London. Improvements in safety devices for use in connection with high-tension electric conductors.
6,865. J. D. F. ANDREWS. London. Improvements in electric conductors and in appliances for making connections with same.

March 22, 1898.

6,902. W. ALDRED and G. CARR. Sheffield. Improved details of electric tramways and railways.
6,903. A. E. TANNER and G. W. LOWCOCK. Manchester. Improvements in electric plug connectors.
6,923. G. V. GRESS. London. Improvements in phonographs.*
6,944. T. H. BECKER and L. SCHREYER. Glasgow. A method of, and furnace for the continuous melting of glass by electricity.*
6,954. J. C. VAUGHAN. London. Improved holders for electric lamps.
6,989. E. WESTON. London. Improvements in electrical measuring instruments.*
6,990. E. WESTON. London. Improvements in electrical measuring instruments.*
6,991. E. WESTON. London. Improvements in electrical measuring instruments.*
6,992. E. WESTON. London. Improvements in electrometers.*
7,016. G. F. PAYNE. London. Improvements in telephone transmitters.*

March 23, 1898.

7,027. S. G. BROWN. Chelmsford. Improvements in dynamo-electric generators and motors.
7057. H. F. PROCTOR and J. R. BLAIKIE. Bristol. Improvements relating to plug switches and plug connections for the control and distribution of electric currents.
7,058. W. R. UNDERHILL and P. W. NORTHEY. London. An approved method of preventing the corrosion of electric battery connections.

March 24, 1898.

7,129. T. HOLMES, A. HOLMES and G. S. HOLMES. Liverpool. An improved means of generating electrical energy.
7,150. H. L. TODD and E. HARKER. London. An electric locomotive.
7,170. F. F. YEATMAN and W. DONOVAN. London. Improvements in or in the construction of electrical storage batteries.
7,179. P. GERMAIN. London. Improvements in telephone posts or stations. (Date applied for under Patents, &c., Act, 1883, Sec. 103, September 1, 1897, being date of application in France.)
7,193. A. J. BOULT. London. Improvements in or relating to primary electrical batteries. (J. Cerpaux and A. Wilbaux, Belgium.)*
7,199. L. G. TATE. London. Improved wall socket and plug for electrical fittings.

March 25, 1898.

7,222. R. LEWIS. Llanelly. A spring power appliance for taking the place of steam, electricity and horse-power.
7,236. J. THOMPSON. Cardiff. An apparatus or improved manner of means for determining or ascertaining the velocity of air-currents in coal mines and other situations by novel electrical and other means.
7,283. S. HARRISON. Liverpool. Improvements in miners' lamps and apparatus for electrically lighting the same.
7,296. H. H. LEIGH. London. Differential electric transformation apparatus. (P. Lemarie, France.)
7,305. J. TABRAR and W. WALLER. London. Improvements in and relating to electrical accumulators.
7,306. J. TABRAR and W. WALLER. London. Improvements in electrical bull's eye lanterns.

March 26, 1898.

7,333. E. MÉRIAN. Manchester. Improvements in the construction of plates for electrical accumulators or storage batteries.
7,367. A. J. BOULT. London. Improvements in or relating to electric indicators or annunciators. (The Antwerp Telephone and Electrical Works, Belgium.)*
7,384. A. CLEMENTS. London. Systems of lever drawbridges with overhead conductors for electric railways. (Union Elektricitäts Gesellschaft, Germany.)*

March 28, 1898.

7,408. W. HOLMES. London. A new or improved electricity meter.
7,423. H. ASCHERMANN. Brussels. Process for the extraction of pure metals or metallic alloys and carbides by electric heat.*
7,450. H. DANIEL. Berlin. An underground electric current delivery for street railways.*
7,467. W. T. BELL. London. Improved means applicable for use in operating electrically-illuminated signs, advertising media, or the like.
7,470. W. L. WISE. London. Improvements in and apparatus for effecting electrolysis. (Solvay and Co., Belgium.)
7,471. W. L. WISE. London. Improvements in electrolysis. (Solvay and Co., Belgium.)

March 29, 1898.

7,487. R. M. MINTON-SENHOUSE and G. F. EMERY. London. Improvements in electric batteries.
7,514. A. WARBURTON. Sheffield. Improvements in plates for battery and other purposes and method of making same.
7,545. G. K. B. ELPHINSTONE. London. Apparatus for electrically winding springs or weights for clock movements.
7,566. W. L. BLISS. London. Improvements in systems of electrical distribution.*
7,569. H. H. LAKE. London. Improvements in electric furnaces. ("Volta" Société Anonyme Suisse de l'Industrie Electro-Chimique, Switzerland.)
7,570. F. CLOUTH. London. Improvements in and relating to means for connecting electric cables.
7,575. W. P. THOMPSON. Liverpool. Improvements in electric furnaces. for manufacturing calcium carbide, &c. (C. L. Wilson, C. Muma, J. W. Unger, H. Schneckloth, A. P. Brosius, and J. C. Kuchel, United States.)*
7,577. N. B. STUBBLEFIELD. Liverpool. Improvements in electrical batteries.*
7,583. H. C. E. JACOBY and WHITE, JACOBY AND CO. (LIMITED). London. Improvements in and connected with electrical switches.

March 31, 1898.

7,696. W. JUDD. Surbiton. Improvements in apparatus for indicating and recording electric currents and signals.
7,700. J. DEWAR. Glasgow. Improvements in and relating to shields for incandescent electric lamps and the like.
7,725. J. M. HUISMAN and C. H. GOVER. Glasgow. Improvements in holders for incandescent electric lamps.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

4,994. BOULT. (Hubbell and Roland.) Portable electric lamps.
5,031. SZCZEPANIK and KLEINBERG. Method and apparatus for producing pictures and the like at a distance by means of electricity.
5,157. DAVY and THOMAS-DAVIES. Electric arc lamps.
5,258. EPSTEIN. Electrically-propelled motor road vehicles.
5,714. JOHNSTON. System of fitting up electric bells.
5,948. ROGERS and MORDEY. Means and apparatus for discharging, neutralising or removing electrical charges from paper and like materials during and after the process of manufacture.
6,212. STAVELEY, PARSONS AND MURDAY. Means for supplying electric current to electrically operated time-keeping mechanism.
6,774. JOHNSON. Method and appliances for brazing or soldering by electricity.
7,772. LANGDON-DAVIES. Alternating current motors.
8,185. WETTER. (The Elektrizitats Aktiengesellschaft vormals Schuckert and Co.) Generation and distribution of alternating electric currents for light and power.
8,970. HAMPSON. Electrical indicating apparatus and couplings used in connection therewith as a system for electrical communication.
9,127. EVERSHED AND VIGNOLES (LIMITED) and EVERSHED. Electric meters.
9,803. DE LAVISON. Voltaic battery having its depolarisation effected by heat.
10,168. GIULIANI. Mode of long distance telephoning and apparatus therefor.
10,280. EGGER. Electric incandescence lamps.
11,226. PRIDDLE. Telephones.
11,808. WOODLEY. Incandescent electric lamps.
13,100. GAUZENTÉS. Primary or galvanic electric batteries.
15,238. BACHMANN, VOGT, KIRCHNER, KONIG, WEINER and JÖRG. Manufacture of electrical resistances.
18,475. SCHNÉE. Galvanic hand-baths and foot-baths or arm-baths and knee-baths for directly introducing medicaments into the tissues of the human body.
18,718. SHORT. Electric railways and tramways with overhead conductors.
19,410. BAGULEY. Drawing off liquors from barrels.
24,073. HEATON and SMITH. Switches for electric light or power.
24,111. SHULTES. Electric conductor wire connectors.
25,655. BOULT. (Wertheimer.) Apparatus for making observations by means of Röntgen or X-rays.
26,412. THE BRITISH THOMSON-HOUSTON COMPANY (LIMITED) and HOBART. Electrical transformers.
26,468. HARRYMAN. Memorandum desk for use with telephones and for other purposes.
26,919. STRECKER and STRECKER. Application of electrodes in electrolytic processes.
26,921. STRECKER and STRECKER. Process for preparing insoluble or hardly soluble salts from metallic anodes by electrolysis of aqueous solutions containing two salts.
26,923. STRECKER and STRECKER. Production of protoxides and oxides or of hydro-protoxides and hydroxides from metallic anodes by electrolysis of alkaline salt solutions.
26,935. BOULT (Travailleur). Apparatus for indicating and registering variations of insulation resistance in electric networks and circuits generally.
27,208. TANNER. Ceiling roses and similar fittings for electric light service.
27,483. SPIES NEWALL and SHOUT. Electric arc lamps.

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COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Company (Limited).

The thirty-first ordinary general meeting was held on Wednesday at Winchester House, Old Broad-street, Mr. J. Herbert Tritton, Chairman of the Board of Directors, presiding.

The MANAGING DIRECTOR (Mr. W. Andrews) read the notice calling the meeting, and the report and accounts were taken as read.

The CHAIRMAN then said: I have now to move—

"*That the report and accounts now submitted be received and adopted, and that a dividend be and is hereby declared, for the half-year ended December 31, 1897, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year.*"

In submitting this resolution, gentlemen, I have to say that for the second year in succession we have to deplore the removal by death of a Director. Captain Earle, who was a valued colleague of ours for many years, met his death, as you doubtless remember, in the spring of last year by an accident while out bicycling. Mr. T. W. Andrews, the son of our much respected Managing Director, has been elected to the vacancy, and is giving thoroughly efficient help to his father and to the Company in the technical details of our undertaking. The business of the year 1897 compares favourably with that of 1896. The revenue has increased by some £7,000, and the expenditure shows a slight increase, as might be expected. In the expenditure there are again included amounts for writing down certain items of the capital account, a course which has already had your approval, and which goes to strengthen our general financial position. We must always remember that we are subject to contingencies, not alone in connection with our concessions, but generally, which must be taken into account; and our position, though strong, is not so absolutely impregnable as our figures might be held to indicate. We stated in our report for 1896 that certain advantages in the direction of liberal treatment respecting messages, systems of counting and so on had been given to the general and mercantile public, but that we did not apprehend any loss in consequence, and we are glad to find that our anticipations were correct. In connection with the maintenance and improvement of the lines there are several items which point to an increased outlay in 1898. For instance, it is proposed to add another wire to our system between Warsaw and Odessa, for which the approval of the Russian Government has already been obtained; a somewhat considerable removal of the line has to be carried out in the Crimea: from the high road to a railway in course of construction, and also an alteration rendered necessary by Imperial arrangements. The Wheatstone automatic transmitter has proved so decidedly satisfactory on a section of the line that we propose to extend its use over the whole line from the German frontier to our terminus at Teheran, Persia. For these reasons we have thought it advisable to carry forward a somewhat larger balance, feeling sure that most, if not all, of these alterations will prove distinctly advantageous. We always wish to be in the forefront when improvements can be adopted, and I am sure you would not wish us to lag behind. The line has now been in operation for more than 30 years, and the results, telegraphically speaking, obtained are better than ever; but there is doubtless room for improvement, more particularly in the wild country traversed by the line in the Caucasus. Mr. T. W. Andrews, whom we have the pleasure of seeing with us as our colleague for the first time to-day, has inspected the line throughout its length during the year, and his report was most favourable. There is only one other item to which I need advert, and that is the cash balance in hand. It is larger than we care to see it, and awaits investment in part of course. As prudent men we have not thought well to invest more than was necessary when prices were falling, but I might say that, since the date of making up the accounts, £20,000 has been invested. Our investments, which you will admit are of a first class character, show a handsome surplus over their cost price, though the fall in high class stocks has been somewhat severe, and we are not quite sure that we have yet seen the bottom. Before I sit down I should like to take the opportunity of expressing the Directors' appreciation of the admirable services rendered by the Company's staff, both at home and abroad. A highly trained and efficient staff such as ours is the result of many years' patience, intelligence and industry on the part of all concerned; and I am anxious that those in the lowest grades should understand that we recognise their efforts as much as those of the superior officers. To all alike our thanks are due. I congratulate the shareholders on the result of the year's working, and hope we may be able to maintain it in the year now current. Our best efforts will always be devoted to doing all that we can in your interest.

Mr. C. HOLLAND seconded the resolution.

Mr. MACANDREW remarked that there had been a good deal of talk lately, even in the House of Commons, about war between Russia and England, and he should be glad if the Chairman would favour them with his opinion as to what would be the effect on the Company's line and business supposing such a contingency should arise.

The CHAIRMAN: I trust the supposition raised by the honourable proprietor is very far removed from being a possibility. I believe this country is on the best of terms with the Russian Government. If you will allow me, I would suggest that the question is one with which we need not concern ourselves. Our relations, so far as the Company is concerned, with the Russian Administration are of the most cordial description, and I trust the relations of the Government of this country with Russia are the same.

The resolution was then agreed to unanimously.

Mr. HOLLAND proposed the re-election of the retiring Directors, the Chairman and Mr. H. H. Meier.

Mr. W. ANDREWS seconded, and it was carried unanimously.

On the motion of Mr. H. ST. LAWRENCE SMITH, seconded by Mr. STEVENS, the auditors, Messrs. C. F. Kemp, Ford and Co., were re-appointed.

A vote of thanks to the Chairman and Board of Directors, proposed by Mr. MACANDREW and seconded by Mr. PHELAN, brought the meeting to a close.

Oriental Telephone and Electric Company (Limited).

The report of the Directors for the year ended Dec. 31, 1897, states that the revenue account shows a credit balance of £10,909. 18s., including £629. 14s. 3d. from 1896, and after deduction of £2,858. 8s., representing the interim dividend of 4d. per share paid on Oct. 30th last, there remains £8,681. 4s. 3d., which the Directors recommend that this be appropriated as follows: £5,716. 16s. in the payment of a final dividend of 8d. per share, free of income tax making 6 per cent. for the year; £1,000 to extinguish balance debit of Colombo exchange "suspense account"; £1,000 to reserve, and £964. 8s. 3d. forward.

The revenues of the Indian companies continue satisfactory. The Bombay Company has paid a dividend of 6 per cent. against 5 per cent. for 1896, and has reserved from profits of the year a further sum of Rs.30,000, which has been deemed desirable, in consequence of the continuance of the plague in that city and the unsatisfactory outlook in connection therewith. The Telephone Company of Egypt has duly declared the dividend on its Six per Cent. Preferred shares, and its business still continues to develop. The China and Japan Telephone Company has paid its debenture interest, and is making fair progress both at Shanghai and Hong Kong. The electric lighting branch of the Company's business carried on at several of its stations has paid its way for the past year, and the current year opened with a fair amount of business in hand.

Submarine Cables Trust.

The report of the trustees to be presented to the annual meeting on Wednesday, the 27th inst., states that the revenue for the year, including £159. 9s. 10d. brought forward, amounted to £23,156. 5s. 9d. During the past year the following coupons have been met:—

Due.	Paid.
April 15, 1897	10s. balance July 15, 1897.
Oct. 15, 1897	£3 in full on due date.
April 15, 1898	£3 in full on due date.

The expenses of the Trust amounted to £1,159. 12s. 9d., and the payments on account of coupons to £21,976. 10s., together £23,136. 2s. 9d. leaving £20. 3s. to be carried forward.

The trustees, in accordance with the reasons given in last year's report have sold the balance of their holding (£69,200) in Anglo-American Telegraph Company Deferred Stock, and by unanimous resolution of all the trustees decided to invest the proceeds of such sale in the purchase of other securities of the character mentioned in the deed of trust. The certificate holders will be asked to confirm this resolution of the trustees, and to sanction such investments.

Mr. Sidney Collett has been appointed secretary of the Trust in place of the Hon. A. G. Brodrick resigned.

Calcutta Electric Supply Corporation (Limited).

The first report of the Directors of this Company states that immediately upon the formation of the Corporation instructions were given to the managing agents in Calcutta to negotiate for the purchase of a site upon which to erect the generating station. After some little time a suitable site was acquired, but the Corporation has only recently obtained possession of the site. The question of the use of overhead wires in some of the streets of Calcutta has involved protracted negotiations with the Government of Bengal, the Telegraph Department and the Municipality. These negotiations have recently been concluded, so far as to permit of the contractors making arrangements for shipping the necessary cables. The contractors have entered into sub-contracts for the erection of the buildings and chimney, the whole of the cables and copper for the mains have been ordered, and a good portion of the generating plant is well advanced towards completion, so that shipment can be made immediately the buildings are ready to receive the plant. The question of the renewal of the Company's concession at the expiration of the period for which it was originally granted, viz., 21 years, for a further like period, has been the subject of negotiation with the Government, and the Directors have no reason to doubt that the assurance, given to the Company before the issue of the prospectus, will be carried out.

NEW COMPANIES, STATUTORY RETURNS, &c.

CORK ELECTRICAL FREE WIRING COMPANY (LIMITED).—This Company was registered in Dublin on the 5th inst., with a capital of £10,000, in 5,000 Preference and 5,000 Ordinary shares of £1 each, to purchase, manufacture, sell and to erect, fix, fit, instal, or repair electrical plant.

ERNEST G. DENNER AND COMPANY (LIMITED).—This Company was registered on March 31 with a capital of £5,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers and dealers. The first subscribers (each with one share) are: Ernest G. Denner, electrical engineer, Miss M. Nicholson, W. Haslam, G. Smith, W. Crake, B. Nicholson, and H. H. Ewing.

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MEXICO ELECTRIC TRAMWAYS (LIMITED).—This Company was registered on April 14, with a capital of £500,000, in £1 shares, to enter into an agreement with Messrs. Wernher, Beit and Co., and to carry out contracts and concessions for the construction, equipment, maintenance and working of tramways, railways, telegraph and telephone lines, electric lighting and other works, &c., in Mexico or elsewhere. The first subscribers (each with one share) are: W. Martin, H. W. Brown, A. J. Swan, E. F. Rouse, G. F. Barnett, C. Field and A. W. Rogers.

JOHN SPENCER (LIMITED).—This Company has been registered with a capital of £75,000, in £5 shares (10,000 5 per cent. cumulative preference), to acquire the business carried on under the style of the Globe Tube Works, at Wednesbury, Staffs., by Mr. J. Spencer, manufacturers of tubes, iron, brass, &c., fittings, and also to establish and maintain electric and gas works, to construct rail and tram roads, &c. The first directors are: J. Spencer, S. Spencer, E. Spencer, M.P., H. S. Smallman and T. H. Spencer.

TYER AND COMPANY (LIMITED).—This Company was registered on March 31, with a capital of £25,000 in £1 shares, to enter into an agreement with Edward Tyer for the acquisition of the business carried on under the style of Tyer and Co., and to carry on the business of electric telegraph and railway train signalling engineers and contractors. The first subscribers (each with one share) are: Edward Tyer, G. H. Jelfs, R. W. E. Davey, Herbert J. Barrow, Arthur Barrow, W. E. Tyer, and Henry J. Field.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The annual return to Feb. 18 has been filed. The nominal capital consists of £7,000,000 stock, all of which is fully paid.

G. R. BLOT AND CO. (LIMITED).—The statutory return to February 14 has been filed. The nominal capital is £75,000 in £1 shares, of which 30,693 have been taken up; 14,400 are considered as paid, and the full amount has been called and paid on the remaining 16,293 shares.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LIMITED).—The annual return to March 7 states that the nominal capital is £250,000, in £5 shares, of which 49,999 have been taken up. The full amount has been called and paid.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The annual return to March 2 has been filed. The nomial capital is £220,000, in £10 shares (of which 6,000 are Preference). All of these have been taken up and paid.

NATIONAL TELEPHONE COMPANY (LIMITED).—The annual return to March 3 has been filed. The capital is £4,000,000, divided into 150,000 First Preference of £10, 150,000 Second Preference of £10, 250,000 Third Preference of £5 and 490,000 Ordinary shares of £5 each, of which all, except 5,403 Ordinary shares, have been taken up; 28,284 Third Preference and 44,413 Ordinary shares have been issued as fully paid, and the full amount has been called on the remainder.

SCARBOROUGH ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return to March 3 has been filed. The capital is £50,000, in £10 shares, of which 4,000 have been taken up; £9 per share has been called and paid.

ST. JAMES AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—The annual return to Feb. 22 has been filed. The nominal capital is £300,000, in 100 Founders' shares of £1 each, 39,980 Ordinary shares of £5 each, and 20,000 Preference shares of £5 each. All the Founders' and Preference, and 31,980 of the Ordinary have been taken up, and the full amount has been called.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—The annual return to March 2nd has been filed. The nominal capital is £399,500 in £5 shares, all of which have been taken up. The full amount has been called, and £399,500 has been paid.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since April 7, 1898). Price of silver 25 1/16d. per oz. (April 21). Consols (2¾ per cent.) 109⅝—109⅞ for money, 109¾—110 for account; 2½ per cent. 101—102 (April 21). Stock Exchange Settling Days: Consols, May 5; Stocks and Shares Continuation Days, April 27 and May 10; Ticket Days, April 28 and May 11; Pay Days, April 29 and May 12; Mining Share Carry-over Days, April 26 and May 9.

BOURNEMOUTH AND DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED). A meeting of this Company was held last week at the London offices under the presidency of Mr. Aymor H. Sanderson. The Chairman said that the whole of the interests of the County of London and Brush Provincial Company in that undertaking (consisting of practically the whole of the share capital, together with a loan of £63,892) had been transferred to and are now vested in the Bournemouth and Poole Electric Supply Company (Limited), which was formed in December last for the purpose of acquiring those interests. The gross receipts of the Bournemouth and District Company were £9,863, against £8,244 for 1896, an increase of £1,619. The improvement in the figures on the debit side of the revenue account was equally satisfactory. The net revenue account, after paying interest charges amounting to £3,622 and writing off £1,174 for depreciation, showed a loss of £92, against a loss of £929 in 1896. The equivalent number of 8-c.p. lamps connected to the Company's mains at Dec. 31, 1897, was 26,113, an increase of 2,910 for the year, and applications for a further 1,000 had since been received. The units sold during the year amounted to 338,658, an increase of 57,348. A steady and continuous supply of current had been given throughout the year.

BRISTOL.—Mr. George White, managing director of the Bristol Tramways and Carriage Company and chairman of the Imperial Tramways Company, was yesterday (Thursday) elected chairman of the Bristol Stock Exchange.

BRITISH GUIANA ELECTRIC LIGHT AND POWER COMPANY.—A dividend at the rate of 7 per cent. per annum has been declared by the Directors of this Company. Satisfactory progress has been made during the half-year in the Company's operations, and in order to meet the continued demand for current it has been found necessary to put in additional plant, estimated to cost about $15,000.

CALCUTTA TRAMWAYS COMPANY (LIMITED).—At the meeting of this Company on Tuesday the Chairman (Mr. E. C. Morgan) announced that the negotiations with the Calcutta Corporation had not yet been brought to a satisfactory conclusion. In December certain proposals were made by the Corporation, but as these were not acceptable to the Directors, counter proposals were submitted to the Corporation, who referred the whole question to a committee, which, so far as he knew, had not yet met. If the Corporation continued to ignore the matter they proposed to represent to the Lieut.-Governor of Bengal the actual state of affairs, and ask him to bring pressure to bear on the municipal authorities.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for December were £4,595, against £3,818 in the corresponding month of last year.

GREAT NORTHERN TELEGRAPH COMPANY.—The net receipts of this Company during 1897, including balance brought forward, amount to £332,474. 11s. 2d., exclusive of interest on the investment of the reserve and renewal fund, which has been credited direct to that fund. Deducting £39,361. 2s. 3d. for interest and amortisation of Debentures and £75,000 for interim dividends (already paid), there remains a balance of £218,113. 8s. 11d., which the Board proposes to distribute as follows:—extra dividend (making 10 per cent. for the year) £75,000. 6s., reserve and renewal fund £77,777. 15. 6d., pension fund of the staff £2,777. 15s. 7d., directors' remuneration £1,500, leaving a balance forward of £61,057. 17s. 10d.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to £50,000 Four per cent. Debenture stock, and 12,000 fully-paid Ordinary shares of £5 each (Nos. 1 to 12,000) of the Smithfield Markets Electric Supply Company (Limited), and to allow the further issue of £129,653 Four per cent. Mortgage Debenture stock of the Eastern Telegraph Company (Limited) to be quoted in the official list.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended April 15 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,630.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated amount of the traffic receipts of this Company for the half-month ended April 15 is £2,541, against £2,710 in the corresponding period of 1897. The December receipts (estimated at £4,445) realised £4,525.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
Birmingham Tramways.	Apl. 16	4,137	+ 811	...	...	...
Bristol Trams & Carriage	,, 15	3,273	+1,054	15	36,702	+ 6,169
City & South London Ry.	,, 17	945	- 100	16	16,771	+ 87
Dover Tramways	,, 16	180	...	32	3,626	...
Dublin United (Southern)	,, 15	638	+ 254	15	6,315	+ 81
Liverpool Overhead Rly.	,, 17	1,736	+ 258	16	22,031	+ 1,170
Sheffield Tramways	,, 17	1,035	+ 160	...	...	...

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price April 13.		Price Wednesday, April 20.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 16. Highest	Lowest
			ELECTRIC RAILWAYS AND TRAMWAYS.					£ s. d.			
£19,126	£10	3/0	Central London Ordinary	10⅝	10¾	10½	10⅝	2 15 10	June and December	10¾	10½
143,106	10	1/0¾	Do. (£6 paid)	6¼	6¼	6¼	6¼	2 13 4	,, ,,	..	..
£680,000	Stock	1¾%	City and South London Railway Con. Ordy.	68	70	68	70	2 13 8	January and July	69¾	69
8,419	£10	5%	Do. 5% Perpetual Preference	15	16	15	16	3 2 6	,, ,,	..	..
£125,701	Stock	4%	Do. 4% Perpetual Debenture	138	140	138	140	2 17 2	May and November	..	..
840,000	Stock	3%	Waterloo and City Ordinary	135	138	135	138	2 3 6	June and December	137	136¾
27,500	10	3¼%	Liverpool Overhead Railway Ordinary	10⅛	10⅜	10⅛	10⅜	3 0 2	February & August	..	..
10,000	10	5%	Do. 5% Preference	15¾	16¼	15¾	16¾	3 1 6	,, ,,	..	..
325 000	Stock	4%	Do. 4% Debenture	109	111	109	111	3 19 0	January and July	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price April 13.		Price Wednesday, April 20.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 16.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£923,960	Stock	15/0	Anglo-American xd	61	61	59	62	4 16 9	Feb., May, Aug., Nov.	—	—
£3,058,020	Stock	£0 0	Do. Preferred xd	111½	112½	109½	110½	5 8 7	" "	..	..
£3,058,020	Stock	5/0	Do. Deferred	12½	13½	12	12½	..		..	..
£137,400	£100	4%	*African Direct Telegraph (Red)	100	104	100	104	3 16 11	January and July	—	—
£25,000	10	..	Amazon Telegraph	7	8	7	8	..		..	..
130,000	10	3/0	Brazilian Submarine	16½	17	16	18½	4 4 10	Mar., June, Oct., Dec.	..	..
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	112	116	112	116	4 6 2	June and December	..	..
10,000,000	$100	$ ¾	Commercial Cable Capital Stock	185	190	175	185	4 6 6	Jan., Apr., July, Oct.	—	—
£653,686	Stock	4%	Do. 4 per Cent. Debenture Stock	104	106	101	103	3 15 6	" "	—	—
16,000	10	6/0	Cuba Submarine	6½	7½	6½	7½	9 6 8	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	14½	15½	14½	15½	6 9 0	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 8 11	April and October	—	—
6,000	5	10%	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	—	—
£30,000	£50	4½%	Do. 4½ per Cent. Debentures	103⅞	106⅞	103⅞	106⅞	4 4 11	January and July	..	..
60,710	£20	3/0	Direct United States Cable, 1877 xd	10½	11½	10½	10¾	6 5 7	Jan., Apr., July, Oct.	11⅛	10⅝
£120,000	100	..	Direct West India Cable 4½% Reg. Deb. (red)	99	102	99	102	..		..	..
400,000	£10	2/6	Eastern xd	17½	18½	17½	17⅝	3 13 3	Jan., Apr., July, Oct.	18⅛	17⅛
70,000	£10	6%	Do. 6 per Cent. Cumulative Preference xd	18½	19½	18	19	3 3 2	" "	—	—
£1,802,616	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	128	131	127	130	3 2 6	May and November	123½	..
£39,900	£100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	..	..
250,000	10	2/6	Eastern Extension	18½	19½	18½	18⅝	3 14 8	Jan., Apr., July, Oct.	19	18⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	128	131	127	130	3 2 0	February & August	..	..
£125,700	£100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	100	103	99	103	4 17 3	January and July	..	..
£120,300	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb.,1900	99	103	99	103	4 17 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures,1909	102	105	102	105	3 16 2	February & August	102	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	107⅞	110⅞	107⅞	110⅞	3 13 9	May and November	—	—
180,227	10	1/9	Globe Telegraph and Trust	11¾	12¼	11½	12	3 19 2	Jan., Apr., July, Oct	11⅝	11½
180,042	10	6%	Do. 6 per Cent. Preference	17½	18	17½	17⅞	3 7 7	" "	17⅛	17⅛
150,000	10	5/0	Great Northern of Copenhagen	29½	3 ½	29½	30⅛	3 5 7	January, April, July	..	..
£160,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	100	103	100	103	4 17 1	March & September	..	..
97,000	100	..	Halifax and Bermuda Cable 4½% 1st Mort. Deb.(red)	95	100	95	100	..	June and December	..	..
17,000	25	12/3	Indo-European	52	55	52	52	4 16 2	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	106	109	106	109	5 10 1	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red) 1942	105	108	105	108	3 13 5	June and December	—	—
11,839	8	4/0	Reuter's	8	9	8	9	4 8 11	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust xd	140	145	138	141	4 5 1	" "	..	..
15,609	10	6/0	West African Telegraph	3½	4½	3½	4½	..	..	—	—
£213,400	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	5 8 5	March & September	100½	—
30,000	10	..	West Coast of America	¼	¾	¼	¾	..	..	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	105	108	105	108	3 14 9	June and December	105	—
88,321	10	1/0	West India and Panama	½	¾	½	¾	..	May and November	..	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	7½	8	7½	7⅞	7 14 10	" "	..	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	7	5	7	8 11 5	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 2	January and July	..	..
64,256	15	3/0	Western and Brazilian	12	13½	11⅞	12½	2 8 11	May and November	12½	12½
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	7⅞	8½	7⅞	8	3 11 11	" "	7⅞	..
33,129	7½	1/6	Do. Deferred Ordinary	4½	5	4½	4⅝	..	" "	4⅝	..
£382,230	—	4%	Do. 4 per Cent. Debenture Stock	106	109	106	109	3 13 9	June and December	103	..
$1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	105	110	6 7 10	Feb., May, Aug., Nov.	—	—
£100,100	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	105	100	106	5 14 3	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	3	3½	3	3½	5 14 4	August	—	—
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16	1/16	1/16	1/16	..	July	..	..
28,000	£5	4/0	Monte Video Telephone 6 per Cent. Preference	2	2½	2 1/16	2½	8 0 0	October	..	..
484,597	5	3/0	National	5½	6	5½	6	5 0 0	February & August	5⅝	5⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	—	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. (fully paid)	15	17	15	17	3 10 7	" "	—	—
210,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref. (fully paid)	5½	6	5½	6	4 3 4	" "	103	101
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	105	100	105	3 7 2	June and December	..	..
171,504	1	0/4	Oriental	⅜	⅝	⅜	⅝	6 13 4	April and October	9/16	..
58,000	5	5/0	United River Plate	4	4½	4	4½	5 11 1	July	4 1/16	—
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105	108	105	108	4 13 6	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
£200,000	5	4½%	Birmingham Electric Supply (fully paid)	10¾		10¾		—	March	..	—
50,000	£10	20/0	City of London Electric Lighting (fully paid)	26	27	21	27	3 14 1	February & August	26⅝	22½
40,000	10	6%	Do. 6% Cumulative Pref. (fully paid)	17½	18½	17½	18½	3 4 10	January and July	17⅝	..
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	129	134	129	134	3 14 3	June and December	..	..
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	13½	14½	13½	14¼	2 8 6	February & August	..	..
20,000	5	2/1	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	..	..
67,500	£100	5%	* Do. 5 per Cent. Debentures (red.)	—	—	—	—	—	January and July	..	..
£26,000	5	3/6	Chelsea Electricity Supply Ordinary	10½	10¾	10	11	3 8 3	March	10½	—
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	115	117	115	117	3 17 5	June and December	—	—
£30,000	£10	..	County of London & Brush Prov. Ord. (fully paid)	14½	15½	14½	15	..	" "	15½	14½
20,000	£10	6%	Do. 6% Cumulative Preference	15½	16	15½	16	3 15 0	March & September	15½	—
10,000	£5	4/0	House-to-House Electric Lighting Supply Ord.	1⅛	11½	10	11	1 13 4	" "	..	..
10,000	£5	3/3	Do. 7 per Cent. Preference	11½	12	11	12	2 18 4	March & September	—	—
111,000	£5	..	London Electric Supply Ordinary	3¾	4½	3½	4½	..	" "	..	..
48,050	£5	..	Do. Preference	6½	7	6½	7	..	" "	—	—
49,900	10	7/0	Metropolitan Electric Supply Ordinary	19½	2½	18	19	3 3 2	April and October	20½	19⅜
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 13 6	June and December	..	..
6,452	10	12/0	Notting Hill Electric Ordinary	2⅛	2	1½	20½	2 18 6	March	20⅜	20 1/16
275,000	1	..	Rand Electric	1½	1⅜	1	1½	..		—	—
£125,000	Stock	5%	River Plate Elec. Lt. Trst'n, Ltd., 5% 1st Mor. Deb.	90	95	90	95	5 6 6		—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares	113	115	113	115	5 10 4		—	—
154,000	100	4½%	* Do. 4½% 1st Mort. Debs.	103	105	103	105	4 5 9	April and October	103½	—
31,980	5	11/0	St. James and Pall Mall Electric Ordinary	17½	18½	17½	18½	3 18 5	February & August	..	—
20,000	5	3/6	Do. 7 per Cent. Preference	10	11	10	11	3 3 6	" "	—	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.	107	110	107	110	3 13 1	June and December	..	—
67,900	5	8/0	Westminster Electric Supply (fully paid)	16½	17½	18½	17½	3 8 9	March & September	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	£3	5%	Brush Electrical Engineering	1⅞	2	1⅝	1⅞	—	—	1⅛	1⅝
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2⅜	4 16 0	—	2⅜	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110	114	110	114	3 13 11	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 3 2	June and December	102½	—
10,000	£10	..	British Aluminium Ordinary	—	—	—	—	—	—	—	—
20,000	10	..	Do 7% Cumulative Preference	—	—	—	—	—	—	—	—
£100,000	£5	4/0	Callender's Cable Construction, Limited, Shares	9	10	9	10	5 0 0	June and December	—	—
£9,000	Stock	4½%	Do. 4½% Mort. Deb. Stock	110	113	110	113	4 0 0	" "	112	—
200,000	1	..	Castner-Kellner Alkali Co. (fully paid)	1	1½	1	1½	—	—	—	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½	—	—	2½	—
£82,850	100	5%	* Do. 5% First Mortgage Debentures (red.)	87	92	83	93	5 9 0	January and July	—	—
99,261	5	1/6	Edison and Swan United ("A" Shares) (£3 paid)	2½	2¾	2½	2⅜	6 0 3	February & August	..	..
17,139	5	2/6	Do. (£5 paid)	4	5	4	5	5 10 0	" "	..	..
£220,500	Stock	33/0	Do. 4% Mortgage Debenture Stock (red.)	103	105	103	105	3 16 2	June and December	..	..
110,000	£2	1/11	Electric Construction Co. (Limited)	2¾	2⅞	2⅝	2⅞	3 13 1	February & August	2 1/16	2⅝
16,343	2	7½	Do. 7 per Cent. Cumulative Pref.	3⅛	3⅜	3⅛	3⅜	4 3 4	August	..	..
91,146	1	10/0	Elmore's Patent Copper Depositing	⅜	½	⅜	½	..		..	..
12,500	10	18/0	Henley's Telegraph Works Ordinary	22	23	21½	22½	5 6 8	February & August	22½	—
2,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	—	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 8	" "	—	—
60,000	£10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21⅞	21½
500,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 14 6	March & September	—	—
87,556	12	24/0	Telegraph Construction and Maintenance	35	38	35	33	4 12 4	March and July	36¾	36
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	102	105	102	105	4 15 8	January and July	..	..
£22,500	£5	4/0	Willans and Robinson Ordinary xd	8	8½	7¾	8½	4 4 10	April and October	8½	—
£22,500	£5	3/0	Do. 6% Cumulative Preference xd	7	7½	7	7½	4 0 0	" "	—	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs.	107	109	107	109	3 19 0	May and November	109	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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